Model CY-50-CA-"D"-"O"
Dual-Chamber, Starved-Air, Oxygen-Controlled Incinerator System

Operating and Maintenance Manual

Westland Environmental Services Inc.
20204 110 Ave. NW
Edmonton, Alberta
Canada T5S 1X8
780 447 5052
info@westlandenvironmental.com

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1 INTRODUCTION

Thank you for selecting Westland Environmental Services Inc. (Westland) to provide you with a reliable, proven and cost-effective system to manage your waste in an environmentally sound manner. This manual has been prepared to allow you to operate and maintain the system safely and efficiently, thereby ensuring its proper operation and continued use for a long period of time.

It also contains information on the combustion process. We believe that understanding the basic principles would make you more knowledgeable, and hence a better operator. Table 1 outlines the contents of this manual, of which Sections 3 and 4 are the required minimum reading.

Table 1 Organization of Manual

Section Number	**Title** Brief Description
2	**Principles of waste incineration** What incineration or combustion process is, why waste is incinerated and the components of a waste, including heating value, and how waste properties affect incinerator operation.
3	**System Description** The components, their designs and their functions are described
4	**Operation and Maintenance** How to operate and maintain the system, including safety equipment to be used.
5	**Manual Mode: Operating the Incinerator without the Control System** How to operate the system when the oxygen control system is out of order.
6	**Warranty** Terms of the warranty

2 PRINCIPLES OF WASTE INCINERATION

2.1 Combustion

Combustion, burning, incineration, and thermal oxidation all denote the same process, which is the reaction of a "combustible" matter with oxygen that occurs at temperatures higher than the ignition temperature [1] of that matter. The reaction is exothermic, meaning that it generates heat in the form of hot gases.

[1] Below the ignition temperature combustion does not take place. Consider, for example, gasoline or wood: it has to be "ignited" for combustion to take place. That is, the temperature in some portion of the matter must be brought up to the ignition temperature for combustion to start.

In the case of waste, it may also contain non-combustible matter which does not react with oxygen. In waste incineration, the non-combustible component ends up as ash and a small portion of it is also present in the hot gas in the form of particulate matter or dust.

Figure 1 shows schematically the process of waste incineration. The oxygen used comes from air, which contains 21% of oxygen by volume, and the hot gas is typically referred to as flue gas or stack gas.

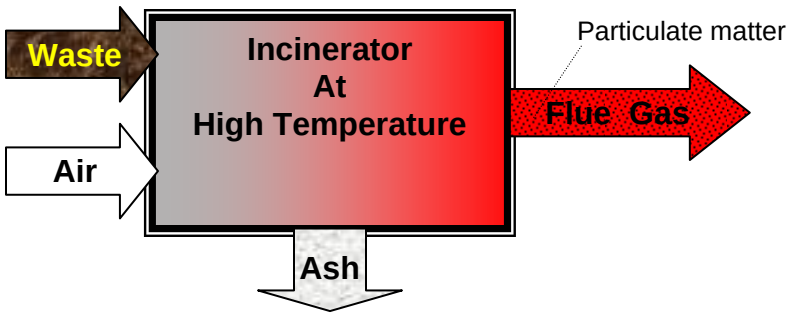

Figure 1 Schematic Diagram of Incineration Process

2.2 Why incinerate waste?

The main purpose is to reduce the mass and volume for final disposal. Another important reason, since the waste may contain pathogenic, infectious or toxic materials, is to "detoxify" it by the high temperature process. In remote areas where wildlife is present, scavenging can be prevented by incineration.

In some cases, typically in large-scale operation, incineration is used to recover the energy contained in the waste in the form of electricity, steam, hot fluids or hot air. In other cases, valuable materials can be recovered from the ash, or the ash as a whole can be used for soil amendment or as a construction material.

2.3 Waste components

There are different ways of characterizing waste, depending on the purpose for doing it. Here, it is sufficient to characterize the components as follows: [2]

A. Water is an important component because in incineration it has to be evaporated first, which requires a lot of energy, [3] which in turn, has the effect of lowering the temperature of the flue gas.

B. Combustible is the component that reacts with oxygen and releases heat in the process. [4] The higher the combustible content in the waste, the more air per kg of waste is needed for incineration.

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[2] This is referred to as proximate analysis. Another method is elemental analysis, which produces the elemental composition (C, H, O, N, S, Cl …) of the waste.

[3] It takes ~ 2.3 MJ (2200 BTU or 90 cc of propane or 60 cc of diesel) to evaporate 1 L or 1 kg of water. This is referred to as the latent heat of evaporation.

This component can be further classified as:
(i) Volatile, which is released to the gas phase when the combustible matter is heated without the presence of oxygen, and
(ii) Fixed carbon which remains in the solid waste after the volatile has been released. This is often referred to as charcoal.

C. Non-combustible is the component that does not react with oxygen. [5] As previously mentioned, this forms ash, and some of it is entrained in the flue gas in the form of particulate matter or dust. The higher the non-combustible content in the waste, the less quantity of waste that can be incinerated without removing ash from the combustion chamber. Note also if the waste contains metals, such as lead and cadmium, these metals will be present in the ash as well as in the flue gas, in the form of particulate matter and vapour.

2.4 Heating Value

Heating value, calorific value and heat of combustion are synonyms that quantify the heat released by the combustible component in the waste upon complete combustion. An understanding of the concept can be gained from the hypothetical processes shown in Figure 2.

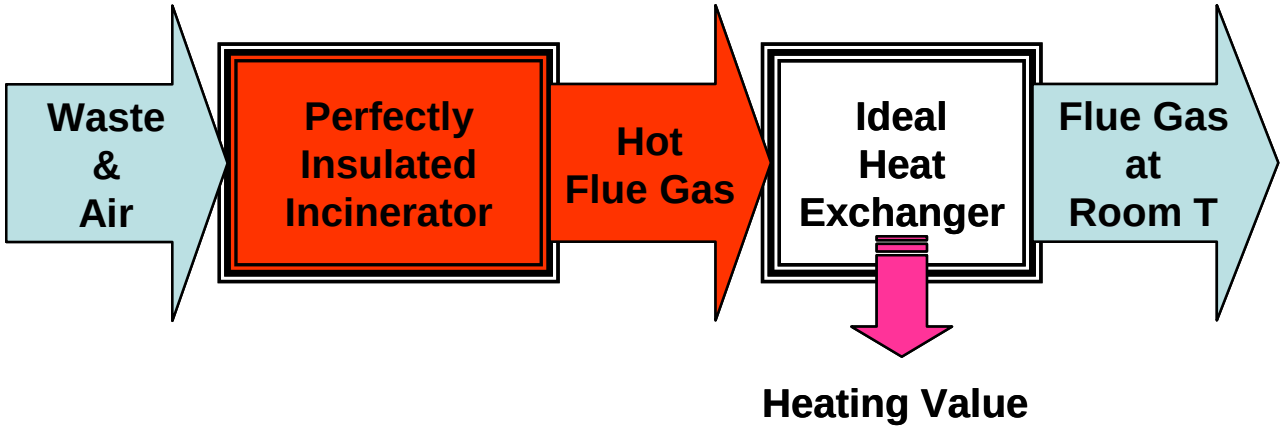


Figure 2 The Concept of Heating Value

A measured mass of dry waste and a sufficient amount of oxygen, at room temperature, are ignited, and the resulting hot flue gas is passed through a heat exchanger, where heat is extracted until the flue gas is brought back to room temperature. Let M be the mass (kg) of the dry waste fed, and H (MJ) the heat extracted from the heat exchanger. The heating value of the dry waste is H/M (MJ/kg).

[4] The term "organic" is also used, which is strictly incorrect in that some "inorganic" elements or compounds are combustible, such as carbon, sulphur, ammonia and carbon monoxide.
[5] The terms "ash" and "inorganic" are also used. Note that the latter is inaccurate as explained previously.

2.5 Different Expressions for Heating Value

Two different values are reported in the literature (a) "high" or "gross", and (b) "low" or "net". The former corresponds to the case where the moisture in the flue gas is condensed, and hence the high or gross heating value *includes* the latent heat of evaporation of the water formed in combustion (see Footnote 3). The latter excludes the latent heat evaporation. The low or net heating value thus represents the maximum available energy that can be recovered from the flue gas without condensation.

To be noted also is the basis on which the heating value is expressed, which can be (a) as fired, (b) dry basis or (c) ash free. The distinction is illustrated in Figure 3. An understanding of the different bases can be gained by noting that heating value is a property of only the combustible component in the waste. Water and the non-combustible component simply "dilute" the heating value. In terms of incinerator operation, the relevant basis is "as fired".

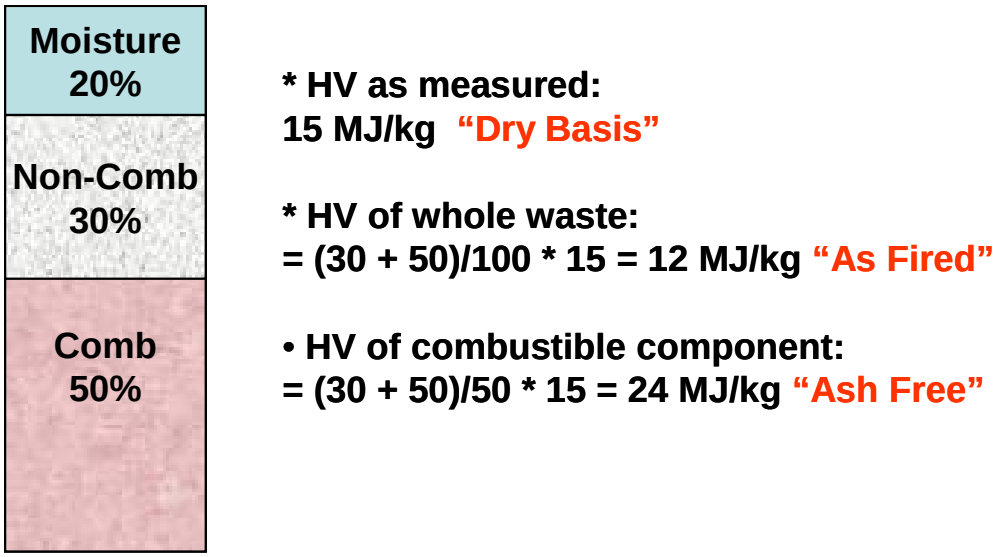


Figure 3 Different Bases for Expressing Heating Value (HV)

2.6 Examples of waste characteristics

Proximate compositions and heating values of commonly found wastes are given in Table 2.

Table 2 Classification and Properties of Common Wastes

Type*	Description	Components	Weight %			MJ/kg
			Moist	Comb	Non-C	HHV (A/F)
0	Trash	Paper, cardboard, cartons wood boxes and combustible floor sweepings from commercial and industrial activities. Up to 10% by weight of plastic bags, coated paper, laminated paper, treated corrugated cardboard, oily rags and plastic or rubber scraps.	10%	85%	5%	19.7
I	Rubbish	Trash + Type 3 (up to 20%)	25%	65%	10%	15
2	Refuse	Rubbish and Garbage	50%	43%	7%	10
3	Garbage	Animal and vegetable wastes, restaurants, hotels, markets, institutional, commercial and club sources	70%	25%	5%	5.8
4	Animal/ Pathological	Carcasses, organs, hospital and laboratory, abattoir, animal pound, veterinary sources	85	10	5	2.3

Notes:
Moist = moisture, Comb = Combustible, Non-C = Non-combustible, HHV = High Heating Value, A/F = As Fired
* In some cases Roman numerals are used. That is Types 0, I, II, III and IV

2.7 Incinerator Capacity and Load Size

Incinerator capacity is dependent on waste composition. For a given mass, the amount of air required for complete combustion increases with increasing heating value. Hence, for a given incinerator which delivers a given flow rate of combustion air, its capacity for waste burning in kg/h decreases with increasing heating value of the waste, or to put it in opposite way, it, increases with decreasing heating value.

Another important consideration is the size of the batch loaded to the incinerator. The higher the heating value, the smaller (lighter) the load should be. Otherwise, the insufficient amount of air will generate black smoke.

Unfortunately, waste composition is usually not known. Nevertheless there may be indications on the basis of the components present. To assist in getting a qualitative estimate of the heating value of a batch of waste, the heating values of common "generic" waste components are shown in Table 3.

Table 3 High Heating Values (Approximate) of Common Waste Components

Component	MJ/kg A/F *	Component	MJ/kg A/F *
Kerosene, Diesel …	44	Leather	16
Plastics	46	Wax paraffin	44
Rubber, Latex	23	Rags (linen, cotton)	17
Wood	18	Animal fats	39
Paper	17	Citrus rinds	4
Agricultural waste	17	Linoleum	25

* A/F: As Fired

Another important waste component is the volatile content in the waste. Table 4 shows the proximate components of various materials and wastes.

In general, this component is responsible for smoke generation. Therefore, as in the case with heating value, the higher the volatile content, the smaller the load that should be charged to the incinerator.

Table 4 Proximate Composition of Various Materials

Material	Volatile	Moisture	FC	Ash	FC/V
	%wt	%wt	%wt	%wt	-
Coal (bit.)	30	5	45	20	1.5
Peat	65	7	20	8	0.3
Wood	85	6	8	1	0.1
Paper	75	4	11	10	0.15
Sewage sludge	30	5	20	45	0.66
MSW	33	40	7	20	0.21
RDF	60	20	8	12	0.13
PDF	73	1	3	13	0.04
TDF	65	2	30	3	0.46
PE,PP,PS	100	0	0	0	0
Plastics + Colour	98	0	0	2	0
PVC	93	0	7	0	0.08

Notes: **FC** : Fixed Carbon; **FC/V**: Ratio of Fixed Carbon to Volatile
(bit: bituminous; MSW: municipal solid waste; RDF: refuse derived fuel; PDF: packaging DF: TDF: Tire DF; PE: polyethylene; PP: polypropylene; PS: polystyrene; PVC: polyvinyl chloride)

3 SYSTEM DESCRIPTION

3.1 Nomenclature for Different Models

This series of incinerator is designated by

CY-(nn)-CA-(x)-O

where **nn :** a number denoting the nominal capacity of the incinerator in kg/h;
x : a letter denoting the auxiliary fuel used, denoted as follows:
D for diesel; **P** for propane and **N** for natural gas

For example, **CY-100-CA-D-O** denotes a 100 kg/h unit using diesel as auxiliary fuel.

3.2 Overview [6]

Regardless of the model of your incinerator, the main components are similar. Figure 4 shows a schematic diagram of the incineration system. It consists of a **Primary Chamber** and a **Secondary Chamber**, which are connected by a "flame-port". Combustion air to the

[6] **Bolded words** correspond to those used in Figure 4

primary chamber is delivered by the **under-fire air blower,** and to the fame-port by the **flame-port air blower**. **Aux**iliary **burners** are provided for start-up and to maintain the minimum temperatures set in the primary and secondary chambers.

Thermocouples are used to measure the temperatures in the primary and secondary chambers, the outputs of which are used by on-off **Omron controllers** which regulate the operation of the auxiliary burners.

The oxygen concentration in the secondary chamber is measured by an **oxygen probe**, the output of which is used by a programmable logic controller (**PLC)** to regulate the flows of the under-fire and flame-port air. This control minimizes the occurrence of black smoke generation, and will ensure that black smoke is not generated provided the size of the waste load is not too large. The PLC also informs the operator when the combustion of a batch has been completed, and hence the next batch can be charged.

Waste is charged manually and intermittently via the **waste charging door (1),** and ash is removed manually and batch-wise after previous operation via the **ash removal door (2).** This door is also used to rake the waste in the primary chamber after several loads have been charged, which is necessary to expose the fixed carbon component in the waste to the under-fire air.

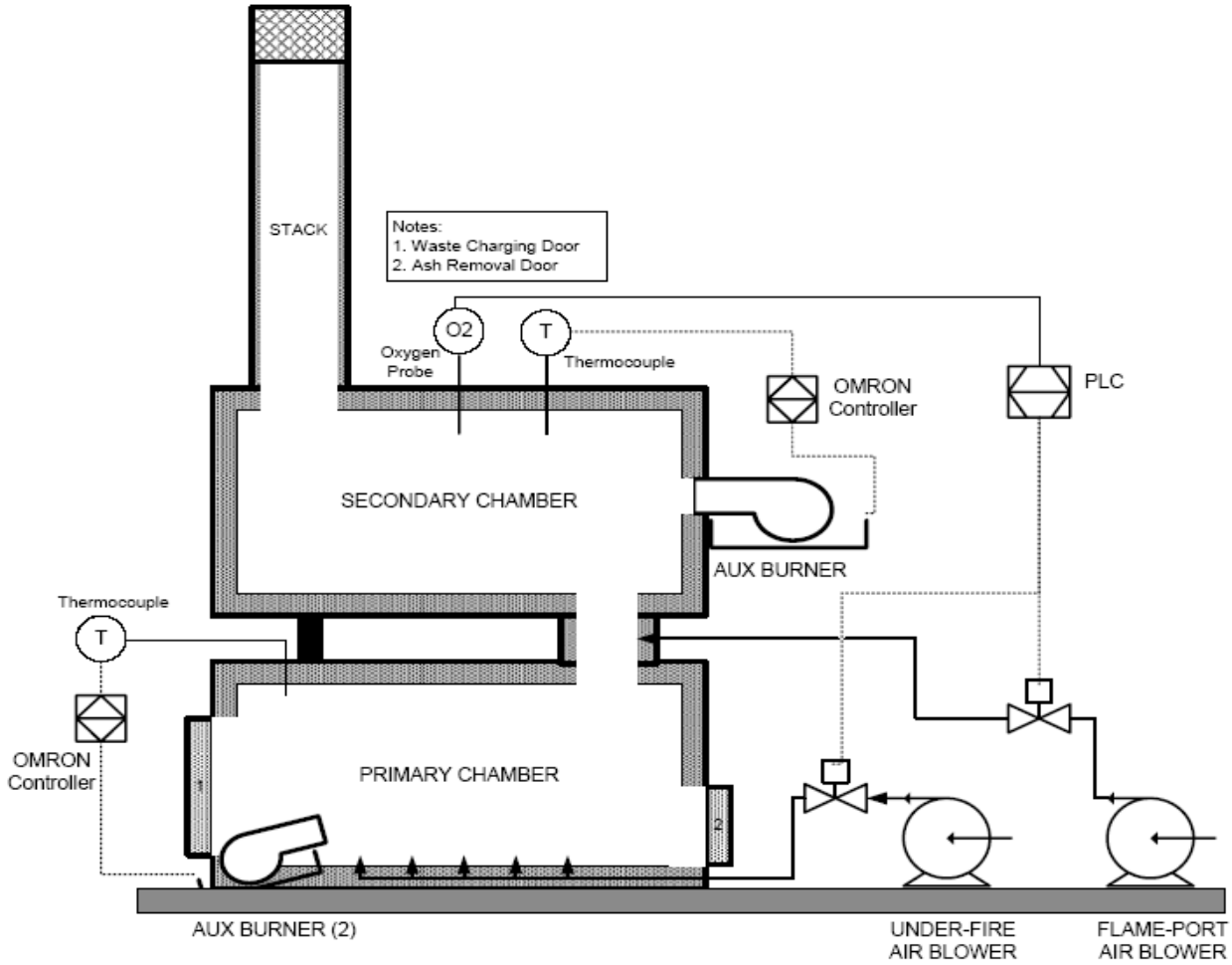


Figure 4 Schematic of the Incineration System

3.3 Description of system components

For convenience, the system has been grouped into sections, as shown in Figure 5. In each section, the components are shown in subsequent photographs. Each component is coded with a number and a prefix corresponding to the section to which it belongs. *These codes are unique and will be used in later sections on operation, maintenance and trouble shooting.* The following Tables contain all the components in the system, their codes and brief descriptions of their functions.

Information on components that are not manufactured in-house, such as blowers and burners, is given in the accompanying binder. Please consult the corresponding manuals for details of operation and maintenance.

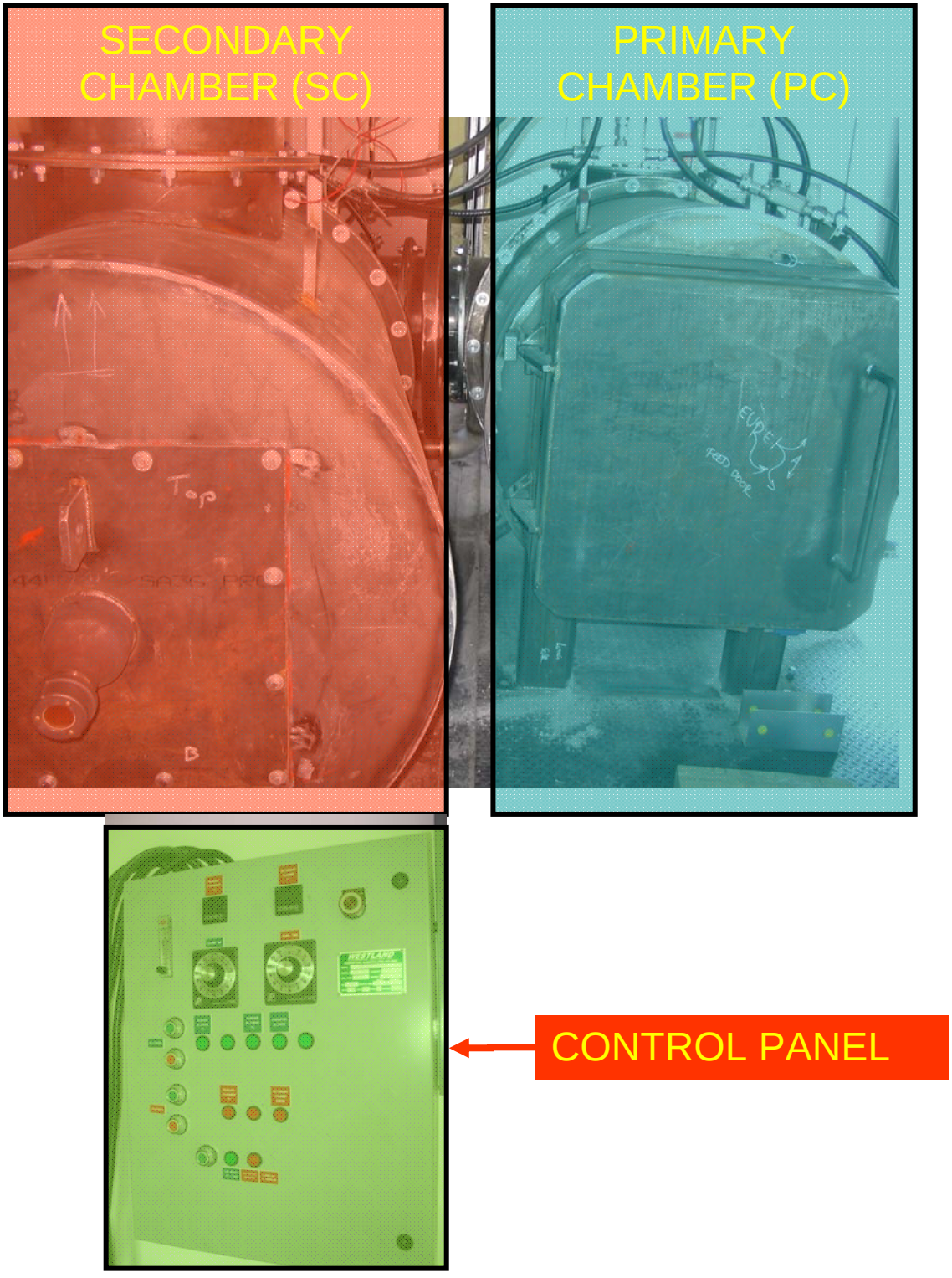


Figure 5 View of the Incinerator Sections

3.4 Primary Chamber Section

The components are listed in Table 5, and the photographs are shown in Figure 6 and Figure 7.

Table 5 Components in the Primary Chamber Section

Code	Component	Description	Function
PC1	Primary Chamber	In-house made. Inside Vol: 0.57 m^3 Refractory: 10.8 cm; Insulation 5.1 cm	Pyrolysis and gasification Combustion of fixed carbon
PC2	Charge Door	In-house made. Door opening: 67 cm in diameter	Load waste to primary chamber
PC3	Ash Door	In-house made. Door opening: approximately 67 cm x 40 cm	Raking and ash removal
PC4a	Contact Switch	SquareD ZCKJ1H7	Turn off primary chamber burner when charge door is opened
PC4b	Same as PC4a for ash door		
PC5	Auxiliary Burner	Becket WIC-201; 630,000 Btu/h; 4.5 USG/h	Start-up and maintains a minimum temperature
PC6	Under-fire Air Blower	AMU 245	Combustion air supply to primary chamber
PC7	Butterfly Valve	V51E-1075	Regulate under-fire air flow
PC8	Actuator	Neptronics BBMF 2000A	Adjust position of butterfly valve
PC9	Under-fire Plenum	In-house made	Distribute under-fire air in primary chamber
PC10	Thermocouple	Wika (sheathed)	Measure temperature in primary chamber

3.5 Secondary Chamber Section

The components are listed in Table 6, and the photographs are shown in Figure 6 to Figure 7.

Table 6 Components in the Secondary Chamber Section

Code	Component	Description	Function
SC1	Secondary Chamber	In-house made. Inside Vol: 0.84 $m^{3,}$ Refractory: 10.8 cm; Insulation 5.1 cm	Combustion of combustible gases and soot generated in primary chamber
SC2	Flame-port Plenum	In-house made.	Mixing of combustible gases and flame-port air
SC3	Flame-port Air Blower	AMU 400	Combustion air supply to flame-port plenum
SC4	Butterfly Valve	V51E-1075	Regulate under-fire air flow
SC5	Actuator	Neptronics BBMF 2000A	Adjust position of butterfly valve
SC6	Thermocouple	Wika (sheathed)	Measure temperature in secondary chamber
SC7	Oxygen Probe	Marathon	Measure oxygen concentration in secondary chamber
SC8	Auxiliary Burner	Becket WIC-201; 770,000 Btu/h; 5.5 USG/h	Start-up and maintain minimum set temperature
SC9	Sight glass	In-house made	Observation of secondary chamber
SC10	Stack	In-house made	Dispersal of flue gas

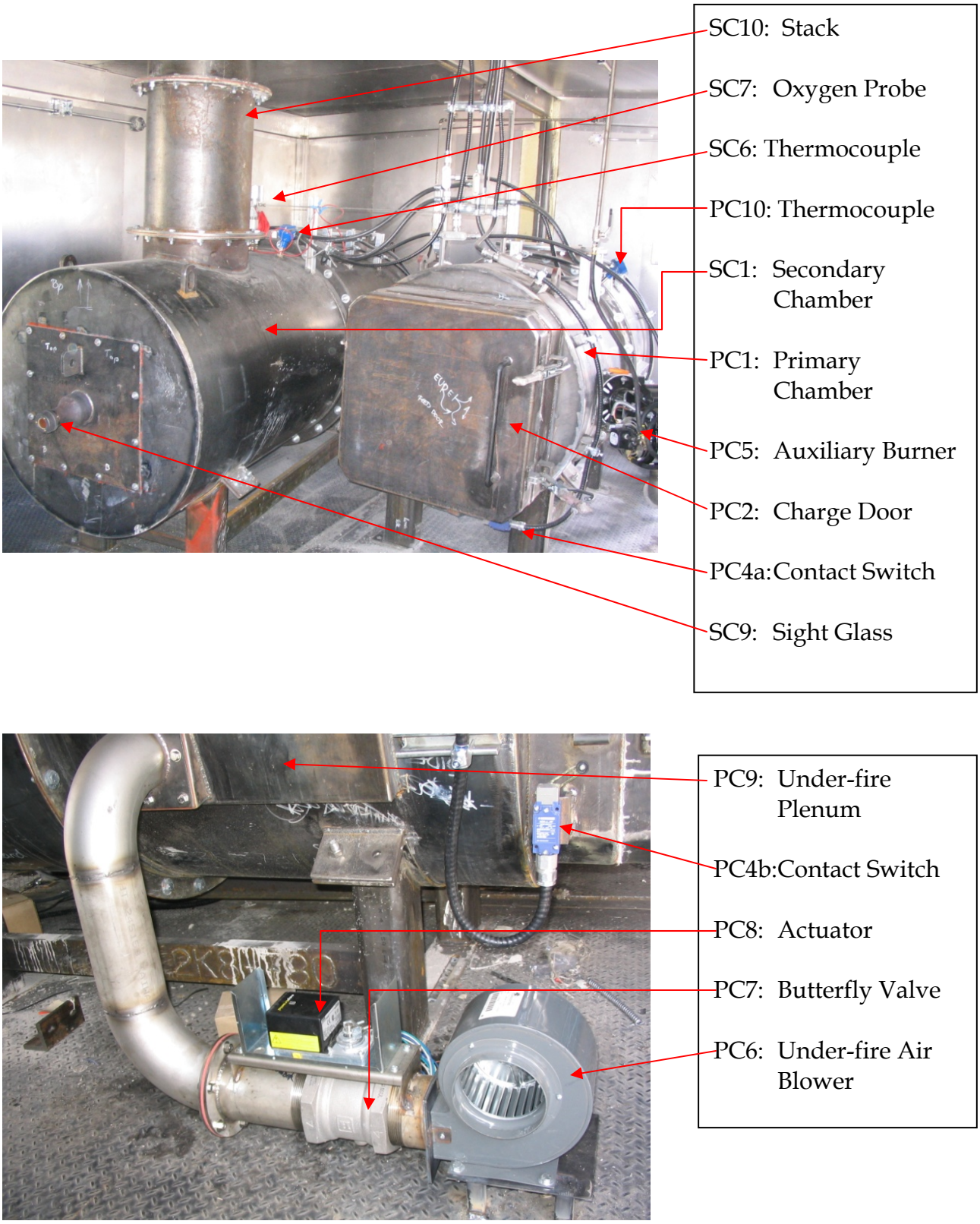


Figure 6 Components in the Primary and Secondary Chamber Sections (1)

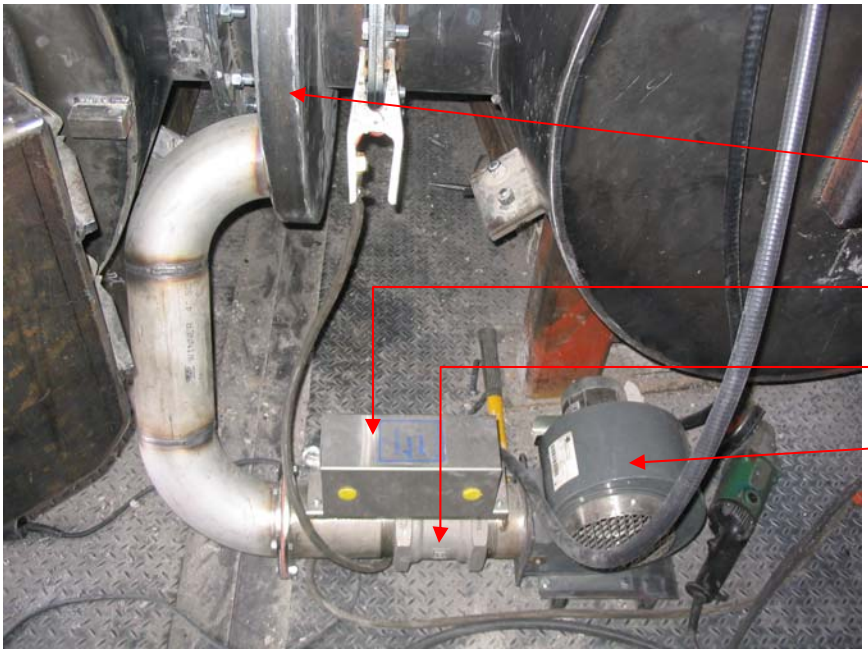


Figure 7 Components in the Primary and Secondary Chamber Sections (2)

3.6 Control Panel Section

The components are listed in Table 7. Figure 8 shows a photograph of the whole control panel, which has been divided into sub-sections marked A, B, C, D and E, each of which is shown in Figure 9 to Figure 11

Table 7 Components in the Control Panel Section

Code	Label	Function
Sub-Section A: Indicating Lights (ON_OFF). Figure 9		
CP1	Burner Blower #1 and #3	#1: Motors for burners in primary chamber: PC5 #3: Motor for burner in secondary chamber: SC8
	Under-fire Blower Flame-port Blower	Under-fire air blower: PC6 Fame–port air blower: SC3
CP2	Primary Chamber Secondary Chamber	Flames in auxiliary burners indicated on the labels
Sub-Sections B and C: Main Controller and Controllers for Burners and Blowers. Figure 10		
CP3	Blower Timer Burner Timer	Turn to connect power to blowers and burners for the specified time periods
CP4	Blowers Start and Stop Burners Start and Stop	Turn ON and OFF all blowers or burners while time has not expired in Timers CP3 (Note: These buttons are inactive when the timers are OFF, that is, at zero time)
CP5	Oxygen Probe Air Flow Rotameter	Adjust to 40 cc/min.
Sub-Section D: Omron Temperature Controllers and Indicators. Figure 11		
CP6	Primary Chamber T.C. Secondary Chamber T.C.	Temperature displays and control of minimum temperatures in primary and secondary chambers by setting adjustable set points (OMRON E5CN)
CP7	E-STOP	Emergency stop: ▪ Push to activate: disconnects main power ▪ Twist right to connect main power
Sub-Section E: PLC Indicating Lights and Control Button. Figure 11		
CP8	Red Indicating Light	▪ FLASHING: PLC is NOT ready since temperature is too low for oxygen probe ▪ ON: PLC is ready
CP9	Green Indicating Light	▪ ON: Combustion from previous batch is complete: READY to load a new batch ▪ OFF: Combustion is taking place. Do NOT load. Wait.
CP10	Green Button	PRESS *immediately* after a loading: Activates PLC control

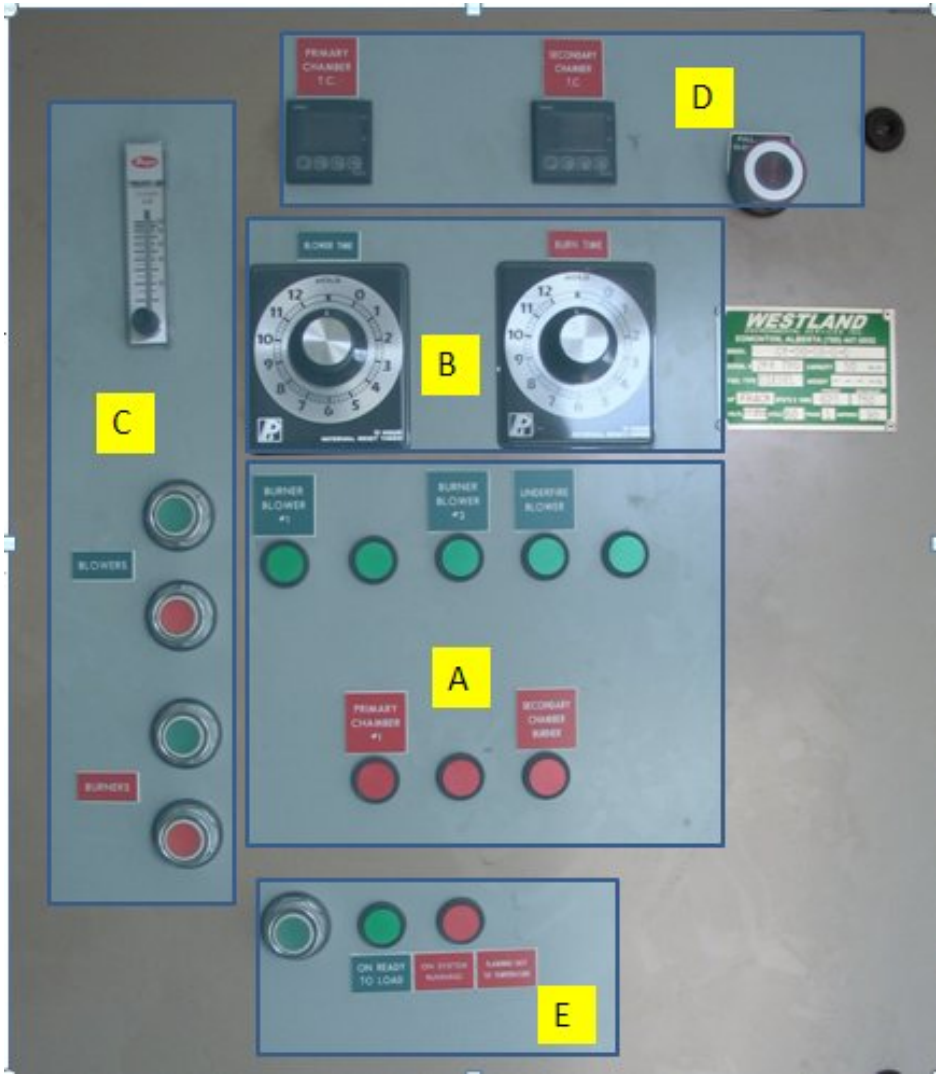


Figure 8 Overview of Control Panel, showing the Different Sections

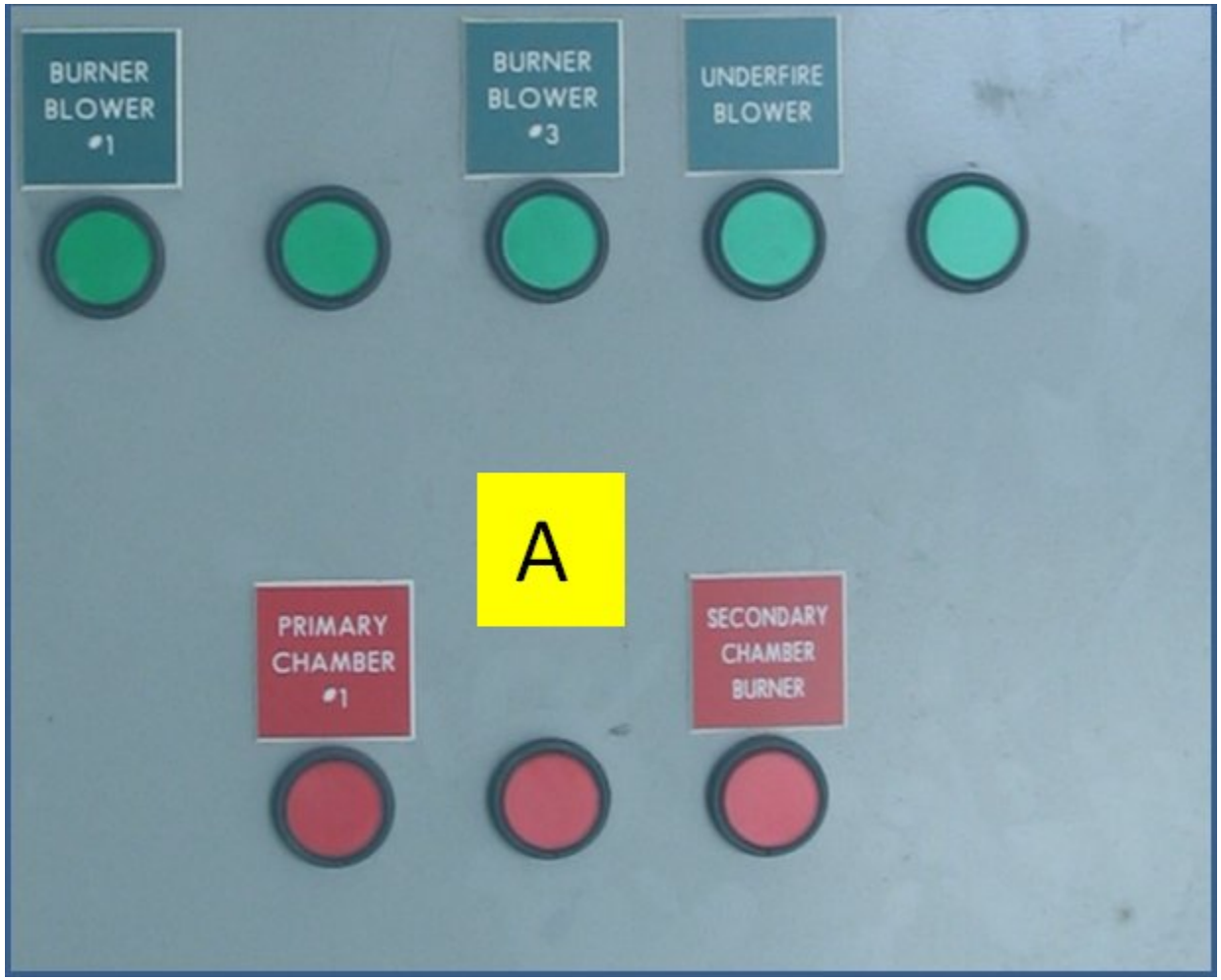


Figure 9 Sub-Section A: Indicating Lights
[CP1 and CP2 in Table 7]

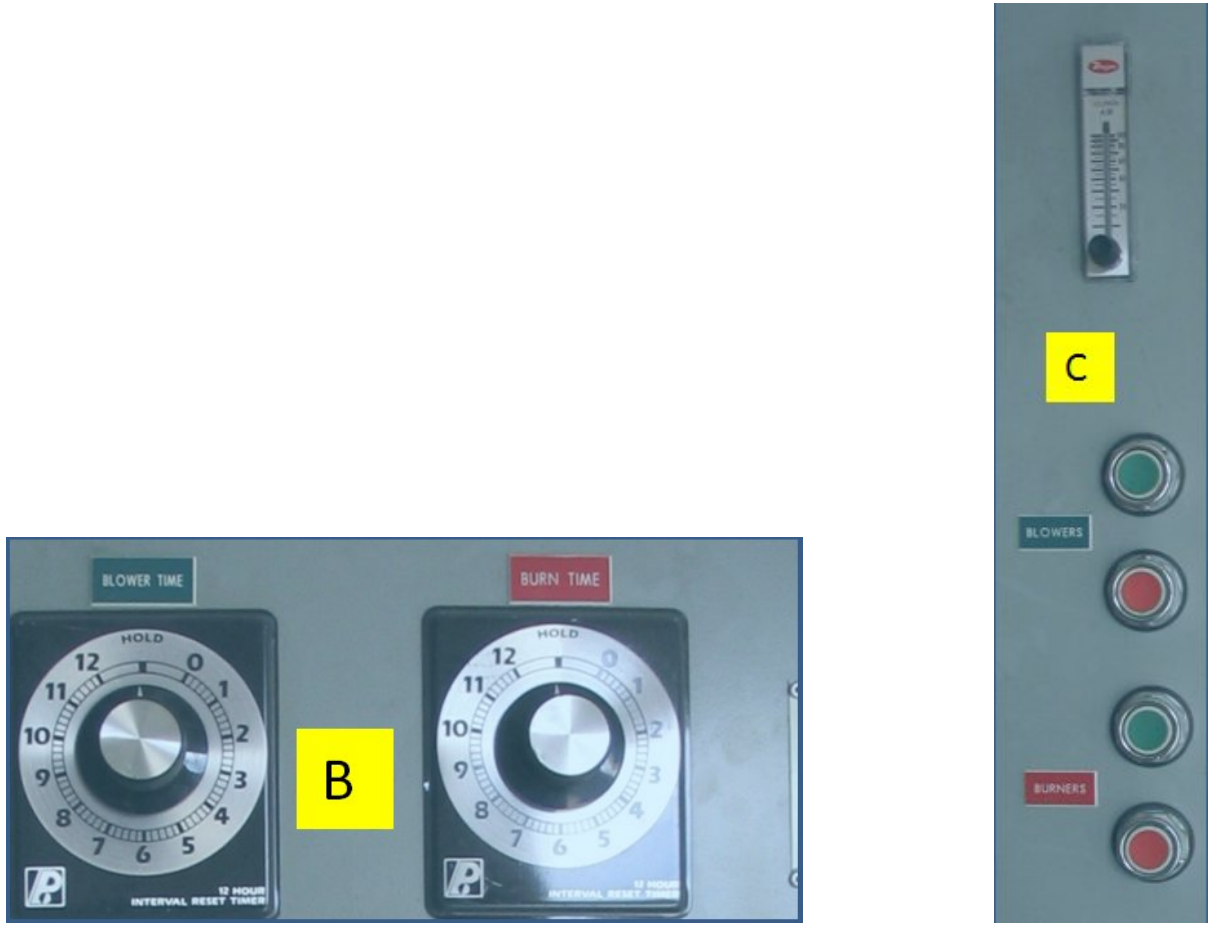


Figure 10 Sub-Sections B and C: Controllers for Burners and Blowers
[CP3, CP4 and CP5 in Table 7]

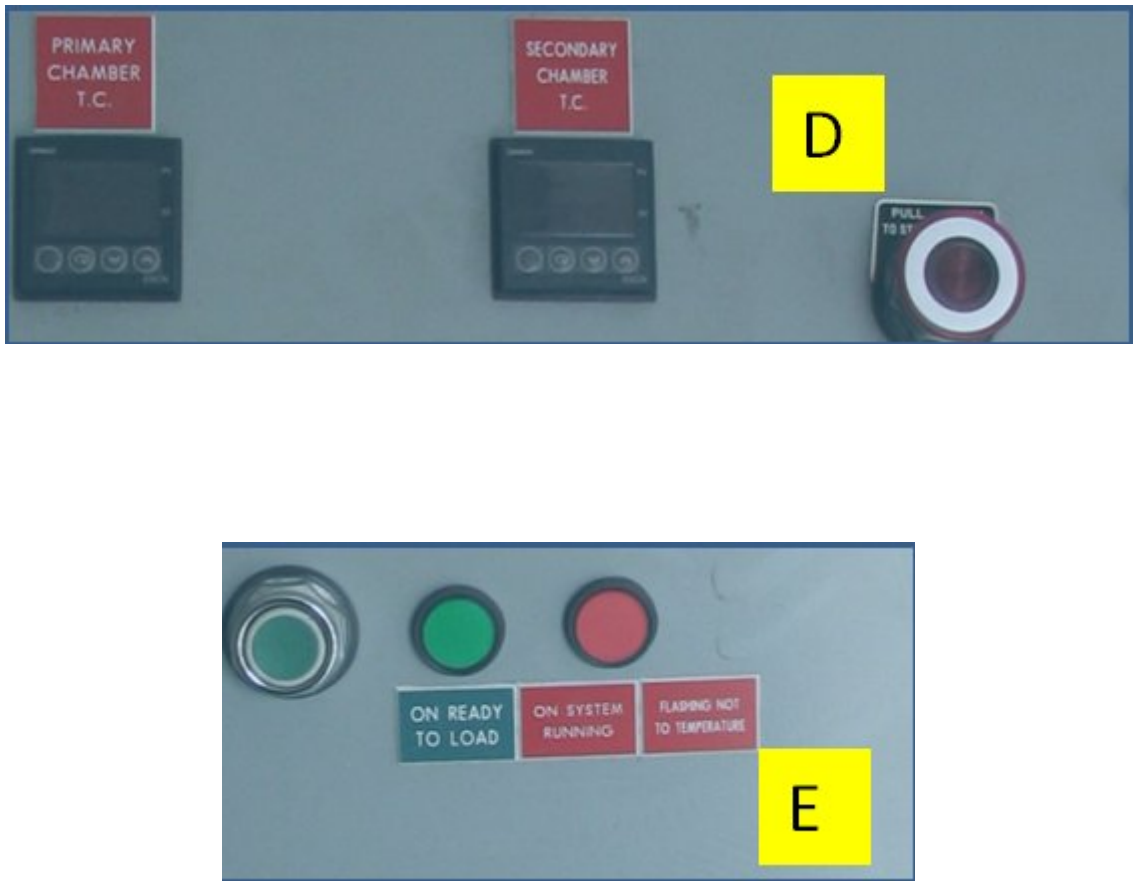


Figure 11 Sub-Section D: Temperature Controllers; E: PLC Indicating Lights and Control Button
[CP6 to CP10 in Table 7]

4 OPERATION AND MAINTENANCE

The operation of the incinerator can be described by distinct sequential steps as shown in Figure 12. In addition there are additional necessary steps which involve safety, routine inspection and waste batch preparation, which will be first described.

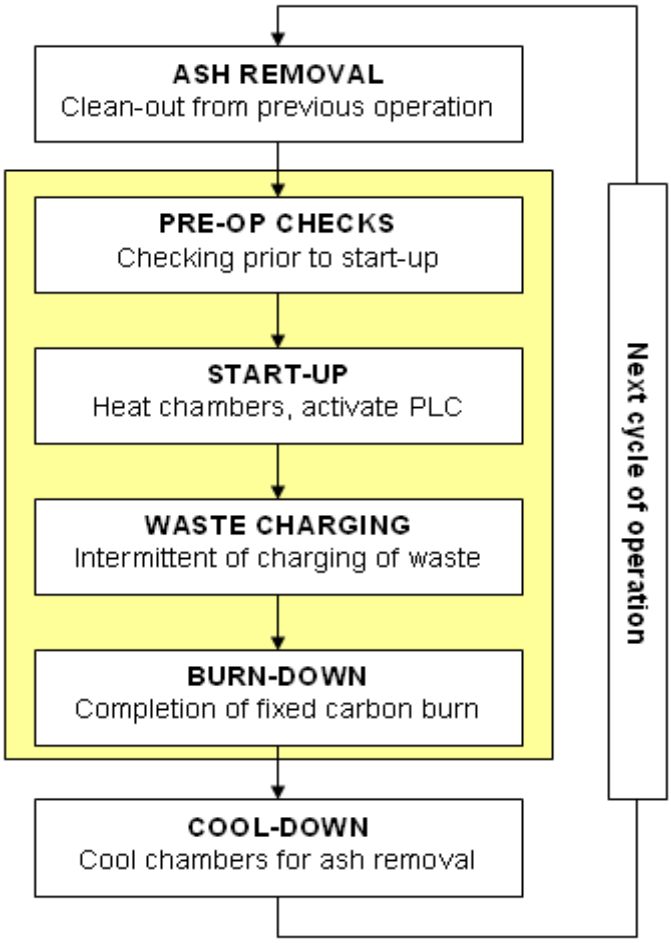


Figure 12 Steps in the Operation of the Incinerator

4.1 Safety equipment and protocol

The following personal protective equipment should be used while operating the incinerator system:

- Long sleeved shirt and long pants;
- Long cuffed, puncture resistant gloves;
- CSA approved, Grade 1 safety footwear;
- CSA/ANSI approved safety glasses.

The personal protective equipment related to specific tasks is listed below:

- Ash removal and handling: NIOSH N85 respirator

- Waste charging: (i) heat protective clothing and gloves, and (2) CSA/ANSI approved full face shield.

The hazards that could be encountered arise from the following (not in any order of importance):

- Contact with waste (infectious or toxic components, or sharps);
- Exposure to heat, from contact with hot surface or radiation from the primary combustion chamber when the waste charging door or ash removal door is opened.

Therefore, the general precautionary actions include:

- Not opening waste batches
- Not touching hot surfaces, and minimum exposure to heat radiation through open doors (charging and ash doors while combustion is taking place).
- Wearing appropriate personal protective equipment for charging waste and raking the primary chamber, AND minimize the time for those tasks.

4.2 Routine inspection and maintenance

- Check fuel lines for leak and check connections
- Check spark arrestor to ensure no plugging
- During ash removal (see later section):
  - Inspect refractory for large cracks (not expansion cracks)
  - Check combustion air hole for plugging
  - Inspect door gaskets for damages

4.3 Waste batch preparation

The following cautionary notes should be followed:

- **NO** explosives, aerosol cans or sealed containers containing combustible liquids
- Make sure that every batch can go through the waste charging door easily, regardless of its weight. If others prepare the batches, the operator should tell them about the maximum batch size.
- Do not open batches and "rearrange" the contents.

4.4 Ash removal

Typically the ash from previous operation was left to cool, and ash removal is done first prior to current operation.

- Make sure combustion chamber is sufficiently cool. [7]
- (Do **NOT** spray water into the combustion chamber)
- While removing ash, avoid plugging the combustion air holes and damaging the burner tip
- Use non-combustible container

[7] The use of a "remote" thermometer is recommended to check the temperatures in the various places in the primary chamber.

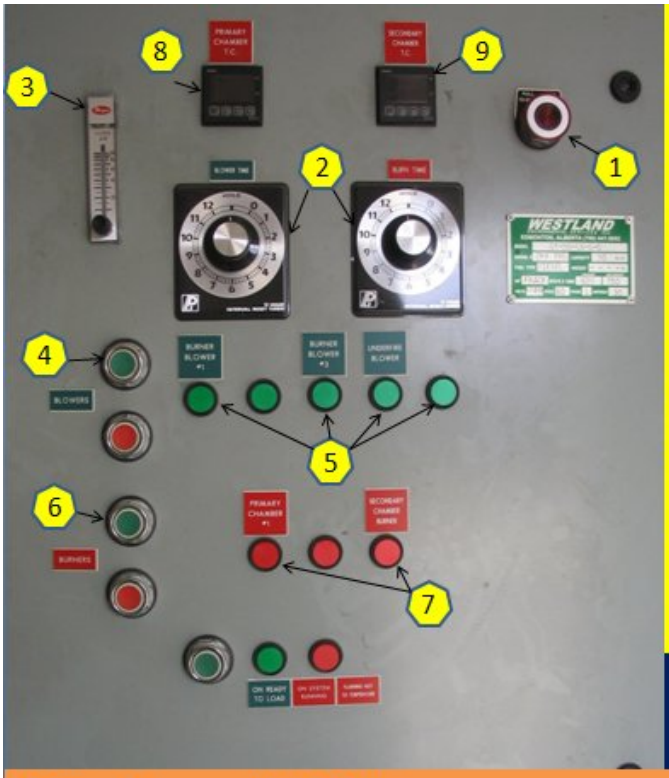
- Minimize dust generation
- Light water spraying on ash in the container is recommended to minimize dust generation
- Dispose of ash as specified in the guidelines or regulations

4.5 Pre-operational checks

- When diesel or propane is used: check fuel tank to make sure enough fuel (see Figure 16 for estimates of fuel consumption, depending on burner size and length of operation)
- Open fuel valve
- Re-check that the combustion chamber is empty and combustion air holes are clear
- Check power connection
- When diesel is used, bleed the diesel lines to the burners if necessary

4.6 Start-up: see Figure 13

Note: Temperatures in Steps 8 and 9 may be regulated: If so, SET TO THE REGULATED VALUES



1. Twist E-STOP to the right to connect main power (button will pop up).
2. Turn BLOWER TIMER and BURNER TIMER clockwise for the intended period of operation.
3. Set oxygen probe air flow rotameter to 40 cc/min.
4. Push START button for BLOWERS.
5. Check all BLOWER INDICATOR LIGHTS are on.*
   Wait for one minute or more.**
6. Push START button of BURNERS.
7. Check that all BURNER INDICATOR LIGHTS are on.*
8. Check set point of PRIMARY CHAMBER TEMPERATURE and adjust to 700 C if necessary.***
9. Check set point of SECONDARY CHAMBER TEMPERATURE and adjust to 900 C if necessary.***

START-UP DONE

Notes: * Report Error.
** Burner can only be started after blowers are on for at least one minute.
*** Consult instrument manual in the appendix of this manual.

Figure 13 Procedure for Start-Up

4.7 Waste charging: see Figure 14

PRE-CHARGING CHECKS

1. If Light Indicator 3 is flashing, the PLC is NOT ready. WAIT.
2. If Light Indicator 2 is on steady, then check that the temperatures in the Primary Chamber and Secondary Chamber are up to the set points.
   a) If 2 is not steady, wait until the chamber temperatures are at the set points.

WASTE CHARGING

1. Confirm that Light Indicator 2 is on steady.
2. Open Charging Door, quickly load the batch and close door.**
3. ***IMMEDIATELY*** push Button 1. This activates the PLC.
4. Check that Light Indicator 2 is off.*
5. Wait until Light Indicator 2 is on again. This indicates that the system is ready for the next batch.***
6. Repeat STEPS 2 to 5 for three or four loads, then go to STEP 7.
7. Open Ash Door or Charging Door, rake the waste and close the door.
8. ***IMMEDIATELY*** push Button 1 and wait until Light Indicator 2 is off.***
9. Repeat STEPS 2 to 8 until the last waste batch is charged.

WASTE CHARGING DONE

Notes:
- * Report Error.
- ** This is very hazardous; see safety notes.
- *** The time varies.

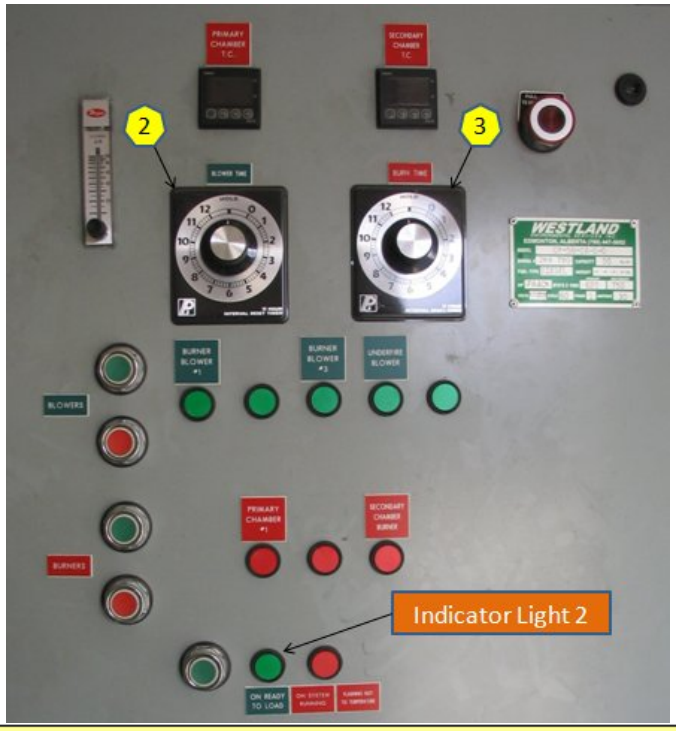
Figure 14 Procedure for Waste Charging

Additional Notes to Figure 14:

** : The main danger is from exposure to heat radiation, and the waste batch catching fire before it is inside the primary chamber. Precautionary steps include: (a) Wear proper PPE, (b) Make sure waste batch can go through the charge door easily, (c) open door, charge waste and close door as quickly as possible.

*** : The time for complete combustion varies, depending on batch size, weight and composition. More than 30 minutes would be unusual. Check burning conditions from ash door or charge door. Rake if necessary [Note Step 8 above].

4.8 Burn-Down: see Figure 15



When the LAST batch has been charged, and the indicator light 2 is ON (steady) , indicating readiness for the non-existent batch:

1. **Rake primary chamber.**
2. **Turn BLOWER TIMER to ~ 3 hours ***
3. **Turn BURNER TIMER to 0.5 to 1 hour**
4. **Wait.**
5. **When burner time period has elapsed, then shut down fuel valve.**

BURN-DOWN DONE

Note: * : The actual time depends on how much and what kind of waste has been charged. The rule-of-thumb is

Burn-Down Time (hours) = 1 + Waste Charging time (hours)/ 3

Figure 15 Procedure for Burn Down

4.9 Cool-down

There is nothing to be done here, except ensuring that the incinerator is sufficiently cooled (approximately 6 – 8 hours) for the scheduled ash removal for the next operation.

4.10 Maintenance and Inspection

In addition to the routine inspection and maintenance previously mentioned, only the burner(s) and the blower(s) require maintenance, which is quite minimal; see manuals in the binder. The following inspection steps are recommended:

Table 8 Recommended Inspections

How Often	Component	Inspection and checking
Daily	Thermocouples PC10 and SC6	Check readings of CP6, Figure 11 that they are "close" to the estimated temperatures of the primary and secondary chambers
	Contact switches PC4a and PC4b	Free movement, no obstruction
	Gasket/seal in charge and ash door PC2 and PC3	Wear and tear; proper seating
	Actuators PC8 and SC5	Observe free movement while waste is burnt. PLC action is typically as follows: a. PC8 at minimum for a few minutes, while SC5 goes up (and down); b. PC8 starts to ramp c. SC5 goes to a minimum d. PC8 goes up and down, then to minimum
	Refractory and under-fire air holes in primary chamber PC1	No large (not expansion) cracks; repair if necessary No plugging of air holes; clean if necessary
Weekly	Air blowers PC6 and SC3	Inspect clean in-takes, clean if necessary
Monthly	External surfaces of PC1 and secondary chamber SC1	"Spotty" discoloration may indicates damage to refractory and/or insulation
	Refractory in SC1	No large (not expansion) cracks; repair if necessary

4.11 Trouble Shooting

Table 9 shows a list of operational problems that may be encountered, the possible causes and corrective measures. No list can cover all potential problems. Please report problems or unusual observations, even if you have solved them yourself. Thanks.

Table 9 Trouble Shooting Guidelines

Observation	Possible Causes	Corrective Measures
Auxiliary burner PC5 or SC8 not lit	No fuel	▪ Fuel tank is empty: fill ▪ Pump not primed: prime
As above, and also blowers PC6 and SC3	No power	E-stop disconnects main power: twist right
Waste not igniting (temperature in primary chamber plummets	Auxiliary burners PC5 not functioning	▪ See above ▪ Check set point: too low? Increase it.
Flame pattern in burner not correct: "lazy", sooting or detached flame	Burner setting	▪ Consult manual and correct

4.12 Auxiliary Fuel Consumption Rate

Figure 16 shows the volumetric flow rates of propane and diesel as a function of burner rating. If the TOTAL burner rating is X million Btu/h, and the operating time from start-up to the end of burn-down is t hours, the maximum fuel needed is:

$$V = Y * t \quad USG$$

where Y is the fuel consumption rate for X million Btu/h rating, as shown in the graph.

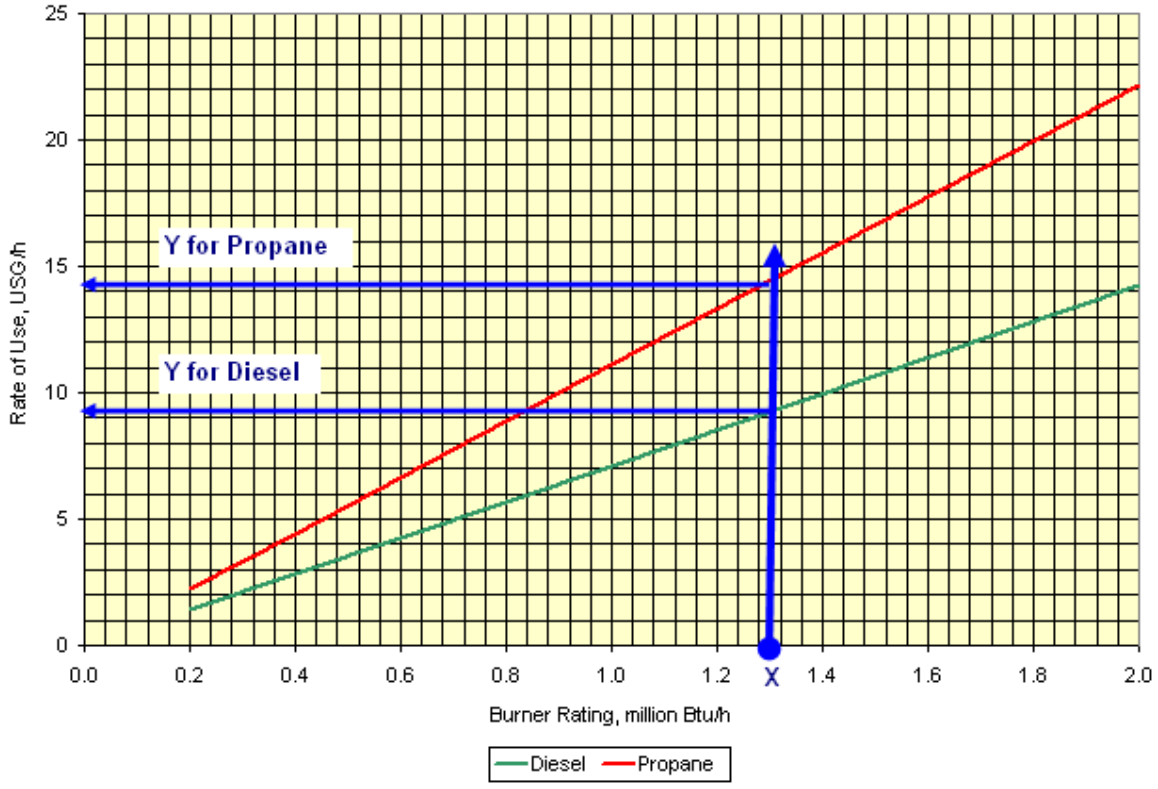


Figure 16 Consumption Rates of Propane and Diesel

5 MANUAL MODE: OPERATING THE INCINERATOR WITHOUT THE CONTROL SYSTEM

The schematic in Figure 4 shows the oxygen control system and how the oxygen probe in the secondary chamber, the PLC, and the under-fire and flame-port air valves are linked. In the event that the incinerator's oxygen control system becomes inoperable due to either a loss of signal from the oxygen probe, SC7, or a failure of the 24 volt power supply that powers the oxygen control system, the incinerator can be temporarily modified to allow operation to continue in a "manual mode" until the appropriate repair(s) is made.

Manual mode operation does not affect the control of the primary and secondary chamber temperatures; however, the ability of the control system to indicate to the operator that a new waste batch can be loaded, as described in STEP5 on Figure 14, will be lost. Visual inspection of the waste in the primary chamber, via the feed door or ash door, will be required to determine when a new waste batch can be loaded. This will be further discussed in Section 5.2.

In manual mode, the under-fire air flow into the primary chamber through the under-fire butterfly valve is at a low rate (10% open), and the flame-port air flow into the secondary chamber is at maximum. That is, the butterfly valve **PC7** is set at 10% open and butterfly valve **SC4** is set at 100% open.

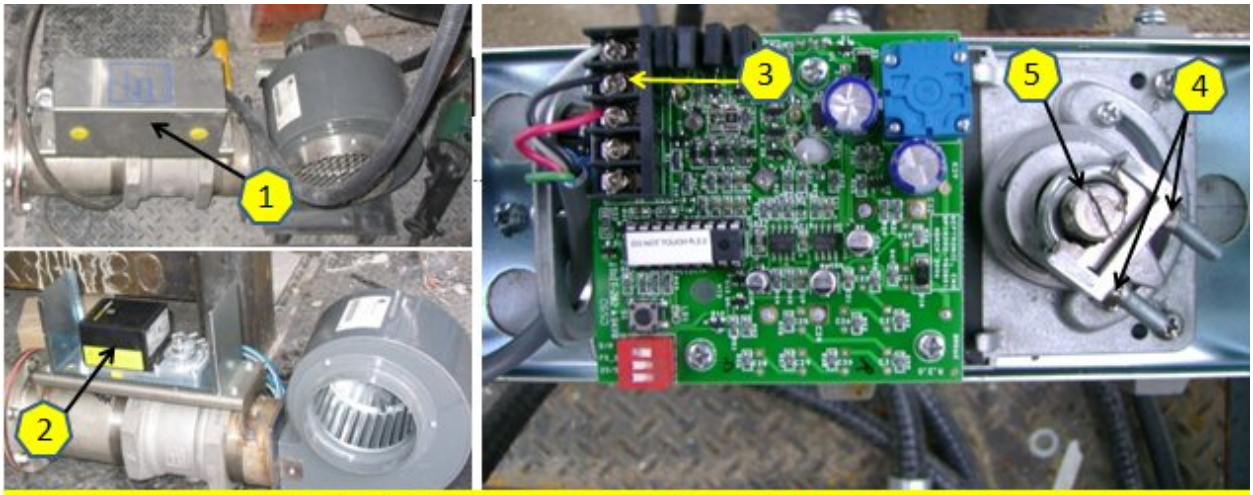
Section 5.1 below describes the mechanical modifications to the incinerator for manual mode operation. Section 5.2 describes the changes to the operational procedure needed for running the system in manual mode.

5.1 Butterfly Valve Adjustments for Manual Mode Operation

As indicated above, physical modification to the incinerator system to accommodate operation under manual mode is necessary, and requires that the under-fire butterfly valve PC7 be adjusted to 10% open, and the flame-port butterfly valve SC4 be adjusted to 100% open.

Figure 17 provides a further description of the adjustments to the butterfly valves. In general, when modifying the butterfly valves for manual mode, the actuator power supply to be disconnected and the actuator is disconnected from the butterfly valve shaft. A flat-blade screwdriver is then used to turn butterfly valve shaft to the desired position. The actuator is then reconnected to the butterfly valve shaft so that it is held in position by the un-powered actuator. Once these adjustments have been made, the butterfly valve should be tagged to show that it has been modified.

When repairs to the incinerator's oxygen control system have been satisfactorily carried out, the flame-port butterfly valve and actuator can be reconnected, that is, the valve shaft can be tuned back to the 10% open position, and the wire reconnected to resume power to the actuator.



Adjustment Steps to Under-Fire (PC7) and Flame-Port (SC4) Butterfly Valves for Manual Mode Operation:

1. Press the Emergency Stop button on the control panel to disconnect power from the incinerator.
2. Remove actuator cover 1.
3. Remove actuator electronics cover 2.
4. Disconnect the black wire 3 and tape the exposed wire with a small piece of electrical tape.
5. Loosen the U-clamp nuts 4.
6. Use a flat-blade screwdriver to turn the shaft 5 to the desired setting: 10% open for PC7 and 100% open for SC4.
7. Tighten the U-camp nuts 4 to secure the valve shaft in place: DO NOT RE-CONNECT THE BLACK WIRE.
8. Replace covers.
9. Place a tag on the valve to indicate that it has been adjusted for manual mode operation.
10. Twist the Emergency Stop button on the control panel to re-connect power to the incinerator.

Adjustments for Manual Mode Done

Figure 17 Butterfly Valve Adjustment for Manual Mode Operation

5.2 Modification to Operation during Manual Mode

During manual mode operation of the incineration system, there are some changes to the loading procedure when compared to normal operation with the oxygen control system in good working order. The Procedure for Startup as outlined in Figure 13 remains the same, but **the Procedure for Waste Charging as outlined in Figure 14 must be ignored**. When the Procedure for Startup has been completed, the procedure shown in Table 10 should be followed for waste charging. The Procedure for Burn Down as outlined in Figure 15 must still be followed during manual mode operations, though the reference to "Indicator Light 2" can be ignored.

Table 10 Waste Charging in Manual Mode

STEP	PROCEDURE
1	Confirm that the primary and secondary chambers are at their respective set points (see Figure 13).
2	Open the Charging Door, quickly load the batch and close the door.**
3	Wait approximately 10*** minutes and repeat Step 2.
4	Repeat Steps 2 and 3 for three or four loads, and then proceed to Step 5.
5	Open the Ash Door or the Charging Door, rake the waste, and then close the door.
6	Wait approximately 10 minutes for any unburned waste to be consumed.
7	Repeat Steps 2 to 6 until the last waste batch has been charged.
8	Follow the Burn Down Procedure outlined in Figure 15.
WASTE CHARGING DONE	
**	This is very hazardous, see the safety notes following Figure 14.
***	The time varies depending on the waste being incinerated.

6 WARRANTY

WESTLAND ENVIRONMENTAL SERVICES INC.

1. Westland Environmental Services Inc. hereby warrants to the Purchaser, for a one (1) year period of time from the date of acceptance and upon the conditions hereinafter set forth, each new product sold by it, to be free from defects in material and workmanship (specifically excluding there from component parts and accessories manufactured, furnished, and supplied by others) under normal use, maintenance and service. Except for the above Warranty, it is agreed and understood that no other WARRANTY or CONDITION whether express, implied, or statutory is made by Westland Environmental Services Inc.
2. The obligation of Westland Environmental Services Inc. under this Warranty shall be limited to the repair or replacement (**not in excess of its factory labour rate**) of its units; which, upon examination by Westland Environmental Services Inc., shall disclose to their satisfaction to have been defective in material and/or workmanship under normal use, maintenance, and service.
3. The foregoing shall be the Purchaser's sole and exclusive remedy whether in contract, tort, or otherwise; and Westland Environmental Services Inc. shall not be liable for injuries to persons, for damage to property or for loss of any kind which results (whether directly or indirectly) from such defects in material or workmanship, or for any other reason; and, it is agreed and understood that the Purchaser shall keep Westland Environmental Services Inc. indemnified against any such claim. In no event shall Westland Environmental Services Inc. be liable for incidental or consequential damages, or commercial losses, or for any loss or damage except as set forth in paragraph 2 herein.
4. This Warranty does not apply to, and no warranty or condition is made by Westland Environmental Services Inc. regarding any purchased components, parts, and accessories; manufactured, supplied and/or furnished by others, or any non-standard features or items specified by the Purchaser; nor does this Warranty expand, enlarge upon, or alter in any way, the warranties provided by the makers and suppliers of such component parts and accessories.
5. The liability of Westland Environmental Services Inc. under this Warranty shall cease and determine if:
   (a) The Purchaser shall not have paid in full all invoices as submitted by Westland Environmental Services Inc., or affiliated companies on or before their due dates:
   (b) Representatives of Westland Environmental Services Inc., are denied full and free right of access to the units:
   (c) The Purchaser permits persons other than the agents of Westland Environmental Services Inc. or those approved or authorized by Westland Environmental Services Inc. to effect any replacement of parts, maintenance, adjustments, or repairs to the units:
   (d) The Purchaser has not properly maintained the units in accordance with instructions, pamphlets or directions given or issued by Westland Environmental Services Inc. at the time of the sale and/or from time to time thereafter:
   (e) The Purchaser uses any spare parts or replacements not manufactured by or on behalf of Westland Environmental Services Inc. and supplied by it, or by someone authorized by it, or fails to follow the instructions for the use of the same:
   (f) The Purchaser misuses, or uses this unit for any purpose other than that for which it was intended or manufactured:
   (g) The defective parts are not returned to Westland Environmental Services Inc. within 15 days of repair.
6. No condition is made or is to be implied, nor is any Warranty given or to be implied as to the life or wear of the units supplied; or that they will be suitable for use under any specific conditions; notwithstanding that such conditions may be known or made known to the seller.
7. Defects in material and/or workmanship must be brought to the attention of Westland Environmental Services Inc. by written notification within ten (10) days of discovery, and repairs must be commenced within forty-five (45) days thereafter.
8. It is agreed and understood that the Purchaser is responsible for and must pay for the transporting of the defective goods or of the replacement parts to the place of repair. Premium freight charges (such as air express or air fare charges for transportation of personnel, tools and for replacement parts) and other expenses, apart from servicemen's regular straight time travel, mileage, and regular straight time labour required to repair or replace defective parts and the cost of the parts, will be paid for by the customer at Westland Environmental Services Inc. regular billing rates on usual credit terms.

9. The liability of Westland Environmental Services Inc. under this Warranty is limited to the purchase price of the unit and in no case shall a claim be advanced for more than such amount.
10. All repairs and replacements are made and furnished subject to the same terms, conditions, warranties, disclaimer or warranty and limitations of liability and remedy as applied to each new unit sold.
11. This warranty and the Purchaser's rights under it, is not transferable, or is it assignable.

DATE IN SERVICE: _____

MODEL NUMBER: CY - 50 - CA- "D"-"O"

SERIAL NUMBER: 2K8 - 780

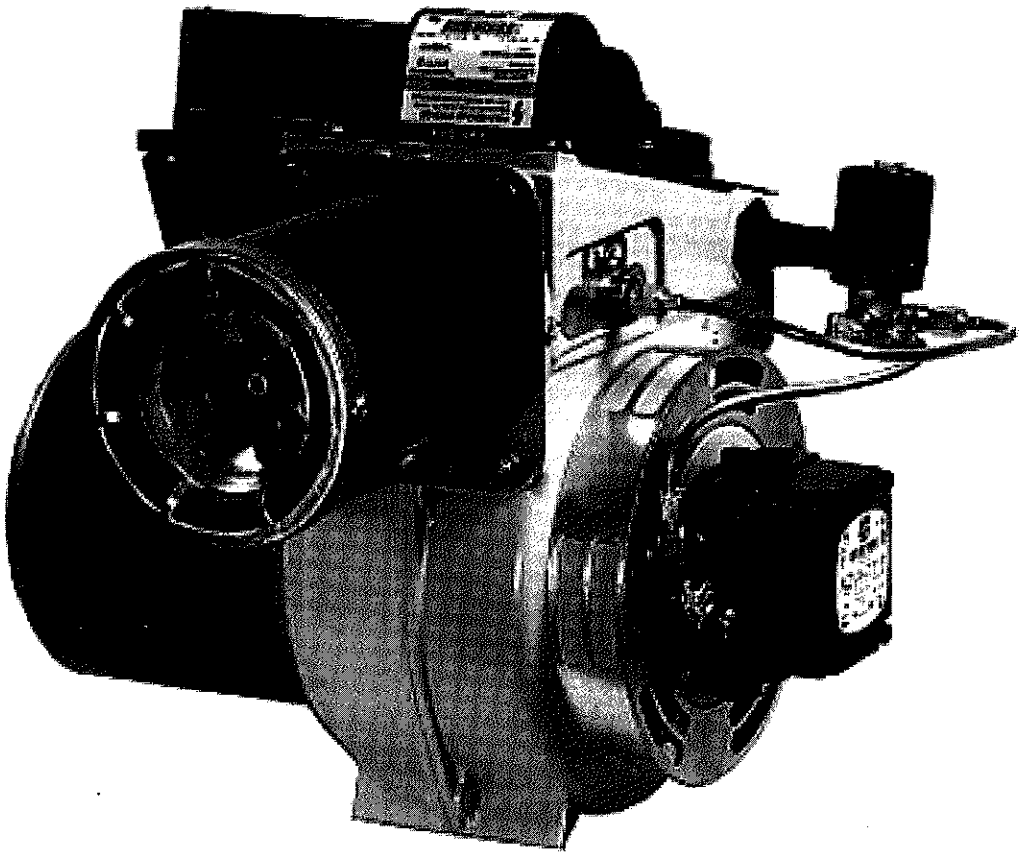
PURCHASED BY: Environment Canada, Eureka Weather Station

SELLING BRANCH: Edmonton, Alberta

7 APPENDIX A: INFORMATION SHEETS AND MANUALS

Models SF & SM Oil Burners

WIC 201 Burner



WARNING **Potential for Fire, Smoke and Asphyxiation Hazards**

Incorrect installation, adjustment, or misuse of this burner could result in death, severe personal injury, or substantial property damage.

To the Homeowner or Equipment Owner:

- Please read and carefully follow all instructions provided in this manual regarding your responsibilities in caring for your heating equipment.
- Contact a professional, qualified service agency for installation, start-up or service work.
- Save this manual for future reference.

To the Professional, Qualified Installer or Service Agency:

- Please read and carefully follow all instructions provided in this manual before installing, starting, or servicing this burner or heating system.
- The Installation must be made in accordance with all state and local codes having jurisdiction.

Table of Contents

Information To Be Used Only By Qualified Service Technicians

Owner's Information

To the Owner:

Thank you for purchasing a Beckett burner for use with your heating appliance. Please pay attention to the Safety Warnings contained within this instruction manual. Keep this manual for your records and provide it to your qualified service agency for use in professionally setting up and maintaining your oil burner.

Your Beckett burner will provide years of efficient operation if it is professionally installed and maintained by a qualified service technician. If at any time the burner does not appear to be operating properly, **immediately contact your qualified service agency** for consultation.

We recommend annual inspection/service of your oil heating system by a qualified service agency.

Daily – Check the room in which your burner/appliance is installed. Make sure:

- Air ventilation openings are clean and unobstructed
- Nothing is blocking burner inlet air openings
- No combustible materials are stored near the heating appliance
- There are no signs of oil or water leaking around the burner or appliance

Weekly

- Check your oil tank level. Always keep your oil tank full, especially during the summer, in order to prevent condensation of moisture on the inside surface of the tank.

WARNING Owner's Responsibility

Incorrect installation, adjustment, and use of this burner could result in severe personal injury, death, or substantial property damage from fire, carbon monoxide poisoning, soot or explosion.

Contact a professional, qualified service agency for the installation, adjustment and service of your oil heating system. This work requires technical training, trade experience, licensing or certification in some states and the proper use of special combustion test instruments.

Please carefully read and comply with the following instructions:

- Never store or use gasoline or other flammable liquids or vapors near this burner or appliance.
- Never attempt to burn garbage or refuse in this appliance.
- Never attempt to light the burner/appliance by throwing burning material into the appliance.
- Never attempt to burn any fuel not specified and approved for use in this burner.
- Never restrict the air inlet openings to the burner or the combustion air ventilation openings in the room.

NOTICE

This manual contains information that applies to both SM and SF burners. These burners may appear to be basically identical, but there are differences in design and performance. Please review the comparison chart below:

Feature	SM	SF
Firing Rate Range	1.25 to 3.00 gph	1.25 to 5.50 gph
Motor	1/5 HP	1/4 HP
Fuel pump capacity	3 gph (standard)	7 gph (standard)
UL Air Tube Combinations	See Table 2	See Table 2
Blocking oil solenoid valve	Optional	Required above 3 gph
Primary control lockout timing	15 to 45 seconds (optional)	15 seconds maximum

Hazard Definitions

DANGER **Indicates an imminently hazardous situation, which, if not avoided, will result in death, serious injury, or property damage.**

WARNING **Indicates a potentially hazardous situation, which, if not avoided, could result in death, severe personal injury, and/or substantial property damage.**

CAUTION **Indicates a potentially hazardous situation, which, if not avoided, may result in personal injury or property damage.**

Within the boundaries of the hazard warning, there will be information presented describing consequences if the warning is not heeded and instructions on how to avoid the hazard.

NOTICE

Intended to bring special attention to information, but not related to personal injury or property damage.

General Information

Table 1 – Burner Specifications

Model SM Capacity (Note1)	Firing rate range: .....01.25 – 3.00 GPH Input: ..... 175,000 – 420,000 Btu/hr
Model SF Capacity (Note1)	Firing rate range: .....1.25 - 5.50 GPH Input: .....175,000 – 770,000 Btu/hr
Certifications/ Approvals	Model SM - UL listed to comply with ANSI/ UL296 & certified to CSA B140.0. Model SF - UL listed to comply with ANSI/UL 296 & certified to CSA B140.0.
Fuels	U. S: No.1 or No.2 heating oil only (ASTM D396) Canada: No. 1 stove oil or No. 2 furnace oil only
Electrical	Power supply: ..... 120 volts AC, 60 Hz, single phase Operating load (SM): .....5.8 Amps max Operating load (SF): .....7.1 Amps max Motor (SM): ..... 1/5 hp, 3450 rpm, NEMA 'N' flange, manual reset over load protection Motor (SF): ..... 1/4 hp, 3450 rpm, NEMA 'N' flange, manual reset over load protection Ignition: ... Continuous duty solid-state igniter
Fuel pump	Outlet pressure: ..... Note 2
Air tube	ATC code: .....See Table 2
Dimensions (Standard)	Height .....12.5 inches Width .....15 inches Depth ..... 8.50 inches Air tube diameter ..... 4.00 inches
Air tube	ATC code: .....See Table 2

Note 1: *Approval agency listed rating for Model SM is 1.25 to 3.00 gph and Model SF is 1.25 to 5.50 gph. However, the firing rate range is limited by the specific air tube combination being used. Refer to Table 2.*

Note 2. *UL Recognized to 4.0 GPH with a CleanCut pump for use in pressure washers.*

Note 3. *See appliance manufacturer's burner specifications for recommended pump discharge pressure.*

• Notice Special Requirements

- For recommended installation practice in Canada, refer to the latest version of CSA Standard B139 & B140.
- Concealed damage — If you discover damage to the burner or controls during unpacking, notify the carrier at once and file the appropriate claim.
- When contacting Beckett for service information — Please record the burner serial number (and have available when calling or writing). You will find the serial number on the silver label located on the left rear of the burner. Refer to Figure 1.

⚠WARNING Professional Service Required

Incorrect installation, adjustment, and use of this burner could result in severe personal injury, death, or substantial property damage from fire, carbon monoxide poisoning, soot or explosion.

Please read and understand the manual supplied with this equipment. This equipment must be installed, adjusted and put into operation only by a qualified individual or service agency that is:

- Licensed or certified to install and provide technical service to oil heating systems.
- Experienced with all applicable codes, standards and ordinances.
- Responsible for the correct installation and commission of this equipment.
- Skilled in the adjustment of oil burners using combustion test instruments.

The installation must strictly comply with all applicable codes, authorities having jurisdiction and the latest revision of the National Fire Protection Association Standard for the installation of Oil-burning Equipment, NFPA 31 (or CSA B139 and B140 in Canada).
Regulation by these authorities take precedence over the general instructions provided in this installation manual.

Table 2 – Air Tube Combination (ATC) codes

Firing Rate (gph)	Head	Static plate size	ATC Codes for usable air tube lengths ('A' in inches; See Figure 3.)			
(min-max)		(inches)	6-5/8	9	13	16
For SF Burner Only						
1.25-2.25	F12	2-3/4	SF65VW	SF90VW	SF130VW	SF160VW
1.75-2.75	F22	2-3/4	SF65VP	SF90VP	SF130VP	SF160VP
1.75-3.25	F220	None	SF65FD	SF90FD	SF130FD	SF160FD
2.5-5.5	F310	None	SF65FU	SF90FU	SF130FU	SF160FU
For SM Burner Only						
1.25-2.00	F12	2-3/4	SM65VW	SM90VW	SM130VW	SM160VW
2.00-3.00	F220	None	SM65FF	SM90FF	SM130FF	SM160FF
2.00-3.00	F22	None	SM65VM	SM90VM	SM130VM	SM160VM

Inspect/Prepare Installation Site

• Chimney or vent

- Inspect the chimney or vent, making sure it is properly sized and in good condition for use.
- For those installations not requiring a chimney, such as through-the-wall vented appliances, follow the instructions given by the appliance and power venter (if used) manufacturers.

• Combustion air supply

⚠WARNING Adequate Combustion and Ventilation Air Supply Required

Failure to provide adequate air supply could seriously affect the burner performance and result in damage to the equipment, asphyxiation, explosion or fire hazards.

- The burner cannot properly burn the fuel if it is not supplied with a reliable combustion air source.
- Follow the guidelines in the latest editions of the NFPA 31 and CSA-B139 regarding providing adequate air for combustion and ventilation.

See NFPA 31 Standard for complete details.

Appliance located in confined space

The confined space should have two (2) permanent openings: one near the top of the enclosure and one near the bottom of the enclosure. Each opening shall have a free area of not less than (1) one square inch per 1,000 BTU's per hour of the total input rating of all appliances within the enclosure. The openings shall have free access to the building interior, which should have adequate infiltration from the outside.

Exhaust fans and other air-using devices

Size air openings large enough to allow for all air-using devices in addition to the minimum area required for combustion air. If there is any possibility of the equipment room developing negative pressure (because of exhaust fans or clothes dryers, for example), either pipe combustion air directly to the burner or provide a sealed enclosure for the burner and supply it with its own combustion air supply.

• Clearances to burner and appliance

- Provide space around burner and appliance for easy service and maintenance.
- Check minimum clearances against those shown by the appliance manufacturer and by applicable building codes.

• Combustion chamber — Burner retrofitting

Verify that the appliance combustion chamber provides at least the minimum dimensions given in Table 3.

Table 3. Chamber Dimensions

Chamber Dimensions (inches)					
Firing Rate (GPH)	Round I.D.	Rectangular		Height	Floor to nozzle
		Width	Length		
1.25	11	10	11	12	5-6
1.50	12	11	12	13	6-7
2.00	14	12	15	13	6-7
2.50	16	13	17	14	7-8
3.00	18	14	18	15	7-8
3.50	19	15	19	15	7-8
4.00	20	16	21	16	8-9
5.00	23	18	23	18	9-10
5.50	24	19	24	19	10-11

WARNING **Protect Steel Combustion Chamber From Burnout**

Failure to comply could result in damage to the heating equipment and result in fire or asphyxiation hazards.

- When retrofitting appliances that have unlined stainless steel combustion chambers, protect the chamber by lining the inside surfaces with a ceramic fiber blanket, such as a wet-pac or other suitable refractory material.
- Some steel chambers may not require liners because the appliance was designed and tested for use with flame retention burners. Refer to the manufacturer's instructions.

Prepare the Burner

• Burner fuel unit

Verify that the burner fuel unit is compatible with the oil supply system. For more details, refer to "Connect fuel lines" later in this manual.

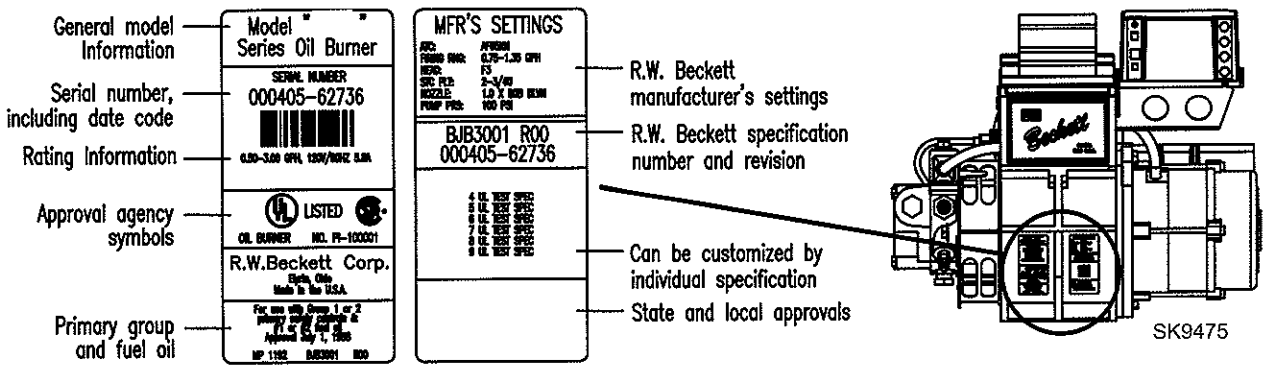
• Attach air tube (if not already installed)

If using a flange and gasket, slide them onto the air tube. Then attach the air tube to the burner chassis using the four sheet metal screws provided. Refer to Figure 3 for details.

• Install burner nozzle (if not already installed)

1. Remove the plastic plug protecting the nozzle adapter threads
2. Place a ¾" open-end wrench on the nozzle adapter. Insert the nozzle into the adapter and finger tighten. Finish tightening with a ⅝" open-end wrench. Use care to avoid bending the electrodes.

Figure 1. Burner Label Location



WARNING Correct Nozzle and Flow Rate Required

Incorrect nozzles and flow rates could result in impaired combustion, under-firing, over-firing, sooting, puff-back of hot gases, smoke and potential fire or asphyxiation hazards.

Use only nozzles having the brand, flow rate (gph), spray angle and pattern specified by the appliance manufacturer.

Follow the appliance manufacturer's specifications for the required pump outlet pressure for the nozzle, since this affects the flow rate.

- Nozzle manufacturers calibrate nozzle flow rates at 100 psig.
- When pump pressures are higher than 100 psig, the actual nozzle flow rate will be greater than the gph stamped on the nozzle body. (Example: A 1.00 gph nozzle at 140 psig = 1.18 gph)

Securely tighten the nozzle (torque to 90 inch pounds). For typical nozzle flow rates at various pressures refer to Table 5.

Table 5. Nozzle Flow Rate by Size

Nozzle flow rate U. S. gallons per hour of No. 2 fuel oil when pump pressure (psig) is:					
Nozzle size (rated at 100 psig)	**125 psi**	**140 psi**	**150 psi**	**175 psi**	**200 psi**
1.25	1.39	1.48	1.53	1.65	1.77
1.35	1.51	1.60	1.65	1.79	1.91
1.50	1.68	1.77	1.84	1.98	2.12
1.65	1.84	1.95	2.02	2.18	2.33
1.75	1.96	2.07	2.14	2.32	2.48
2.00	2.24	2.37	2.45	2.65	2.83
2.25	2.52	2.66	2.76	2.98	3.18
2.50	2.80	2.96	3.06	3.31	3.54
2.75	3.07	3.25	3.37	3.64	3.90
3.00	3.35	3.55	3.67	3.97	4.24
3.25	3.63	3.85	3.98	4.30	4.60
3.50	3.91	4.14	4.29	4.63	4.95
3.75	4.19	4.44	4.59	4.96	5.30
4.00	4.47	4.73	4.90	5.29	-
4.50	5.04	5.32	5.51	-	-
5.00	5.59	-	-	-	-
5.50	-	-	-	-	-

Table 6. Nozzle Spray Angles

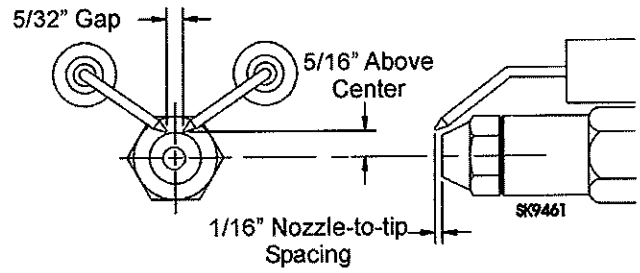
Recommended nozzle spray angles	
"F" head	70°, 80° or 90° nozzle

Note: Always follow the appliance manufacturer's nozzle specification, when available.

3. If the nozzle is already installed, remove the nozzle line assembly to verify that the nozzle size and spray pattern are correct for the application (per appliance manufacturer's information). Verify that the electrode tip settings comply with Figure 2.
4. If the nozzle is not installed, obtain a nozzle having the capacity and spray angle specified in the appliance manufacturer's information. For conversions or upgrades, when information is not available for the application:
   - Refer to Table 6 to select the mid-range nozzle spray angle for the head type being used.
   - Fire the burner and make sure the combustion is acceptable and the flame is not impinging on chamber surfaces.
   - If a shorter flame is needed, select a wider spray angle. If a longer flame is needed, select a narrower spray angle.
   - Either hollow or solid spray patterns may be used. If combustion results are not satisfactory with the selected spray pattern, try the other pattern.

• Check/adjust electrodes

Figure 2. – Electrode Tip Adjustment



Check the electrode tip settings. Adjust if necessary to comply with the dimensions shown in Figure 2. To adjust, loosen the electrode clamp screw and slide/rotate electrodes as necessary. Securely tighten the clamp screw when finished.

• Servicing nozzle line assembly

1. Turn off power to burner before proceeding.
2. Disconnect oil connector tube from nozzle line.
3. Loosen the two screws securing igniter retaining clips and rotate both clips to release igniter baseplate. Then tilt igniter back on its hinge.
4. Remove splined nut.
5. "F" head air tube. - Remove nozzle line assembly from burner, being careful not to damage the electrodes or insulators while handling. To ease removal of long assemblies (over 9 inches), rotate assembly 180° from installed position after pulling partially out of tube.
6. To replace the nozzle assembly, reverse the above steps.

Mount Burner on Appliance

WARNING **Do Not use Adjustable Mounting Flange on Mobile Units**

The shock and vibration could cause loss of burner alignment and insertion problems resulting in flame impingement, heavy smoke, fire and equipment damage.

- Only use specified factory-welded flange and air tube combinations.

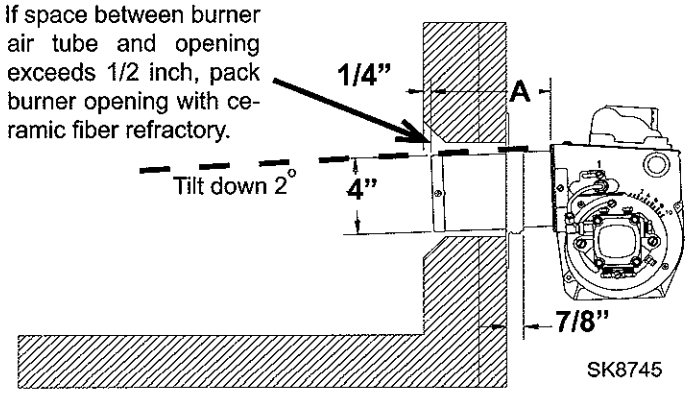
• Mounting options

Bolt the burner to the appliance using the factory-mounted flange or an adjustable flange.

• Mounting dimensions

1. When using the Beckett universal adjustable flange, mount the air tube at a 2° downward pitch unless otherwise specified by the appliance manufacturer.
2. Verify that the air tube installed on the burner provides the correct insertion depth. See Figure 3.
3. The end of the air tube should normally be ¼" back from the inside wall of the combustion chamber. Never allow the leading edge of the head assembly to extend into the chamber, unless otherwise specified by the heating appliance manufacturer. Carefully measure the insertion depth when using an adjustable flange. Verify the insertion depth when using a welded flange.

Figure 3. – Mounting Burner in Appliance



• Connect fuel lines

Carefully follow the fuel unit manufacturer's literature and the latest edition of NFPA 31 for oil supply system specifications.

WARNING **Do Not Install By-pass Plug with 1-Pipe System**

Failure to comply could cause Immediate pump seal failure, pressurized oil leakage and the potential for a fire and injury hazard.

- The burner is shipped without the by-pass plug installed. **EXCEPTION**: Unless specified by the equipment manufacturer and noted on the label at top of pump cover.
- Install the by-pass plug in two-pipe oil supply systems ONLY.

CAUTION **Oil Supply Pressure Control Required**

Damage to the filter or pump seals could cause oil leakage and a fire hazard.

- The oil supply inlet pressure to the burner ***cannot exceed 3 psig***.
- Insure that a pressure limiting device is installed in accordance with the latest edition of NFPA 31.
- Do not install valves in the return line. (NFPA 31, Chapter 8)
- **Gravity Feed Systems:** Always install an anit-siphon valve in the oil supply line or a solenoid valve (RWB Part # 2182602U or 2233U) in the pump/nozzle discharge tubing to provide backup oil flow cut-off protection.

Fuel supply level with or above burner –
The burner may be equipped with a single-stage fuel unit for these installations. Connect the fuel supply to the burner with a single supply line if you want a one-pipe system (making sure the bypass plug is NOT installed in the fuel unit.) Manual bleeding of the fuel unit is required on initial start-up. If connecting a two-pipe fuel supply, install the fuel unit bypass plug.

Fuel supply below the level of the burner –
When the fuel supply is more than eight feet below the level of the burner, a two-pipe fuel supply system is required. Depending on the fuel line diameter and horizontal and vertical length, the installation may also require a two-stage pump. Consult the fuel unit manufacturer's literature for lift and vacuum capability.

Check/Adjust 'Z' Dimension for 'F' Heads

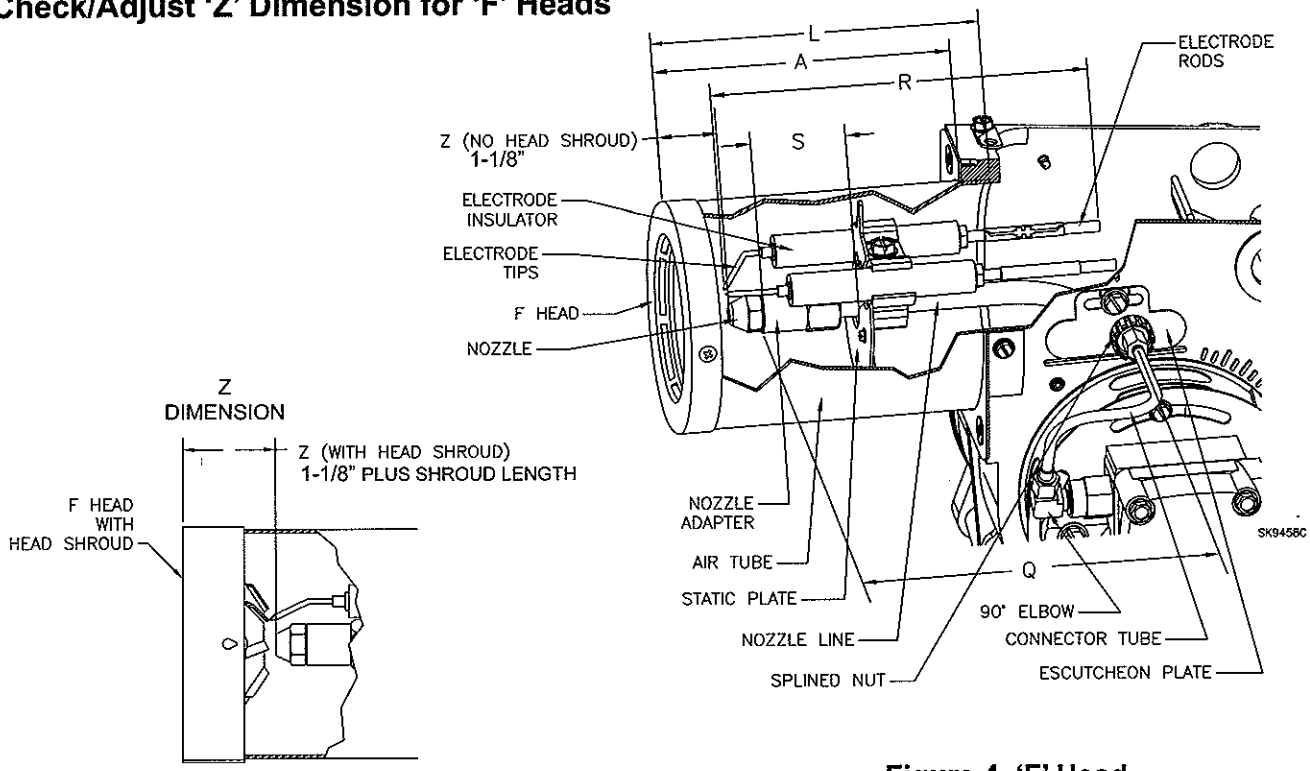


Figure 4. 'F' Head

• Check/Adjust 'Z' Dimension - 'F' heads

⚠ WARNING Adjust the 'Z' dimension to the required specification.

Incorrect Adjustments could cause combustion problems, carbon deposition from flame impingement, heavy smoke generation and fire hazard.

- Make all adjustments exactly as outlined in the following information.

1. The important 'Z' dimension is the distance from the face of the nozzle to the flat face of the head (or heat shield, if applicable). This distance for F heads is 1-⅛" (1-⅜" if the air tube has a heat shield). The "Z" dimension is factory set for burners shipped with the air tube installed. Even if factory set, verify that the "Z" dimension has not been changed.
2. Use the following procedure to adjust the "Z" dimension, if it is not correct:
   - Turn off power to the burner.
   - Disconnect the oil connector tube from the nozzle line
   - See above figure. Loosen the splined nut from the nozzle line. Loosen the hex head screw securing the escutcheon plate to the burner housing.
   - Place the end of a ruler at the face of the nozzle and, using a straight edge across the head, measure the distance to the face of the head. A Beckett T501 or T650 gauge may also be used.
   - Slide the nozzle line forward or back until the Z dimension for F heads is 1-⅛" (1-1/8" plus shroud length, if using a straight edge).
   - Tighten the hex head screw to secure the escutcheon plate to the burner chassis. Then tighten the splined nut and attach the oil connector tube.
3. Recheck the "Z" dimension periodically when servicing to ensure the escutcheon plate has not been moved. You will need to reset the "Z" dimension if you replace the air tube or nozzle line assembly. The Beckett Z gauge (part number Z-2000) is available to permit checking the F head "Z" dimension without removing the burner from the appliance.

• Burner Dimensions - Models SM & SF

Dimension (inches)	F Head
A = Usable air length (inches)	(Measure accurately)
L (Total tube length)	A+1/2
R (electrode length), ± 1/4	A+2-1/4
S (adapter to static plate), ± 1/16	(Note 1)
Q (nozzle line length),	A+ 15/16
Z (F head w/o head shroud) (F head-with head shroud)	1-1/8 1-1/8 + shroud length. (Note 2)

Note 1: 1-3/8 for dimension A less than 4"; 1-5/8 for dimension A from 4" through 4-1/2 ", 2-13/32 for dimension A greater than 4-1/2".
Note 2: When using a straight edge.

Fuel line installation –

CAUTION Do Not Use Teflon Tape

Damage to the pump could cause impaired burner operation, oil leakage and appliance soot-up.

- Never use Teflon tape on fuel oil fittings.
- Tape fragments can lodge in fuel line components and fuel unit, damaging the equipment and preventing proper operation.
- Use of Teflon tape will void the Suntec warranty.
- Use oil-resistant pipe sealant compounds.

Continuous lengths of heavy wall copper tubing are recommended. **Always use flare fittings. Never use compression fittings.**

- Always install fittings in accessible locations. Proper routing of fuel lines is required to prevent air cavitation and vibration.

Fuel line valve and filter –

- Install two high quality fusible-handle design shut-off valves in accessible locations on the oil supply line to comply with the NFPA 31 Standard and authorities having jurisdiction. Locate one close to the tank and the other close to the burner, upstream of the filter.

- Install a generous capacity filter inside the building between the fuel tank shutoff valve and the burner, locating both the filter and the valve close to the burner for ease of servicing. Filter should be rated for 50 microns or less.

Wire Burner

WARNING Electrical Shock Hazard

Electrical shock can cause severe personal injury or death.

- Disconnect electrical power before installing or servicing the burner.
- Provide ground wiring to the burner, metal control enclosures and accessories. (This may also be required to aid proper control system operation.)
- Perform all wiring in compliance with the National Electrical Code ANSI/NFPA 70 (Canada CSA C22.1)

• Burner packaged with appliance

Refer to appliance manufacturer's wiring diagram for electrical connections.

• Burner installed at jobsite

Refer to Figure 5, for typical burner wiring, showing cad cell primary controls. Burner wiring may vary, depending on primary control actually used.

The R7184 primary control with valve-on delay (prepurge) and burner motor-off delay (postpurge), requires a constant 120 volts AC power source supplied to the BLACK wire on the control. The RED wire goes to the appliance limit circuit. Please note that other control manufacturers may use different wire colors for power and limit connections.

Start Up Burner/Set Combustion

WARNING Explosion and Fire Hazard

Failure to follow these instructions could lead to equipment malfunction and result in heavy smoke emission, soot-up, hot gas puff-back, fire and asphyxiation hazards.

- Do not attempt to start the burner when excess oil has accumulated in the appliance, the appliance is full of vapor, or when the combustion chamber is very hot.
- Do not attempt to re-establish flame with the burner running if the flame becomes extinguished during start-up, venting, or adjustment.
- **Vapor-Filled Appliance:** Allow the unit to cool off and all vapors to dissipate before attempting another start.
- **Oil-Flooded Appliance:** Shut off the electrical power and the oil supply to the burner and then clear all accumulated oil before continuing.
- If the condition still appears unsafe, contact the Fire Department. Carefully follow their directions.
- Keep a fire extinguisher nearby and ready for use.

1. Open the shutoff valves in the oil supply line to the burner.
2. If the air control is not preset, close air band and partially open air shutter. This is an initial air setting for the pump bleeding procedure only. Additional adjustments must be made with instruments to prevent smoke and carbon monoxide generation.
3. Set the thermostat substantially above room temperature.

Typical Burner Wiring & Burner Sequence of Operation for R7184 Control.

Refer to the appliance manufacturer's wiring diagram for actual specifications.

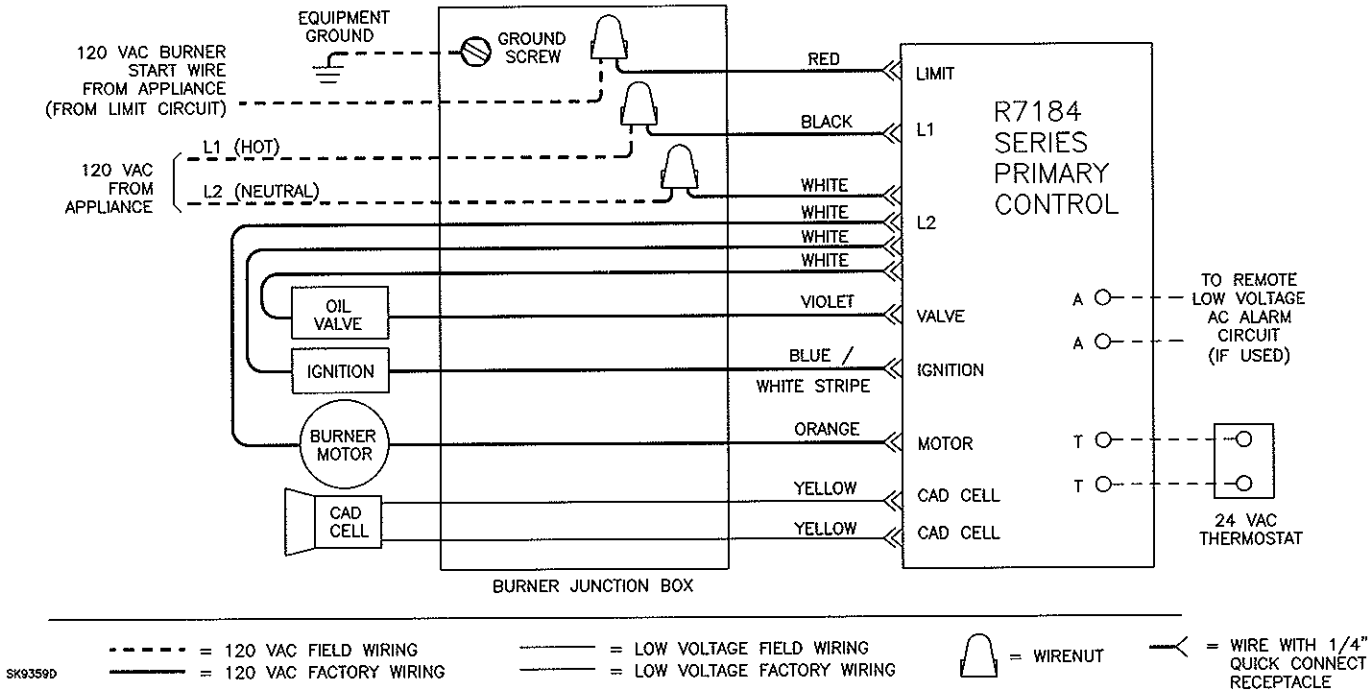
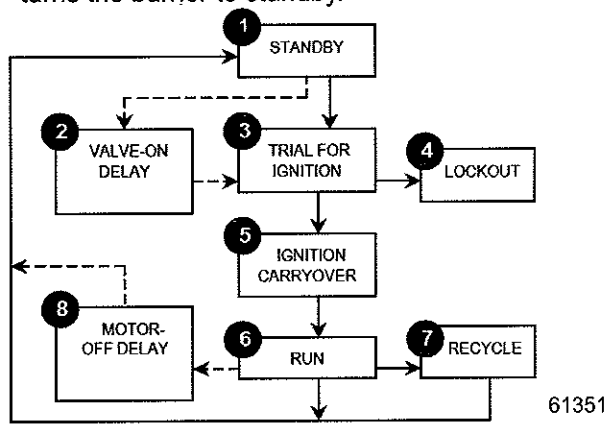


Figure 5. – Typical Burner Wiring

1. **STANDBY.** The burner is idle, waiting for a call for heat. When a call for heat is initiated, there is a 3-10 second delay while the control performs a safe start check.
2. **VALVE-ON DELAY.** The ignition and motor are turned on for a 15 second valve-on delay.
3. **TRIAL FOR IGNITION (TFI).** The fuel valve is opened. A flame should be established within the 15 second lockout time.
4. **LOCKOUT.** If flame is not sensed by the end of the TFI, the control shuts down on safety lockout and must be manually reset. If the control locks out three times in a row, the control enters restricted lockout.
5. **IGNITION CARRYOVER.** Once flame is established, the ignition remains on for 10 seconds to ensure flame stability before turning off. If the control is wired for intermittent duty ignition, the ignition unit stays on the entire time the motor is running.
6. **RUN.** The burner runs until the call for heat is satified. The burner is then sent to burner motor off delay, if applicable, or it is shut down and sent to standby.
7. **RECYCLE.** If the flame is lost while the burner is firing, the control shuts down the burner, enters a 60 second recycle delay, and then repeats the above ignition sequence. If flame is lost three times in a row, the control locks out to prevent cycling with repetitious flame loss due to poor combustion.
8. **BURNER MOTOR-OFF DELAY.** The fuel valve is closed and the burner motor is kept on for the selected motor-off delay time before the control returns the burner to standby.



Control System Features

Feature	Interrupted ignition	Limited reset, Limited recycle	Diagnostic LED, cad cell indicator	Valve-on delay	Burner motor off delay	Alarm Contacts
R7184A	YES	YES	YES	—	—	—
R7184B	YES	YES	YES	YES	—	—
R7184P	YES	YES	YES	YES	YES	Optional

4. Close the line voltage switch to start the burner. If the burner does not start immediately you may have to reset the safety switch of the burner primary control.
5. Bleed air from fuel unit as soon as burner motor starts rotating.
   - To bleed the fuel unit, attach a clear plastic hose over the vent fitting. Loosen the fitting and catch the oil in an empty container. Tighten the fitting when all air has been purged from the oil supply system.
   - If the burner locks out on safety during bleeding, reset the safety switch and complete the bleeding procedure. Note — Electronic safety switches can be reset immediately; others may require a three- to five-minute wait.
   - If burner stops after flame is established, additional bleeding is probably required. Repeat the bleeding procedure until the pump is primed and a flame is established when the vent fitting is closed.
   - For R7184 primary controls, see Technician's Quick Reference Guide, part number 61351 for special pump priming sequence.
   - Prepare for combustion tests by drilling a ¼" sampling hole in the flue pipe between the appliance and the barometric draft regulator.
6. Initial air adjustment — Test the flue gas for smoke. Adjust the air shutter (and air band, if necessary) to obtain a clean flame. Now the additional combustion tests with instruments can be made

• Set combustion with instruments

1. Allow the burner to run for approximately 5 to 10 minutes.
2. Set the stack or over-fire draft to the level specified by the appliance manufacturer.
   - **Natural Draft Applications;** typically over-fire draft is -0.01" or -0.02" w.c.
   - **Direct Venting**; typically may not require draft adjustment.
   - **High Efficiency/Positive Pressure Appliances**; also vary from traditional appliances (see manufacturer's recommendations).
3. Follow these four steps to properly adjust the burner:
   Step 1: Adjust the air shutter/band until a trace of smoke is achieved.
   Step 2: At the trace of smoke level, measure the CO_2 (or O_2) . This is the vital reference point for further adjustments. Example: 13.5% CO_2 (2.6% O_2)
   Step 3: Increase the air to reduce the CO_2 by 1.5 to 2 percentage points. (O_2 will be increased by approximately 2.0 to 2.7 percentage points.) Example: Reduce CO_2 from 13.5% to 11.5% (2.6% to 5.3% O_2).
   Step 4: Recheck smoke level. It should be Zero.
   - This procedure provides a margin of reserve air to accommodate variable conditions.
   - If the draft level has changed, recheck the smoke and CO2 levels and readjust the burner, if necessary
4. Once combustion is set, tighten all fasteners on air band, air shutter and escutcheon plate.
5. Start and stop the burner several times to ensure satisfactory operation. Test the primary control and all other appliance safety controls to verify that they function according to the manufacturer's specifications.

Perform Regular Maintenance

WARNING **Annual Professional Service Required**

Tampering with or making incorrect adjustments could lead to equipment malfunction and result in asphyxiation, explosion or fire.

- Do not tamper with the burner or controls or make any adjustments unless you are a trained and qualified service technician.
- To ensure continued reliable operation, a qualified service technician must service this burner annually.
- More frequent service intervals may be required in dusty or adverse environments.
- Operation and adjustment of the burner requires technical training and skillful use of combustion test instruments and other test equipment.

- ❒ Replace the oil supply line filter. The line filter cartridge must be replaced to avoid contamination of the fuel unit and nozzle.
- ❒ Inspect the oil supply system. All fittings should be leak-tight. The supply lines should be free of water, sludge and other restrictions.
- ❒ Remove and clean the pump strainer if applicable.
- ❒ Replace the nozzle with the exact brand, pattern, gph flow rate and spray angle..
- ❒ Clean and inspect the electrodes for damage, replacing any that are cracked or chipped.
- ❒ Check electrode tip settings. Replace electrodes if tips are rounded.
- ❒ Inspect the igniter spring contacts.
- ❒ Clean the cad cell lens surface, if necessary.
- ❒ Inspect all gaskets. Replace any that are damaged or would fail to seal adequately.
- ❒ Inspect the combustion head and air tube. Remove any carbon or foreign matter. Replace all damaged units with exact parts.
- ❒ Clean the blower wheel, air inlet, air guide, burner housing and static plate of any lint or foreign material.
- ❒ If motor is not permanently lubricated, oil motor with a few drops of SAE 20 nondetergent oil at each oil hole. DO NOT over oil motor. Excessive oiling can cause motor failure.
- ❒ Check motor current. The amp draw should not exceed the nameplate rating.
- ❒ Check all wiring for secure connections or insulation breaks.
- ❒ Check the pump pressure and cutoff function.
- ❒ Check primary control safety lockout timing.
- ❒ Check ignition system for proper operation.
- ❒ Inspect the vent system and chimney for soot accumulation or other restriction.
- ❒ Clean the appliance thoroughly according to the manufacturer's recommendations.
- ❒ Check the burner performance. Refer to the section "Set combustion with test instruments".
- ❒ It is good practice to make a record of the service performed and the combustion test results.

- **Replacing the blower wheel:**

- When replacing the blower wheel, insure that the wheel is centered between the two sides of the burner housing as shown below.

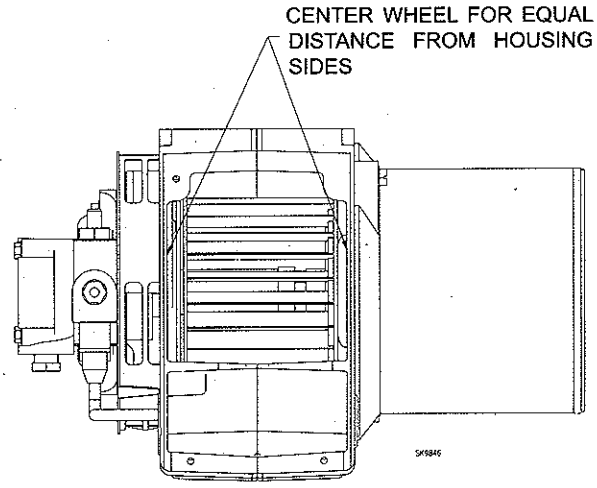
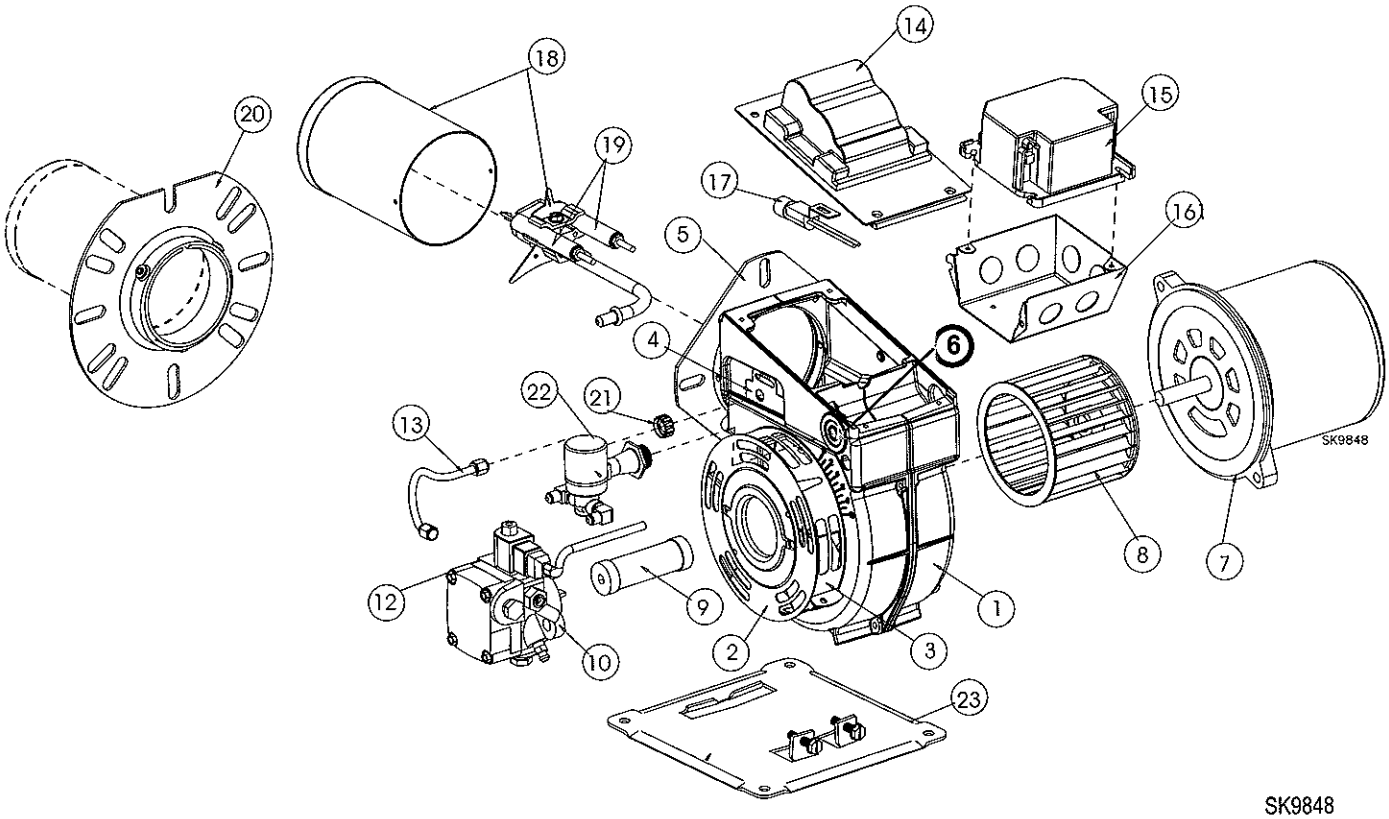


Figure 6. Blower Wheel Assembly

Burner Parts Diagram



SK9848

#	Part No.	Description
1		Burner Housing Assembly with Inlet Bell
2	3215	Air shutter, 10 Slot
3	3819	Bulk Air Band, 10 Slot
4	3493	Nozzle-line Escutcheon Plate
5	Specify ** 3399	Unit Flange or Square Plate
Not Shown	3416	Air Tube Gasket
6	2139	Hole Plug - Wiring Box
7	2900U 2364U	Drive Motor, 1/5 HP (SM Models) Drive Motor, 1/4 HP (SF Models)
8	2383U	Blower Wheel (6-1/4 X 3-7/16)
9	2433	Flexible Coupling (Fits 5/16" pump shaft)
10	 2591U 21188U	Fuel Units SF only Single-Stage 'A' Two-Stage 'B'
10	 2184404U 2460	Fuel Units SM only CleanCut Single-Stage 'A'
12	2256	Pump outlet fitting
	482	Pump holding screws (not shown)
13	5394	Connector tube assembly, pump to nozzle line

#	Part No.	Description
14	51824U	Igniter and Base Plate
14	2289U	Ignition Transformer (10,000 V/23mA)
15	7455U	R7184A - Interrupted Ignition
	7456U	R7184B - Pre-purge
	7457U	R7184P - Pre and Post-purge
	7458U	R7184P w/ Alarm Contacts
16	5770	Electrical Box
17	7006U	Cad Cell Detector
18	Specify **	Air Tube Combination
19	5780	Electrode Kit - F Head up to 9"
	5782	Electrode Kit - F Head over 9"
20	5432 3616	Universal Flange w/ Gasket Gasket Only
21	3666	Splined Nut
22	2182602U	Blocking Oil Solenoid Valve
23	5685	Base Pedestal Kit

** Contact your Beckett Representative for part number and pricing.

Limited

WARRANTY

For Residential, Commercial and Specialty Burners

The R. W. BECKETT CORPORATION ("Beckett") warrants to persons who purchase its Beckett burners from Beckett for resale or for incorporation into a product for resale ("Customers") that its equipment is free from defects in material and workmanship under normal use and service for 60 months from the date of manufacture for Residential Burners and 18 months from the date of manufacture for Commercial and Specialty Burners. *Residential burner models include:* AF, AFG, AFII, NX, SF, SR and SMG. *Commercial burner models include:* CF375, CF500, CF800, CF1400, CF2300A, CF2500, CF3500A, CG10, CG15, CG25 and CG50. *Specialty burner models include:* ADC, ADCP, ARV, SDC and SM. The provisions of this warranty are extended to individual major burner components as follows:

a) 60 months from date of manufacture for all Beckett-branded major components, except for 12 Vdc components.
b) 18 months from date of manufacture for all non-Beckett-branded major components and Beckett branded 12 Vdc components.

Note: Normal service items found to be defective upon receipt by the customer are covered by this warranty.

THIS WARRANTY DOES NOT EXTEND TO EQUIPMENT SUBJECTED TO MISUSE, NEGLECT, OR ACCIDENT: NOR DOES THIS WARRANTY APPLY UNLESS THE PRODUCT COVERED BY IT IS PROPERLY INSTALLED BY A QUALIFIED, COMPETENT TECHNICIAN, WHO IS LICENSED WHERE STATE AND LOCAL CODES REQUIRE, AND WHO IS EXPERIENCED IN MAKING SUCH INSTALLATIONS, IN ACCORDANCE WITH THE LATEST EDITION OF NFPA NO. 31 OF THE NATIONAL FIRE PROTECTION ASSOCIATION, THE LATEST EDITION OF THE NATIONAL FUEL GAS CODE (NFPA NO. 54) AND IN ACCORDANCE WITH ALL APPLICABLE LOCAL, STATE AND NATIONAL CODES HAVING JURISDICTIONAL AUTHORITY.

Equipment, which is defective in material or workmanship and within the warranty period, may be returned for credit as follows:
Beckett Burners, Beckett-branded major components and non-Beckett-branded major components that came as original equipment on a Beckett burner or were sold as a replacement part by Beckett should be returned, freight prepaid, to Beckett's home office. Credit will be issued to the customer unless the returned equipment is determined by Beckett to be out of warranty or damaged by user, in which case the equipment will be scrapped.
Note: Beckett is not responsible for any labor cost for removal and replacement of equipment.

THIS WARRANTY IS LIMITED TO THE PRECISE TERMS SET FORTH ABOVE, AND PROVIDES EXCLUSIVE REMEDIES EXPRESSLY IN LIEU OF ALL OTHER REMEDIES, AND IN PARTICULAR THERE SHALL BE EXCLUDED THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. IN NO EVENT WILL BECKETT BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGE OF ANY NATURE. Beckett neither assumes nor authorizes any person to assume for Beckett any other liability or obligation in connection with the sale of this equipment, Beckett's liability and Customer's exclusive remedy being limited to credit as set forth above.

R.W. BECKETT CORPORATION

P.O. Box 1289 Elyria, Ohio 44036 Form No. 61545 R72905

The Oilheat Manufacturers' Association supports the use of low sulfur fuels as defined by ASTM D396, Grades No. 1 Low Sulfur and No. 2 Low Sulfur, as the preferred heating fuel for the following reasons:

- Low sulfur fuels reduce deposits on heat exchanger surfaces, extending the service interval between cleanings.
- The reduced deposits increase the efficiency of the appliance.
- Low sulfur fuels reduce particulate emissions.
- Low sulfur fuels reduce oxides of nitrogen emissions.

R.W. BECKETT CORPORATION

U.S.A.: P.O. Box 1289 · Elyria, Ohio 44036
www.beckettcorp.com
Canada: R.W. Beckett Canada, Ltd. · Unit #3, 430 Laird Road · Guelph, Ontario N1G 3X7

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12/06

OMRON

Digital Temperature Controller

E5CN

Compact and Intelligent Temperature Controller

- Auto-tuning and self-tuning available. Can auto-tune even during execution of self-tuning
- Heating or heating/cooling control is available
- Event input allows multiple SP selection and run/stop function
- Water-resistant construction: NEMA4 (equivalent to IP66)
- Various temperature inputs: thermocouple, platinum resistance thermometer, non-contact temperature sensor, and analog inputs
- Conforms to UL, CSA, IEC, and CE

Ordering Information

■ E5CN STANDARD MODELS

Description				Part number	
Size	Power supply voltage	No. of alarm points	Output	**Thermocouple model**	**Platinum resistance thermometer model**
1/16 DIN 48(W) x 48(H) x 78(D) mm	100 to 240 VAC	---	Relay	**E5CN-RMTC-500 AC100-240**	**E5CN-RMP-500 AC100-240**
			Voltage output (for driving SSR)	**E5CN-QMTC-500 AC100-240**	**E5CN-QMP-500 AC100-240**
		2	Relay	**E5CN-R2MTC-500 AC100-240**	**E5CN-R2MP-500 AC100-240**
			Voltage output (for driving SSR)	**E5CN-Q2MTC-500 AC100-240**	**E5CN-Q2MP-500 AC100-240**
	24 VAC/VDC	---	Relay	**E5CN-RMTC-500 AC/DC24**	**E5CN-RMP-500 AC/DC24**
			Voltage output (for driving SSR)	**E5CN-QMTC-500 AC/DC24**	**E5CN-QMP-500 AC/DC24**
		2	Relay	**E5CN-R2MTC-500 AC/DC24**	**E5CN-R2MP-500 AC/DC24**
			Voltage output (for driving SSR)	**E5CN-Q2MTC-500 AC/DC24**	**E5CN-Q2MP-500 AC/DC24**

Note: 1. The suffix “500” is added to the part number of each Controller provided with a E53-COV10 Terminal Cover.
2. The heating and cooling function is available for models with two alarm points.

■ E5CN OPTION BOARDS

The E5CN provides communications or event input functionality when mounted with one of the following Option Boards.

Item	Function	**Part number**
Communications Board	RS-485 communication	**E53-CNH03**
Event Input Board	Event input	**E53-CNHB**

Note: The heater burnout alarm is available by mounting the E53-CNH03 or E53-CNHB Option Unit on the E5CN.

■ ACCESSORIES

Terminal Cover (Sold Separately)

Applicable Controller	**Part number**
E5CN	**E53-COV10**

Current Transformer (Sold Separately)

Item	Hole diameter	**Part number**
Current Transformer	5.8 dia.	**E54-CT1**
	12.0 dia.	**E54-CT3**

■ INPUT RANGES

Platinum Resistance Thermometer Input

Shaded ranges indicate default settings.

	Platinum resistance thermometer input				
Input type	Platinum resistance thermometer				
Name	Pt100			JPt100	
Temperature range	850 / −200	500.0 / −199.9	100.0 / 0.0	500.0 / −199.9	100.0 / 0.0
Set value	0	1	2	3	4

Thermocouple Input

Shaded ranges indicate default settings.

	Thermocouple input																
Input type	Thermocouple												ES1A Non-contact Temperature Sensor				Analog input
Name	K		J		T	E	L	U	N	R	S	B	K10 to 70°C	K60 to 120°C	K115 to 165°C	K160 to 260°C	0 to 50 mV
Temperature range	1300 / −200	500.0 / −20.0	850 / −100	400.0 / −20.0	400 / −200	600 / 0	850 / −100	400 / −200	1300 / −200	1700 / 0	1700 / 0	1800 / 100	70 / 0	120 / 0	165 / 0	260 / 0	Usable in the following ranges by scaling: −19999 to 9999 or −199.9 to 999.9
Set value	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

Applicable standards by input type are as follows:

K, J, T, E, N, R, S, B: JIS C1602-1995
L: Fe-CuNi, DIN 43710-1985
U: Cu-CuNi, DIN 43710-1985
JPt100: JIS C1604-1989, JIS C1606-1989
Pt100: JIS C1604-1997, IEC751

Note: The ES1A Non-contact Temperature Sensor will be available soon.

Specifications

■ RATINGS

Supply voltage		100 to 240 VAC, 50/60 Hz	24 VAC, 50/60 Hz/24 VDC
Operating voltage range		85% to 110% of rated supply voltage	
Power consumption	E5CN	7 VA	4 VA/3 W
Sensor input		Thermocouple: K, J, T, E, L, U, N, R, S, B Platinum resistance thermometer: Pt100, JPt100 Non-contact temperature sensor: K10 to 70°C, K60 to 120°C, K115 to 165°C, K160 to 260°C Voltage input: 0 to 50 mV	
Control output	Relay output	SPST-NO, 250 VAC, 3A (resistive load), electrical life: 100,000 operations	
	Voltage output	12 VDC (PNP), max. load current: 21 mA, with short-circuit protection	
Alarm output		SPST-NO, 250 VAC, 1 A (resistive load), electrical life: 100,000 operations	
Control method		PID or ON/OFF control	
Setting method		Digital setting using front panel keys	
Indication method		7-segment digital display and single-lighting indicator	
Other functions		According to Controller model	
Ambient temperature		-10°C to 55°C (14°F to 131°F) with no condensation or icing	
Ambient humidity		25% to 85% relative humidity	
Storage temperature		-25°C to 65°C (-13°F to 149°F) with no condensation or icing	

■ CHARACTERISTICS

Indication accuracy		Thermocouple: (±0.5% of indicated value or ±1°C, whichever greater) ±1 digit max. (See Note.) Platinum resistance thermometer: (±0.5% of indicated value or ±1°C, whichever greater) ±1 digit max. Analog input: ±0.5% FS±1 digit max. CT input: ±5% FS±1 digit max.	
Hysteresis		0.1 to 999.9 EU (in units of 0.1 EU)	
Proportional band (P)		0.1 to 999.9 EU (in units of 0.1 EU)	
Integral time (I)		0 to 3999 s (in units of 1 s)	
Derivative time (D)		0 to 3999 s (in units of 1 s)	
Control period		1 to 99 s (in units of 1 s)	
Manual reset value		0.0% to 100.0% (in units of 0.1%)	
Alarm setting range		-1999 to 9999 (decimal point position depends on input type)	
Sampling period		500 ms	
Insulation resistance		20 MΩ min. (at 500 VDC)	
Dielectric strength		2000 VAC, 50 or 60 Hz for 1min (between different charging terminals)	
Vibration resistance		10 to 55 Hz, 10 m/s^2 for 2 hours each in X, Y and Z directions	
Shock resistance		300 m/s^2, 3 times each in 3 axes, 6 directions (relay: 100 m/s^2)	
Weight		Approx. 150 g	Mounting bracket: Approx. 10g
Protective structure	Front panel	NEMA4 for indoor use (equivalent to IP66)	
	Rear case	IP20	
	Terminals	IP00	
Memory protection		EEPROM (non-volatile memory) (number of writes: 100,000)	
EMC		Emission Enclosure: EN55011 Group 1 class A Emission AC Mains: EN55011 Group 1 class A Immunity ESD: EN61000-4-2: 4 kV contact discharge (level 2) 8 kV air discharge (level 3) Immunity RF-interference: ENV50140: 10 V/m (amplitude modulated, 80 MHz to 1 GHz) (level 3) 10 V/m (pulse modulated, 900 MHz) Immunity Conducted Disturbance: ENV50141: 10 V (0.15 to 80 MHz) (level 3) Immunity Burst: EN61000-4-4: 2 kV power-line (level 4) 2 kV I/O signal-line (level 4)	
Approval standards		UL3121-1, CSA22.2 No. 14, E.B.1402C Conforms to EN50081-2, EN50082-2, EN61010-1 (IEC1010-1) Conforms to VDE0106/part 100 (Finger Protection), when the terminal cover is mounted.	

Note: The indication of K thermocouples in the -200 to 1300°C range, and T and N thermocouples at a temperature of -100°C or less, and U and L thermocouples at any temperature is ±2°C±1 digit maximum. The indication of B thermocouples at a temperature of 400°C or less is unrestricted.
The indication of R and S thermocouples at a temperature of 200°C or less is ±3°C±1 digit maximum.

■ COMMUNICATIONS SPECIFICATIONS

Transmission path connection	Multiple points
Communications method	RS-485 (two-wire, half duplex)
Synchronization method	Start-stop synchronization
Baud rate	1,200/2,400/4,800/9,600/19,200 bps
Transmission code	ASCII
Data bit length	7 or 8 bits
Stop bit length	1 or 2 bits
Error detection	Vertical parity (none, even, odd) Frame check sequence (FCS): with SYSMAC WAY Block check character (BCC): with CompoWay/F
Flow control	Not available
Interface	RS-485
Retry function	Not available
Communications buffer	40 bytes

Note: The baud rate, data bit length, stop bit length, or vertical parity can be individually set using the communications setting level.

■ CURRENT TRANSFORMER (SOLD SEPARATELY) RATINGS

Dielectric strength		1,000 VAC (1 min)
Vibration resistance		50 Hz 98 m/s^2
Weight	E54-CT1	Approx. 11.5 g
	E54-CT3	Approx. 50 g
Accessories (E54-CT3 only)	Armature	2
	Plug	2

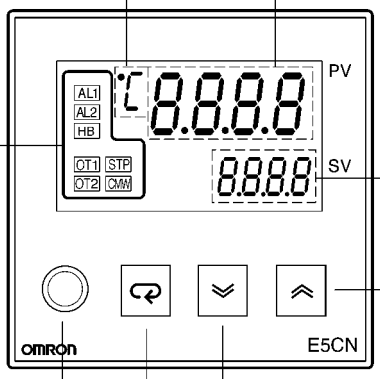
■ HEATER BURNOUT ALARM SPECIFICATIONS

Max. heater current	Single-phase AC: 50 A (See Note 1.)
Input current readout accuracy	±5%FS±1 digit max.
Heater burnout alarm setting range	0.0 to 50.0 A (0.1 A units) (See Note 2.)
Min. detection ON time	190 ms (See Note 3.)

Note: 1. When heater burnout is detected on a 3-phase heater, use the K2CU-F□□A-□GS (with gate input terminal).
2. When the set value is “00 A,” the heater burnout alarm will always be OFF. When the set value is “50.0 A,” the heater burnout alarm will always be ON.
3. When the control output ON time is less than 190 ms, heater burnout detection and heater current measurement will not be carried out.

Nomenclature

E5CN



Operation Indicators

1. AL1 (alarm 1)
   Lights when alarm 1 output is ON.
   AL2 (alarm 2)
   Lights when alarm 2 output is ON.
2. HB (heater burnout alarm display)
   Lights when a heater burnout is detected.
   The heater burnout alarm remains ON by setting the heater burnout latch. To reset, turn the power supply OFF and then ON or set the heater burnout alarm value to "0.0A."
3. OT1, OT2 (control output 1, control output 2)
   Lights when control output 1 and/or control output 2 (cool) are ON.
4. STP (stop)
   Lights when control of the E5CN has been stopped. During control, this indicator lights when an event or the run/stop function has stopped, or this indicator is out.
5. CMW (communications writing control)
   Lights when communications writing is enabled and is out when it is disabled.

Temperature Unit

The temperature unit is displayed when the display unit parameter is set to a temperature. Indication is determined by the currently selected "temperature unit" parameter set value. When this parameter is set to "°C," "C" is displayed, and when set to "°F," "F" is displayed.

No. 1 Display

Displays the process value or parameter type.

No. 2 Display

Displays the set point, manipulated variable, or set value (setup) of the parameter.

Up Key

Each press of this key increases values displayed on the No.2 display. Holding down this key continuously increases values.

Down Key

Each press of this key decreases values displayed on the No.2 display. Holding down this key continuously decreases values.

Level + Mode Keys

This key combination sets the E5CN to the "protect level."

Level Key

Press this key to select the setup level. The setup level is selected in this order: "operation level" ←→ "adjustment level," "initial setting level" ←→ "communications setting level."

Mode Key

Press this key to select parameters within each level.

Operation

■ INITIAL SETUP

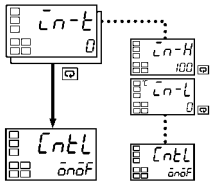
On previous Controllers, sensor input type, alarm type and control period were set on DIP switches. These hardware settings are now set in parameters in setup menus. The ◎ and ↩ keys are used to switch between setup menus, and the amount of time that you hold the keys down determines which setup menu you move to. This section describes two typical examples.

Note: On the E5GN, the ◎ Key is the ▭ Key.

1. ON/OFF Control

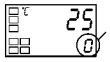
Typical Application Examples

- Changing Parameters



indicates that there is a parameter. Keep on pressing the mode key until the desired parameter is selected.

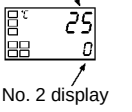
- Changing Set Values



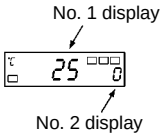
Use the ▽ or △ keys to change the set value displayed in the setup menu.

Display

E5CN



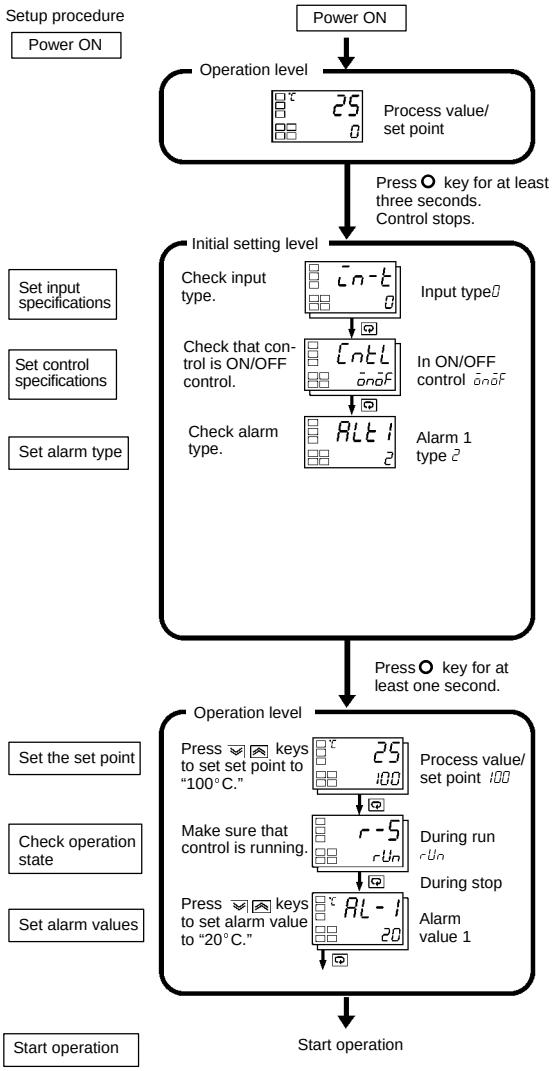
E5GN



Typical Example

Input type:	0 K thermocouple -200 to 1300°C
Control method:	ON/OFF control
Alarm type:	2 upper limit
Alarm value 1:	20°C (For setting deviation)
Set point:	100°C

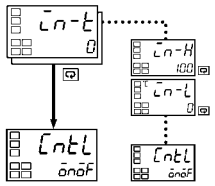
Change only the alarm value 1 and set point.
The rest must be left as default settings.



2. PID Control Using Auto-tuning

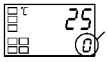
Typical Application Example

- Changing Parameters



indicates that there is a parameter. Keep on pressing the mode key until the desired parameter is selected.

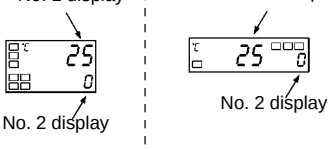
- Changing Set Values



Use the ▼ or ▲ keys to change the set value displayed in the setup menu.

Display

E5CN	E5GN
No. 1 display	No. 1 display
No. 2 display	No. 2 display



Typical Example

Input type:	4 T thermocouple -200 to 400°C
Control method:	PID control
ST (self-tuning):	OFF
Calculate PID constants by AT (auto-tuning).	
Alarm type:	2 upper limit
Alarm value 1:	30°C (For setting deviation)
Set point:	150°C

Setup procedure

Power ON

Power ON

Operation level

Process value/ set point

Press O key for at least three seconds. Control stops.

Initial setting level

Set input specifications

Press keys to select input type.

Input type 4

Set control specifications

Press keys to select PID control.

In PID control

Self-tuning

Press keys to set ST to OFF.

To cancel ST

Check control period

Check the control period.

Control period (heat) (unit: seconds)

When set to ON, self-tuning operates. Recommended settings: 20 seconds for the relay output and 2 seconds for the SSR output.

Check alarm type

Check alarm type.

Alarm 1 type 2 (upper-limit alarm)

Press O key for at least one second.

Operation level

Set the set point

Press keys to set set point to "150°C."

Process value/ set point 150

Press O key for less than one second.

Adjustment level

AT execution

Execute AT (auto-tuning).

To execute AT

Set to on for executing AT and to oFF for stopping AT.

Press O key for less than one second.

Operation level

Set operation status

Make sure that control is running.

During run

Set alarm values

Make sure that set point is "150°C."

Process value/ set point 150

Press keys to set alarm value to "30°C."

Alarm value 1 30

Start operation

Start program execution

PV/SP

After AT execution.

During AT execution.

While AT is being executed, SP will flash.

After AT execution.

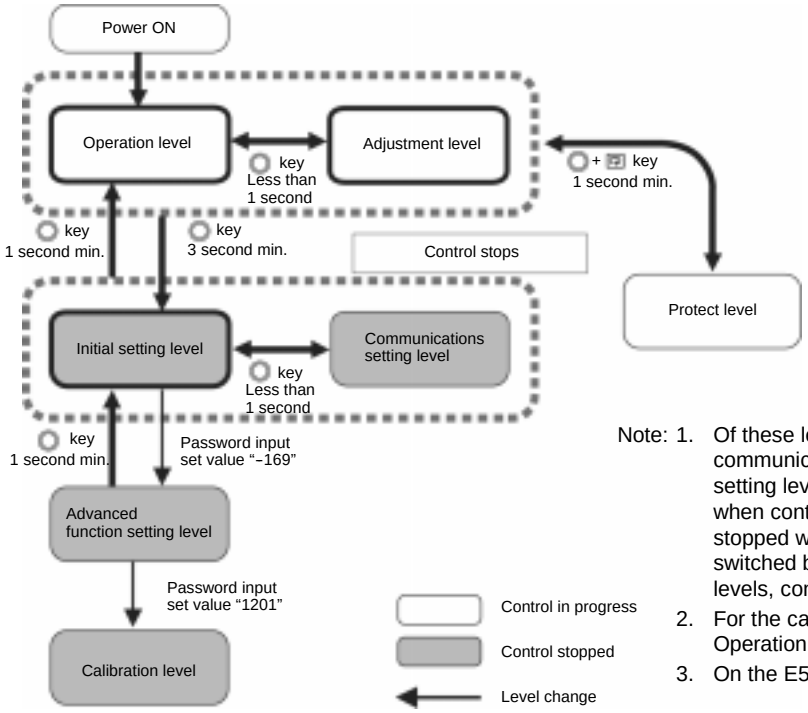
During AT execution.

Specification Setting After Turning ON Power

■ OUTLINE OF OPERATION PROCEDURES

Key Operation

In the following descriptions, all the parameters are introduced in the display sequence. Some parameters may not be displayed depending on the protect settings and operation conditions.



Note: 1. Of these levels, the initial setting level, communications setting level, advanced function setting level and calibration level can be used only when control has stopped. Note that control is stopped when these four levels are selected. When switched back to the operation level from one of these levels, control will start.
2. For the calibration mode, refer to the relevant Operation Manual (H100 or H101).
3. On the E5GN, the ◎ Key is the ⬭ Key.

■ DESCRIPTION OF EACH LEVEL

Operation Level

This level is displayed when you turn the power ON. You can move to the protect level, initial setting level and adjustment level from this level.

Normally, select this level during operation. During operation, the process value, set point and manipulated variable can be monitored, and the alarm value and upper- and lower-limit alarms can be monitored and modified.

Adjustment Level

To select this level, press the ◎ key once for less than one second.

This level is for entering set values and offset values for control. This level contains parameters for setting the set values, AT (auto-tuning), communications writing enable/disable, hysteresis, multi-SP, input shift values, heater burnout alarm (HBA) and PID constants. You can move to the top parameter of the operation level or initial setting level from here.

Initial Setting Level

To select this level, press the ◎ key for at least three seconds in the operation level. This level is for specifying the input type, selecting the control method, control period, setting direct/reverse action and alarm type. You can move to the advanced function setting level or communications setting level from this initial setting level. To return to the operation level, press the ◎ key for at least one second. To move to the communications setting level, press the ◎ key once for less than one second.

Protect Level

To select this level, simultaneously press the ◎ and ⮌ keys for at least one second. This level is to prevent unwanted or accidental modification of parameters. Protected levels will not be displayed, and so the parameters in that level cannot be modified.

Communications Setting Level

To select this level, press the ◎ key once for less than one second in the initial setting level. When the communications function is used, set the communications conditions in this level. Communicating with a personal computer (host computer) allows set points to be read and written, and manipulated variables to be monitored.

Advanced Function Setting Level

To select this level, you must enter the password (“-169”) in the initial setting level.

You can move only to the calibration level from this level.

This level is for setting the automatic return of display mode, MV limiter, event input assignment, standby sequence, alarm hysteresis, ST (self-tune) and to move to the user calibration level.

Calibration Level

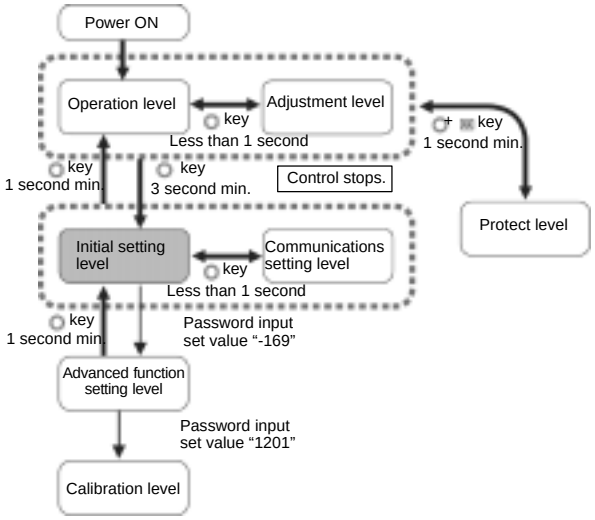
To select this level, you must enter the password (“1201”) in the advanced function setting level. This level is for offsetting deviation in the input circuit.

You cannot move to other levels by operating the keys on the front panel from the calibration level. To cancel this level, turn the power OFF then back ON again.

■ SPECIFICATION SETTING (AFTER TURNING ON POWER)

Initial Setting Level

This level is used for setting basic specifications of the Temperature Controller. Using this level, set the input type for selecting the input to be connected such as the thermocouple or platinum resistance thermometer and set the range of set point and the alarm mode.

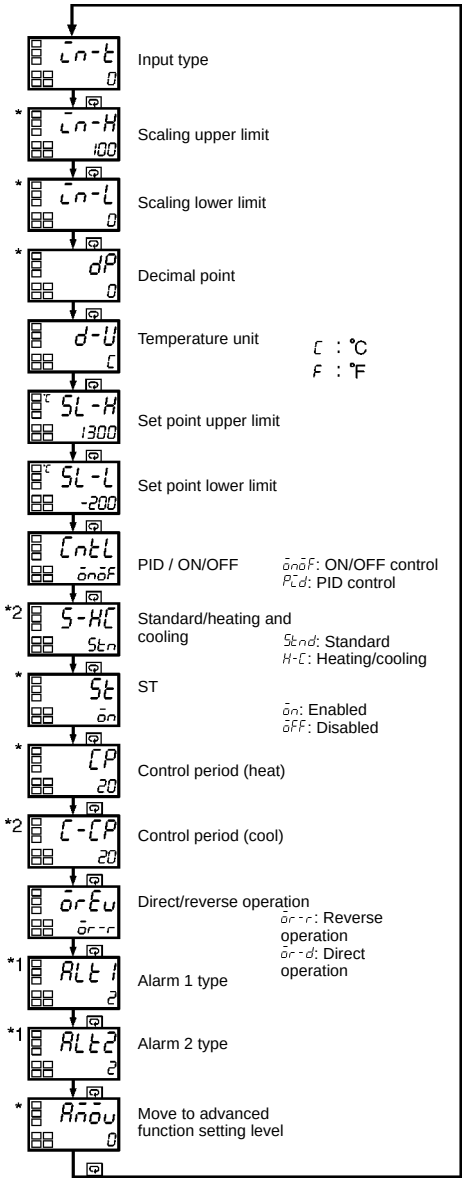


The move from the operation level to the initial setting level, press ◎ key for three seconds or more.

The initial setting level is not displayed when "initial/communications protection" is set to "2." This initial setting level can be used when "initial setting/communications protection" is set to "0" or "1."

The "scaling upper limit," "scaling lower limit," and "decimal point" parameters are displayed when an analog voltage input is selected as the input type.

Initial setting level



To return to the operation level, press the ◎ key for longer than one second

*Not displayed as default setting.

Note: 1. Displayed only with models provided with an alarm function.
2. Displayed only with the E5CN provided with a two-point alarm function.

■ INPUT TYPE

Using a Thermocouple Input Type

When using a thermocouple input type, follow the specifications listed in the following table.

Input type	Specifications	Set Value	Input Temperature Range
Thermocouple	K	0	−200 to 1300 (°C) /−300 to 2300 (°F)
		1	−20.0 to 500.0 (°C) /0.0 to 900.0 (°F)
	J	2	−100 to 850 (°C) /−100 to 1500 (°F)
		3	−20.0 to 400.0 (°C) /0.0 to 750.0 (°F)
	T	4	−200 to 400 (°C) /−300 to 700 (°F)
	E	5	0 to 600 (°C) /0 to 1100 (°F)
	L	6	−100 to 850 (°C) /−100 to 1500 (°F)
	U	7	−200 to 400 (°C) /−300 to 700 (°F)
	N	8	−200 to 1300 (°C) /−300 to 2300 (°F)
	R	9	0 to 1700 (°C) /0 to 3000 (°F)
	S	10	0 to 1700 (°C) /0 to 3000 (°F)
	B	11	100 to 1800 (°C) /300 to 3200 (°F)
Non-contact temperature sensor ES1A	K10 to 70°C	12	0 to 90 (°C) /0 to 190 (°F)
	K60 to 120°C	13	0 to 120 (°C) /0 to 240 (°F)
	K115 to 165°C	14	0 to 165 (°C) /0 to 320 (°F)
	K160 to 260°C	15	0 to 260 (°C) /0 to 500 (°F)
Analog input	0 to 50mV	16	One of following ranges depending on the results of scaling: 1999 to 9999, 199.9 to 999.9

Note: The initial settings are: 0: −200 to 1300°C/−300 to 2300°F.

Using a Platinum Resistance Thermometer Input Type

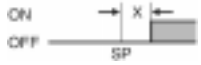
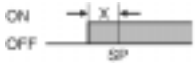
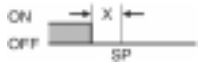
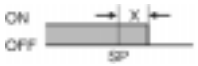
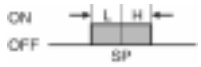
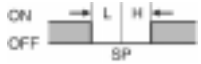
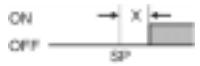
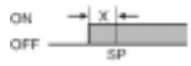
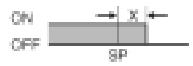
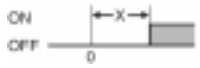
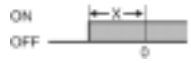
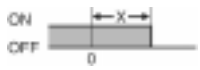
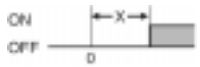
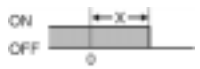
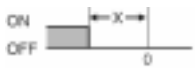
When using the platinum resistance thermometer input type, follow the specifications listed in the following table.

Input type	Specifications	Set Value	Input Temperature Range
Platinum resistance thermometer	Pt100	0	−200 to 850 (°C) /−300 to 1500 (°F)
		1	−199.9 to 500.0 (°C)/−199.9 to 900.0 (°F)
		2	0.0 to 100.0 (°C) /0.0 to 210.0 (°F)
	JPt100	3	−199.9 to 500.0 (°C)/−199.9 to 900.0 (°F)
		4	0.0 to 100.0 (°C) /0.0 to 210.0 (°F)

Note: 1. The initial settings are: 0: Pt100 −200 to 850°C/−300 to 1500°F.
2. The ES1A Non-contact Temperature Sensor will be available soon.

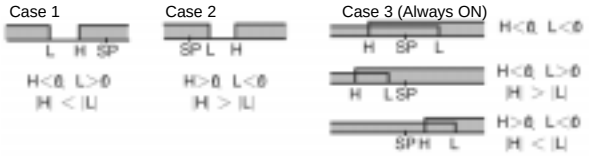
■ ALARM 1 AND ALARM 2

For the alarm 1 and alarm 2, select alarm types out of the 12 alarm types listed in the following table.

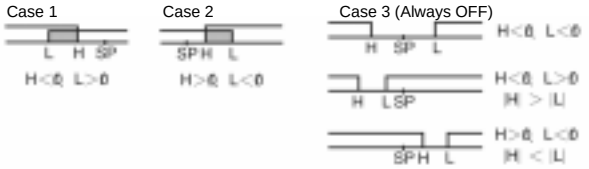
Set Value	Alarm Type	Alarm Output Operation	
		When X is positive	When X is negative
0	Alarm function OFF	Output OFF	
1*1	Upper- and lower-limit (deviation)		*2
2	Upper-limit (deviation)		
3	Lower-limit (deviation)		
4*1	Upper- and lower-limit range (deviation)		*3
5*1	Upper- and lower-limit with standby sequence (deviation)		*4
6	Upper-limit with standby sequence (deviation)		
7	Lower-limit with standby sequence (deviation)		
8	Absolute-value upper-limit		
9	Absolute-value lower-limit		
10	Absolute-value upper-limit with standby sequence		
11	Absolute-value lower-limit with standby sequence		

*1: With set values 1, 4 and 5, the upper and lower limit values can be set independently for each alarm type and are expressed as “L” and “H.”
Following operations are for cases when an alarm set point is “X” or negative.

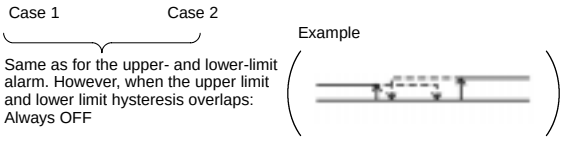
*2: Set value: 1, upper- and lower-limit alarm



*3: Set value: 4, upper- and lower-limit range



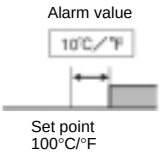
*4: Set value: 5, upper- and lower-limit with standby sequence



Example: When the alarm is set ON at 110°C/°F or higher.

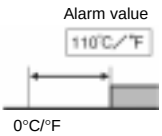
- **When an alarm type other than the absolute-value alarm is selected**

(For alarm types 1 to 7)
The alarm value is set as a deviation from the set point.



- **When the absolute-value alarm is selected**

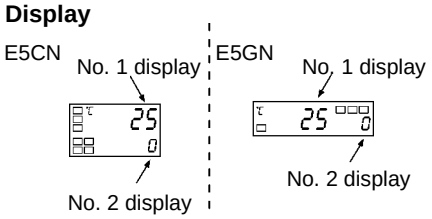
(For alarm types 8 to 11)
The alarm value is set as an absolute value from the alarm value of 0°C/F.

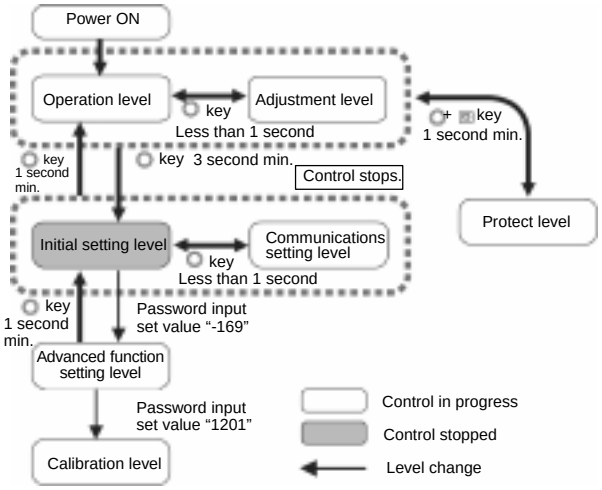


■ PARAMETERS

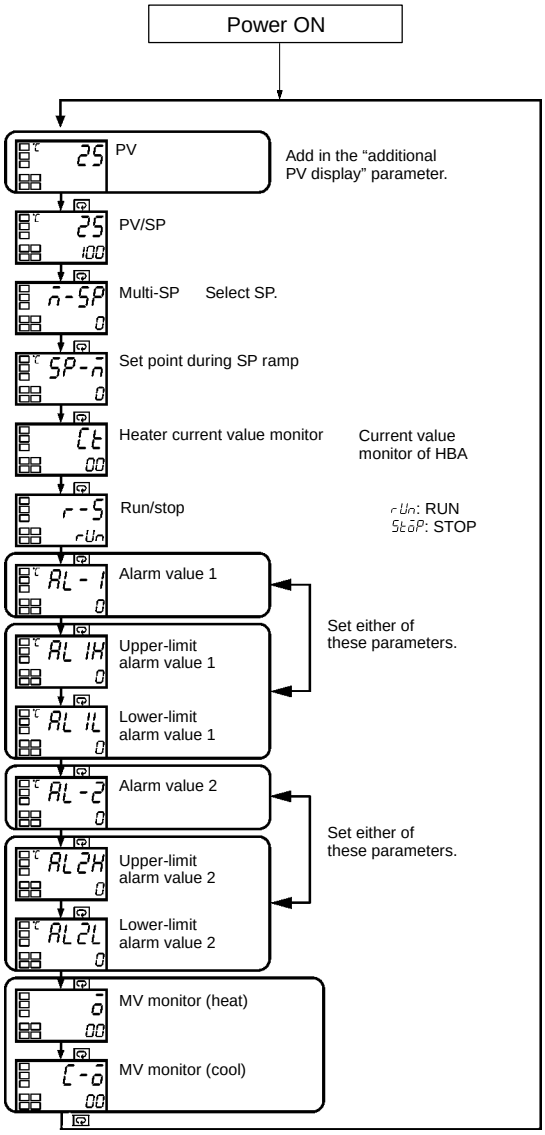
Parameters related to setting items for each level are marked in boxes in the flowcharts and brief descriptions are given as required. At the end of each setting item, press the mode key to return to the beginning of each level.

Display

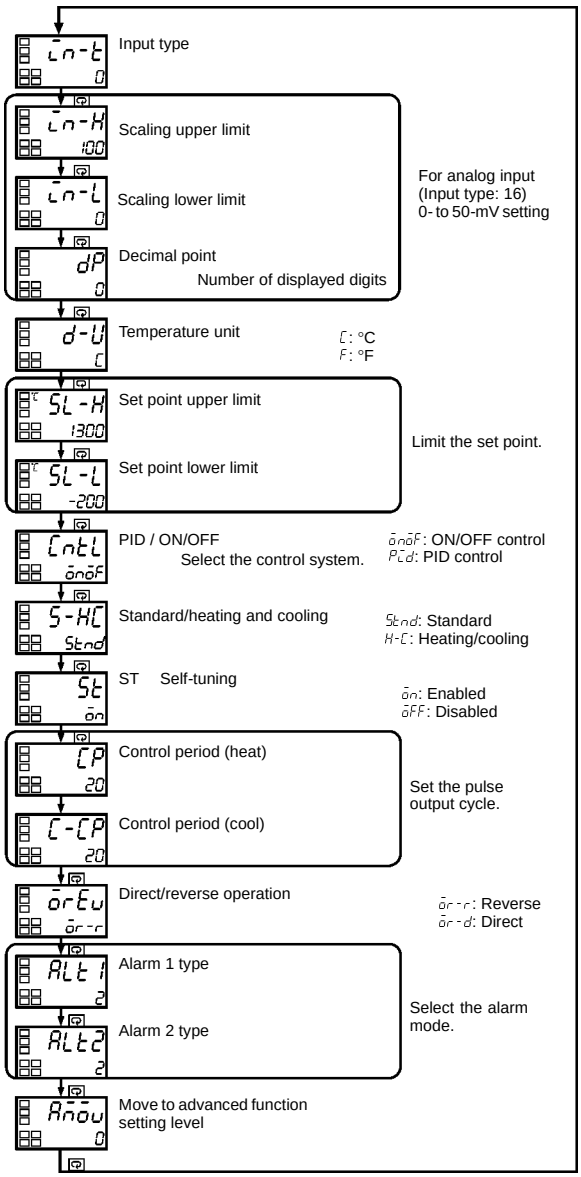




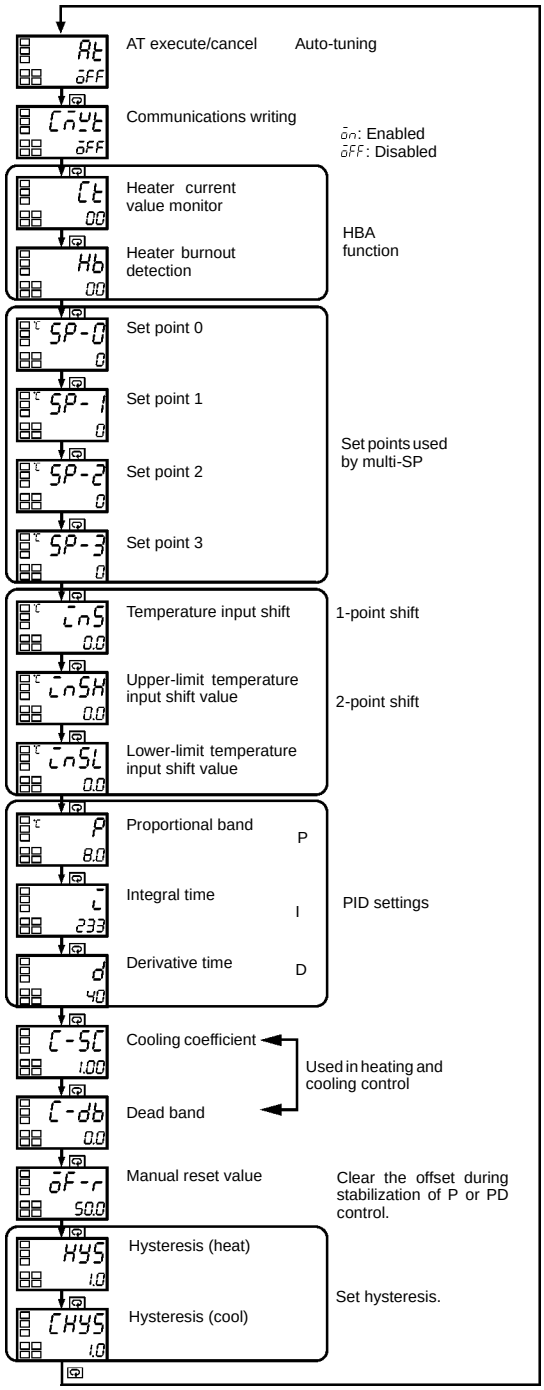
Operation Level



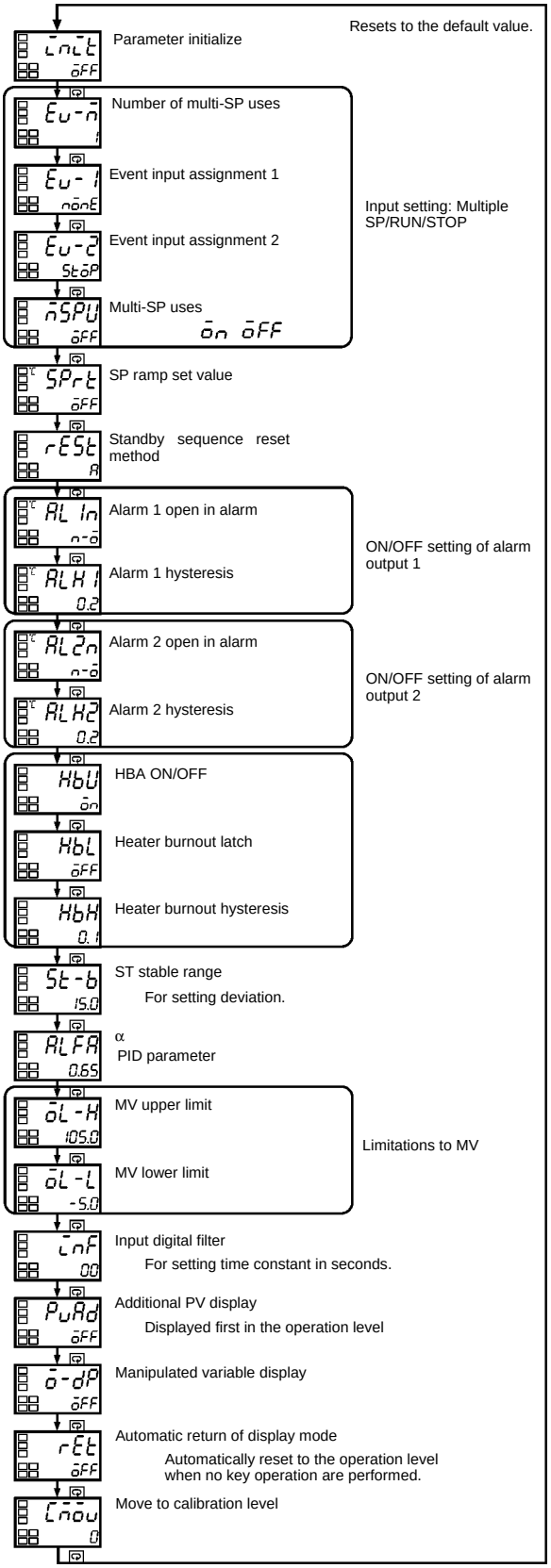
Initial Setting Level



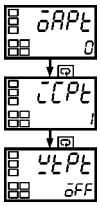
Adjustment Level



Advanced Function Setting Level



Protect Level



Operation/adjustment protection

Restricts display and modification of menus in the operation and adjustment levels.

Initial setting/communications protection

Restricts display and modification of menus in the initial setting, operation level and adjustment levels.

Setting change protection

Protects changes to setups by operating the front panel keys.

Operation/Adjustment Protection

The following table shows the relationship between set values and the range of protection.

Level		Set value			
		0	1	2	3
Operation level	PV	○	○	○	○
	PV/SP	◎	◎	◎	◎
	Other	◎	◎	X	X
Adjustment level		◎	X	X	X

When this parameter is set to “0,” parameters are not protected.

Default setting: 0

◎ : Can be displayed and changed
○ : Can be displayed
× : Cannot be displayed and move to other levels not possible

Initial Setting/Communications Protection

This protect level restricts movement to the initial setting level, communications setting level and advanced function setting level.

Set value	Initial setting level	Communications setting level	Advanced function setting level
0	○	○	○
1	○	○	X
2	X	X	X

Default setting: 1

○ : Move to other levels possible
× : Move to other levels not possible

Setting Change Protection

This protect level protects setup from being changed by operating the keys on the front panel.

Set value	Description
OFF	Setup can be changed by key operation.
ON	Setup cannot be changed by key operation. (The protect level, can be changed.)

Default setting: OFF

Communications Setting Level

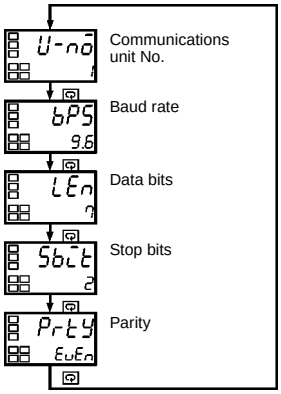
Set the E5CN/E5GN communications specifications in the communications setting level. For setting communications parameters, use the E5CN/E5GN panel. The communications parameters and their settings are listed in the following table.

Parameter	Displayed characters	Set (monitor) value	Set value
Communications unit No.	U-no	0 to 99	0.1 to 99
Baud rate	bPS	1.2/2.4/4.8/9.6/19.2 (kbps)	1.2/2.4/4.8/9.6/19.2
Data bits	LEn	7/8 (bit)	7/8 (bit)
Stop bits	Sbit	1/2	1/2 (bit)
Parity	Prty	None, even, odd	nonE/EvEn/odd

Note: The highlighted values indicate default settings.

Before executing communications with the E5CN/E5GN, set the communications unit No., baud rate, etc., through key operations as described below. As for other operations, refer to the relevant Operation Manual.

1. Press the ◎ key for at least three seconds in the “operation level.” The level moves to the “initial setting level.”
2. Press the ◎ key for less than one second. The “initial setting level” moves to the “communications setting level.”
3. Pressing the ↵ key advances the parameters as shown in the following figure.
4. Press the ▲ or ▼ keys to change the parameter setups.



Note: On the E5GN, the ◎ Key is the ⬭ Key.

Set each communications parameter to match those of the communicating personal computer.

Communications Unit No. (U-no)

When communicating with the host computer, the unit number must be set in each Temperature Controller so that the host computer can identify each Temperature Controller. The number can be set in a range from 0 to 99 in increments of 1. The default setting is 1. When using more than one Unit, be careful not to use the same number twice. Duplicate settings will cause malfunction. This value becomes valid when the power is turned OFF and ON again.

Baud Rate (bPS)

Use this parameter to set the speed of communications with the host computer. It can be set to one of the following values; 1.2 (1200 bps), 2.4 (2400 bps), 4.8 (4800 bps), 9.6 (9600 bps), and 19.2 (19200 bps).
This setting becomes valid when the power is turned OFF and ON again.

Data Bits (LEn)

Use this parameter to change the communications data bit length to 7 bits or 8 bits.

Stop Bits (Sbit)

Use this parameter to change the communications stop bit to 1 or 2.

Parity (Prty)

Use this parameter to set the communications parity to None, Even, or Odd.

■ TROUBLESHOOTING

When an error occurs, an error code will be displayed on the No. 1 display. Check the contents of an error and take appropriate countermeasures.

No. 1 display	Type of error	Countermeasures
S.Err	Input error	Check the wiring of inputs for miswiring, disconnections, short-circuits, and the input type.
E111	Memory error	First, turn the power OFF then back ON again. If the display remains the same, the Unit must be repaired. If the display is restored, then a probable cause can be external noise affecting the control system. Check for external noise.
cccc	Display range over	Though not error, this is displayed when the process value exceeds the display range when the control range is larger than the display range. • When less than "-1999" cccc • When larger than "9999" ɔɔɔɔ
ɔɔɔɔ		
HErr	HB error	First, turn the power OFF then back ON again. If the display remains the same, the controller must be repaired. If the display is restored, then a probable cause can be electrical noise affecting the control system. Check for electrical noise.

Note: Error will be displayed only when the display is set for the PV or PV/SP.

Fuzzy Self-tuning

The fuzzy self-tuning (ST) is a function that automatically calculates an optimum PID constant depending on items to be controlled.

■ FEATURE

The Temperature Controller determines when to execute this fuzzy self-tuning.

■ FUNCTIONS

SRT: Performs PID tuning according to the step response method when the SP is changed.

LCT: Performs PID tuning according to the limit cycle method when the SP is changed.

Requirements for SRT Functionality

The ST will be executed according to the step response method when the following conditions are satisfied when operation is started or when the SP is changed.

When operation is started	When SP is changed
1. The SP at the startup is different from the SP at the time the previous SRT was executed. (See Note.) 2. The temperature upon startup is smaller than the SP in the reverse operation and larger than the SP in the direct operation. 3. Restarting of operation is not due to an input error. Note: The "SP that existed when the previous SRT was executed" refers to the SP used for obtaining the PID constant in the previous SRT.	1. The SP after change is different from the SP at the time the previous SRT was executed. (See Note.) 2. In the reverse operation, the value obtained by deducting the SP before change from the SP after change is larger than the ST stable range. In the direct operation, the value obtained by deducting the SP after change from the SP before change is larger than the ST stable range. 3. The SP change width is larger than the current proportional band x 1.27 + 4. 4. The temperature is in the stable state. (It can be in the balanced state if no output is generated when the power is turned ON.)

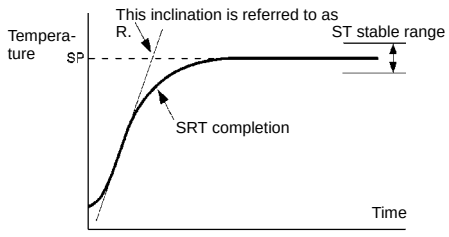
If the SP is changed while SRT is being executed and if SRT completion conditions are satisfied, no PID change will take place.

Stabilization State

Measured values remain in the stable range for a certain period of time.

Balanced State

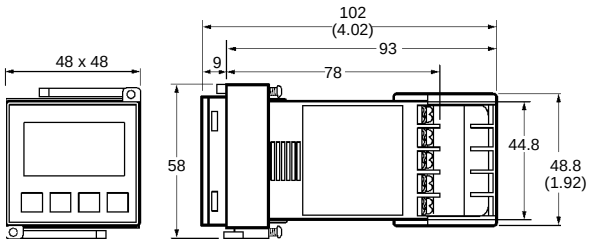
Output is 0% for 60 seconds and measured values fluctuate within the width of the stable range.



Dimensions

Unit: mm (inch)

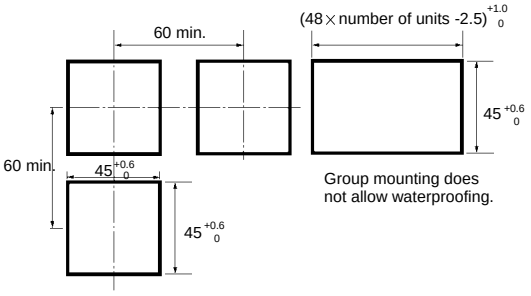
■ E5CN



Note: The suffix “500” is added to the model number of each Controller provided with a E53-COV10 Terminal Cover.

Panel Cutouts

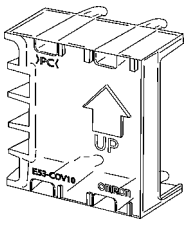
Mounted Separately **Group Mounted**

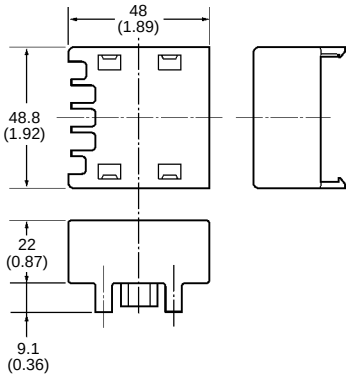


- Recommended panel thickness is 1 to 5 mm.
- Group mounting is not possible in the vertical direction. (Maintain the specified mounting space between Controllers when they are group mounted.) To mount the E5CN so that it is waterproof, apply the waterproof seal to the E5CN.
- When two or more E5CNs are mounted, make sure that the surrounding temperature does not exceed the allowable operating temperature, as specified in the specifications.

■ TERMINAL COVER

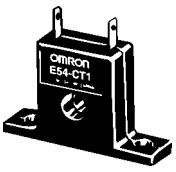
E53-COV10

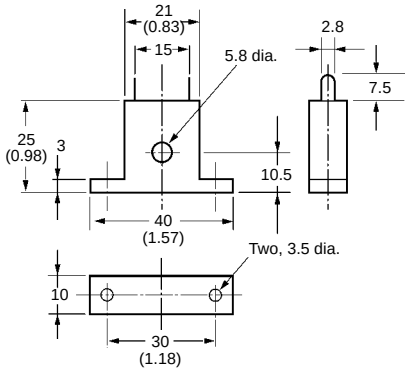




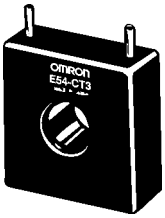
■ CURRENT TRANSFORMER (SOLD SEPARATELY)

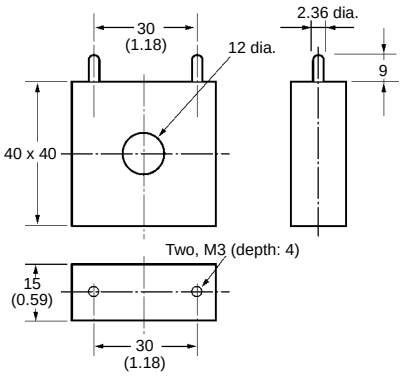
E54-CT1





E54-CT3





Installation

■ SETTING UP OPTION BOARDS

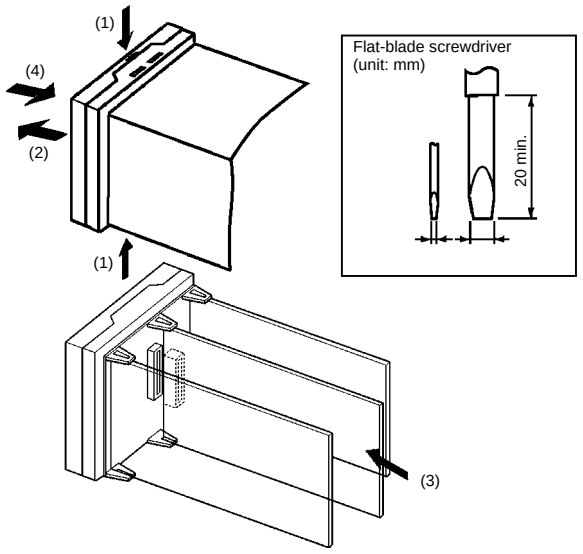
If communications, event input, or heater burnout functions are required, mount the E53-CNH03 Communications Board or the E53-CNHB Event Input Board. The heater burnout function is supported on either of these two Option Boards.

Option Boards

Name	Model	Function
Communications Board	E53-CNH03	RS-485 communications
Event Input Board	E53-CNHB	Event inputs

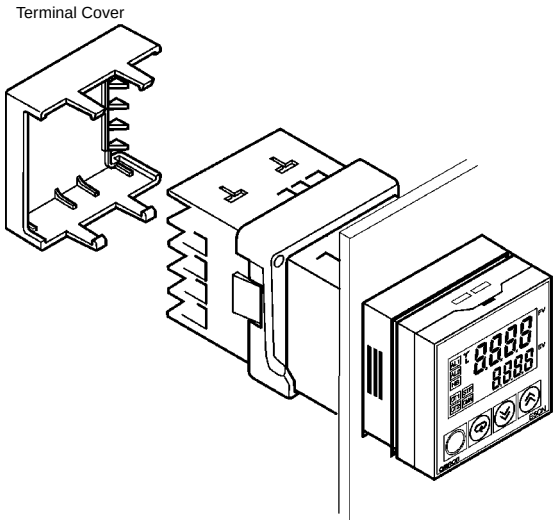
Note: Terminal label: x1

■ ASSEMBLY OF UNIT



1. Insert the tools (see drawing above) into the slots (one on the top and one on the bottom) and release the hooks.
2. Insert the tool in the space between the front and rear panels and slightly pull out the front panel. Hold the top and bottom of the front panel and pull toward yourself to remove it.
3. Match up the upper and lower claws with the connection points and insert the Option Board. Mount the Option Board in the center.
4. Before inserting the Unit, confirm that the waterproof seal is in place. Insert the Unit into the rear case until you hear a click. When inserting the Unit, press down the hooks on the top and bottom of the rear case, so they firmly hook on the board inserted.

■ MOUNTING



Attaching the E5CN to a Panel

1. Insert the E5CN into the mounting hole in the panel.
2. Push the adapter along the E5CN body from the terminals up to the panel and secure it temporarily.
3. Tighten the two screws on the adapter. When tightening screws, tighten the two screws alternately, keeping the torque to between 0.29 and 0.39 N•m (2.9 kgf•cm to 3.9 kgf•cm).

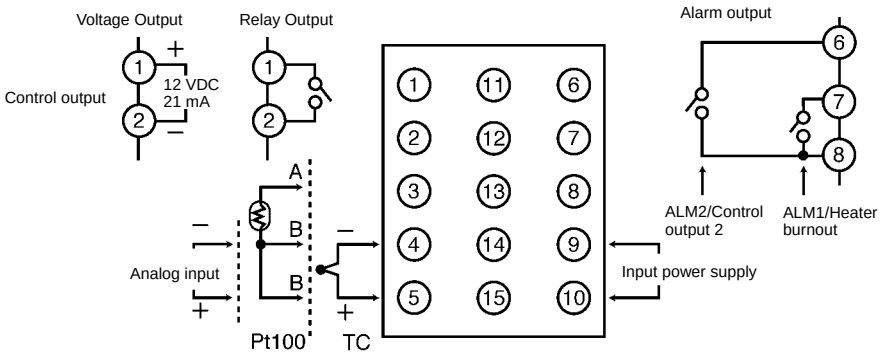
Attaching the Terminal Cover

Make sure that the “UP” mark is facing up, and then fit the Terminal Cover (E53-COV10) into the holes on the top and bottom. A E5CN-□-500 Controller is provided with a Terminal Cover.

WIRING TERMINALS

The voltage output (control output) is not electrically insulated from the internal circuits. When using a grounding thermocouple, do not connect the control output terminals to the ground. If the control output terminals are connected to the ground, errors will occur in the measured temperature values as a result of leakage current.

Standard insulation is applied to the power supply I/O sections. If reinforced insulation is required, connect the input and output terminals to a device without any exposed current-carrying parts or to a device with standard insulation suitable for the maximum operating voltage of the power supply I/O section.

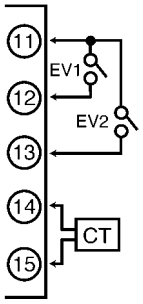


Two input power supplies are available: 100 to 240 VAC or 24 VDC.

E5CN OPTION BOARDS

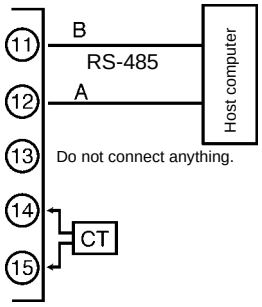
E53-CNHB Event Input Unit

Event Input/Heater Burnout Detection



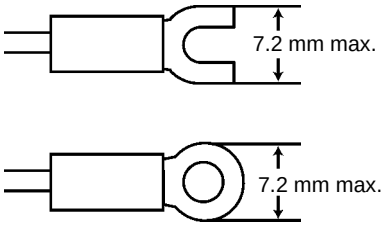
E53-CNH03 Communications Board

Communications Specification/Heater Burnout Specification



WIRING PRECAUTIONS

- Separate input leads and power lines to protect the E5CN and its lines from external noise.
- We recommend using solderless terminals when wiring the E5CN.
- Tighten the terminal screws using a torque no greater than 0.78 N•m.
- Use the following type of solderless terminals for M3.5 screws.



Precautions

OPERATING ENVIRONMENT

- Use the Temperature Controller within the rated operating temperature, storage temperature, and operating humidity specified for each model.
- Use the Temperature Controller according to the performance specifications such as vibration, shock, and degree of protection specified for each model.
- Do not use the Temperature Controller in places where it is subject to dust or corrosive gases.
- Install the Temperature Controller away from the devices that generate high-frequency noise.

SERVICE LIFE

The service life of relays used for the control output or alarm output varies depending on mostly switching conditions. Be sure to confirm their performance under actual operating conditions and do not use them beyond the allowable number of switchings. If they are used in a deteriorated condition, insulation between circuits may be damaged and, as a result, the Temperature Controller itself may be damaged or burned.

The service life of electronic devices such as Temperature Controllers is determined not only by the number of switchings of relays, but also by the service life of internal electronic components. The component service life is affected by the ambient temperature: the higher the temperature becomes, the shorter the service life becomes; the lower the temperature becomes, the longer the service life becomes. For this reason, the service life can be extended by lowering the internal temperature of the Temperature Controller.

When two or more Temperature Controllers are mounted horizontally close to each other or vertically next to each other, the internal temperature will increase, due to heat radiated by the Temperature Controllers, and the service life will decrease. In these situations, forced cooling by fans or other means of air ventilation will be required to cool down the Temperature Controllers. When providing forced cooling, however, be careful not to cool down the terminals solely, to avoid measurement errors.

ORDERING PRECAUTIONS

Units separately sold, such as Control Output Units and Current Transformers, are specified for each Temperature Controller. Be sure to order appropriate units according to the application.

INSTALLATION

Mounting

Mount the Temperature Controller horizontally level.

Connection

When extending or connecting the thermocouple lead wire, be sure to use compensating wires that match the thermocouple types.

When extending or connecting the lead wire of the platinum resistance thermometer, be sure to use wires that have low resistance.

When wiring the platinum resistance thermometer to the Temperature Controller, keep the wire route as short as possible. Separate this wiring away from the power supply wiring and load wiring to avoid inductive or other forms of noise.

Do not use empty terminals.

Crimp Terminal Connection

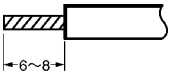
Use crimp terminals that match M3.5 screws. M3.5 x 8 self-rising screws are used.

E5CN

Be careful not to excessively tighten the terminals screws.

Soldering Connection

The self-rising screws provide easy soldering connection. Strip the lead wire by a length of 6 to 8 mm.



OPERATING PRECAUTIONS

For Temperature Controllers with alarm outputs, alarm output may not be generated correctly when an abnormality occurs in the device. A separate alarm device should be incorporated into the system.

To ensure proper performance, parameters of the Temperature Controllers are set to default values before they are shipped. Change these parameters depending on actual applications. If left unchanged, the Temperature Controller will operate under the default settings.

It takes several seconds for the relay to turn ON from the moment the power is turned ON. Consider this time when incorporating Temperature Controllers in a sequence circuit.

When pulling out the Temperature Controller body, do not apply excessive force. After the body is removed, be careful not to apply any shock to the connectors or other electronic components on the PCB.

Models without any specification on their degree of protection or those with IP□0 do not offer a waterproofing feature.

OMRON®

OMRON ELECTRONICS, INC.
One East Commerce Drive
Schaumburg, IL 60173
1-800-55-OMRON

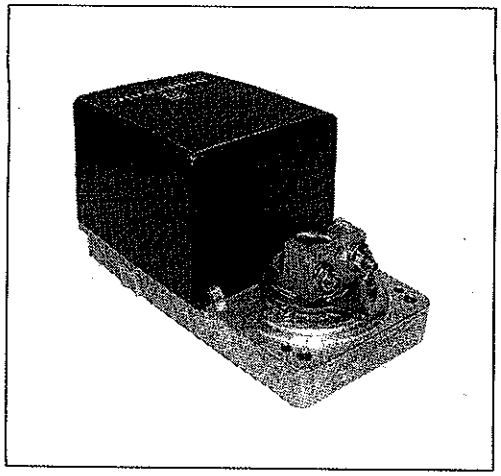
OMRON CANADA, INC.
885 Milner Avenue
Scarborough, Ontario M1B 5V8
416-286-6465

Cat. No. GCTC12 1/99 Specifications subject to change without notice. Printed in U.S.A.

neptronic®

Actuator

Specification & Installation instruction



Feature:

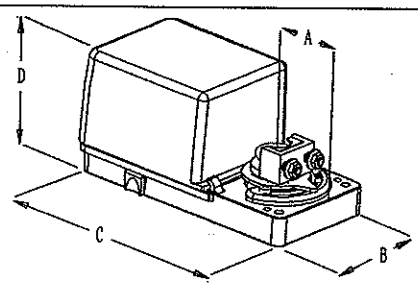
- Mounts easy on round & square shaft (with option –8).
- External clutch for manual adjustments.
- Maintenance free.
- Position indicator.
- Control signal fully programmable.
- The fastest actuator of the world (model BM_ _ _FF).
- Fail safe by *Enerdrive System* [1] (on model 060 & 080).
- Auxiliary switches (on model 020 & 080).

Old Number	
BBM2000A	BM000
BBM2021A	BM020
BBM2060A	BM060
BBM2080A	BM080
BBMF2000A	BM000F
BBMF2021A	BM020F
BBMF2060A	BM060F
BBMF2080A	BM080F
BBMFF2000A	BM000FF
BBMFF2021A	BM020FF
BBMFF2060A	BM060FF
BBMFF2080A	BM080FF

Technical Data	BM000 *BBM 2000A*	BM020 *BBM 2021A*	BM060 *BBM 2060A*	BM080 *BBM 2080A*	BM000F *BBMF 2000A*	BM020F *BBMF 2021A*	BM060F *BBMF 2060A*	BM080F *BBMF 2080A*	BM000FF *BBMFF 2000A*	BM020FF *BBMFF 2021A*	BM060FF *BBMFF 2060A*	BM080FF *BBMFF 2080A*
Auxiliary switches	No	Yes(2)	No	Yes(2)	No	Yes(2)	No	Yes(2)	No	Yes(2)	No	Yes(2)
Fail safe - *Enerdrive*	No		Yes		No		Yes		No		Yes	
Power consumption	6 VA		15VA Peak, 6VA		15 VA		24VA Peak, 15VA		15 VA		24VA Peak, 15VA	
Torque	50 in.lb. [5,6 Nm] at rated voltage				35 in.lb. [3,9 Nm] at rated voltage				25 in.lb. [2,8 Nm] at rated voltage			
Running time through 90°	20 to 30 sec torque dependant				3.5 to 4.5 sec torque dependant				1.5 to 2.5 sec torque dependant			
Feedback	4 to 20 mA or 2 to 10 VDC adjustable											
Power supply	22 to 26 VAC or 28 to 32 VDC											
Electrical connection	18 AWG [0.8 mm^2] minimum											
Inlet bushing	2 inlet bushing of 5/8 in [15.9 mm] & 7/8 in [22.2 mm]											
Control signal	Analog, Digital or Pulse with modulation (PWM) programmable (factory set with Analog control signal)											
Angle of rotation	0 to 90 degrees, mechanically adjustable (factory set with 90° stroke)											
Direction of rotation	Reversible, Clockwise (CW) or Counterclockwise (CCW) (factory set with CW direction)											
Ambient temperature	-22°F to +122°F [-30° C to +50° C]											
Storage temperature	-22°F to +122°F [-30° C to +50° C]											
Relative Humidity	5 to 95 % non condensing.											
Weight	3 lbs. [1.4 kg]											

Warning: Do not press the clutch when actuator is powered

Dimensions



Dimension		Inches	Metric (mm)
A		1.50	38.1
B		3.26	82.8
C		6.60	167.5
D	model 000 & 060	3.01	76.4
	model 020 & 080	3.72	94.5

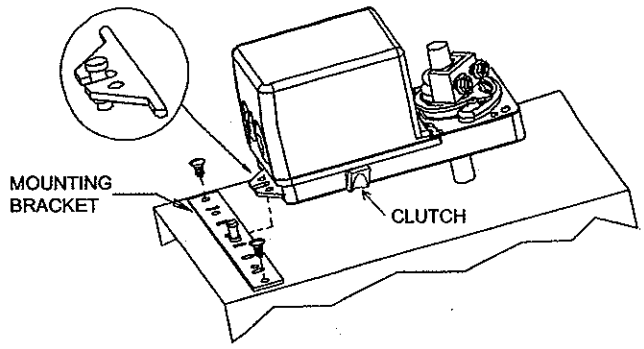
Caution

We strongly recommend that all neptronic® products be wired to a separate transformer and that transformer shall service only neptronic® products. This precaution will prevent interference with, and/or possible damage to incompatible equipment.
When multiple actuators are wired on a single transformer, polarity must be observed. Long wiring runs create voltage drop which may affect the actuator performance.

[1] *Enerdrive System* U.S.A. Patent #5,278,454

CE SP® C US UL LISTED TEMPERATURE REGULATING EQUIPMENT 41X9 CLASS 2 CIRCUIT

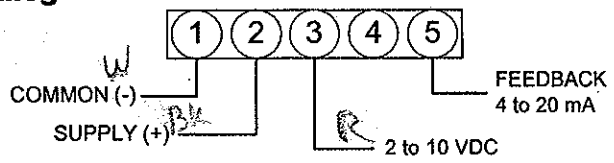
Mechanical installation



1. Manually close the damper blades and positioned the actuator at 0° or 90°.
2. Slide the actuator onto the shaft.
3. Tighten the nuts on the "U" bolt to the shaft with a 8mm wrench to a torque of 60 in.lb. [6,7 Nm].
4. Slide the mounting bracket under the actuator. Ensure free movement of the slot at the base of the actuator. The bracket pin must be placed in the mid distance of the slot.
5. Fix the bracket to the ductwork with #8 self-tapping screws.

Wiring Diagrams

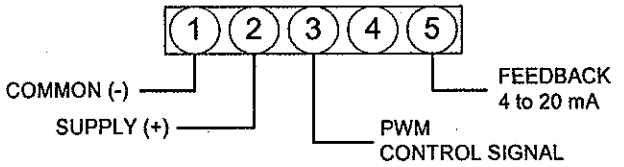
Analog



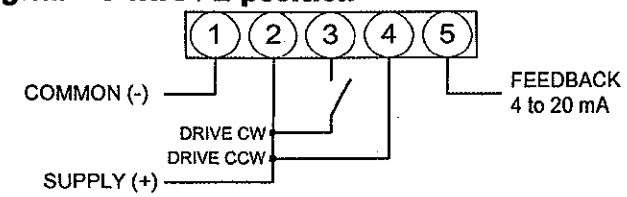
For 4 to 20 mA control signal

Connect one of the supplied 500 ohm resistors between pins 1 and 3.

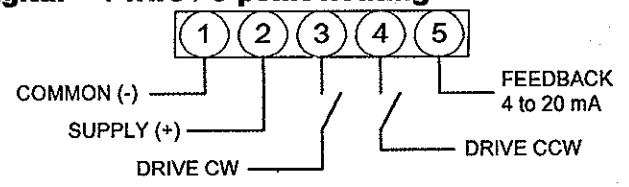
PWM



Digital – 3 wire / 2 position



Digital – 4 wire / 3 point floating



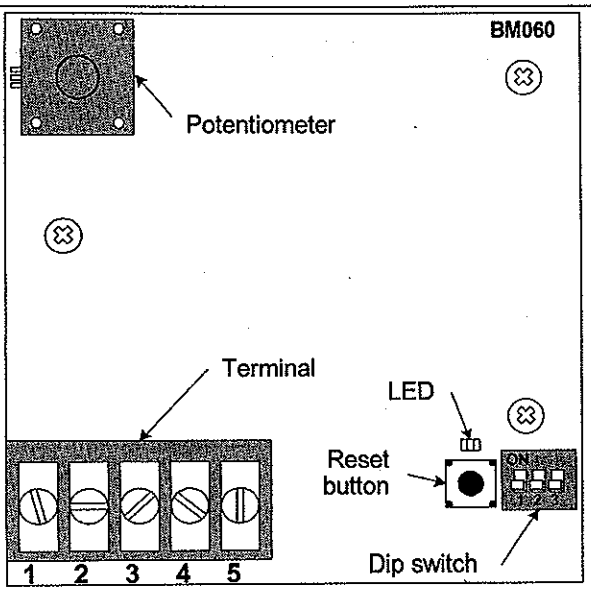
Special consideration for Digital control

In this mode, actuator is sensitive to induced electrical voltages from other sources. To prevent such interference, wire one 2.2k ohm 0.5W resistor between pins 4 and 1 and a second 2.2k ohm 0.5W resistor between pins 3 and 1. These resistors are supplied.

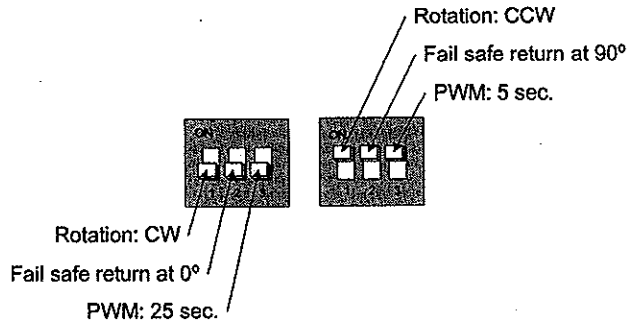
For 2 to 10 VDC output feedback

For any of above wiring configurations, connect one of the supplied 500 ohm resistors between pins 1 and 5.

PC Board



Dip switch settings



Stroke adjustment – No control signal change

1. Apply power and, **wait for at least 10 seconds.**
2. Press and release the reset button to start the auto-stroke process.
   The LED should be illuminated.
   - First option:
     The actuator will then travel in both directions to find it's limit and position itself according to the demand.
     The LED will extinguish, the process is complete.
   - Second option:
     When the desired end position is reached, press and release the reset button. The actuator will now return back to its original position. (you can also press and release the reset button when It's reaches the original position)
     The LED will extinguish, the process is complete.

Programming – Change of control signal

1. Remove power and put all dip switches "OFF". (factory preset).
2. Apply power and, **within 10 seconds**, press and release the reset button. The LED should be blinking.
3. Select the control signal with dip switches:
   - Digital (On/Off or 3 point floating)
     move switch No1 "ON" and then "OFF".
   - PWM
     move switch No2 "ON" and then "OFF".
   - Analog (factory preset)
     move switch No3 "ON" and then "OFF".
4. **Stroke adjustment**
   see the stroke adjustment section above.

Note, If PWM mode is selected:

- Time base : When programming is done,
  if switch No3 is "on" time base is 0.1 to 5 sec. (resolution 20 msec.)
  if switch No3 is "off" time base is 0.1 to 25 sec. (resolution 100 msec.)
  * For 5 sec. time base, we strongly recommend a switch common connection for better position stability.
- Switch 24 VAC: Triac or dry contact, 40mA maximum switching current.
- Switch common: NPN transistor, SCR, Triac or dry contact 75mA maximum switching current.

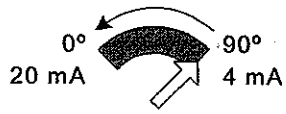
Feedback selection (CCW direction)

To select CCW direction put switch No1 "ON".

In Analog or 3 point floating mode you can program the feedback control.

If switch No3 is "OFF":

The feedback control is automatically reverse to 4 to 20 mA for 90 to 0 degrees.



If switch No3 is "ON":

The feedback control is to 20 to 4 mA for 90 to 0 degrees.

Zero and span calibration

This feature is applicable to analog control signal only.

1. Remove power and put all dip switches "OFF". (factory preset).
2. Apply power and, **within 10 seconds** press and hold the reset button until the LED blinks once.
   The Zero and span calibration process then start.
3. Release the reset button. The LED is now constantly illuminated.
4. Apply new minimum voltage.
   It can be any value between 0 to 7 VDC, with an external 0 to 10 volt supply (ex: MEP).
5. Press and release the reset button to memorize the new minimum voltage. The LED blinks once.
6. Apply new maximum voltage.
   It can be any value between 3 to 10 VDC, this value should be greater than the new minimum value.
7. Press and release the reset button to memorize the new maximum voltage. The LED blinks once.
   The Zero and span calibration process is complete.

Note: To reset zero and span to 2 to 10 VDC (factory value). You just have to re-select the analog control signal mode, see Programming.

OXYFIRE

High-Temperature In-Situ Oxygen Sensor for Combustion Trim Control Applications

Oxyfire

Oxyfire is Industry's Most Powerful Weapon in the battle against skyrocketing fuel costs!

TÜV CERTIFIED

CE MARKED

MAXIMIZE Combustion Efficiency
MINIMIZE NO_X formation
REDUCE fuel costs

Providing dependable and verifiable oxygen measurement in the fossil fuel-fired environments found in most steel, glass, power generation, petrochem and petroleum refining, as well as kilns and incinerator applications. Oxyfire users worldwide include PPG, Owens Corning, North Star Steel, NIPSCO, Entergy, Hylsa, LTV, Saint Gobain and many others. *Oxyfire is a low-cost, Clean Air Act-compliant technology.*

Oxyfire "Measures where it Matters" in the combustion chamber, close to the source of combustion. So response to combustion atmosphere change is instant and precise and there is no need for the compensation of an extractive or heated system.

Features and Performance Advantages:

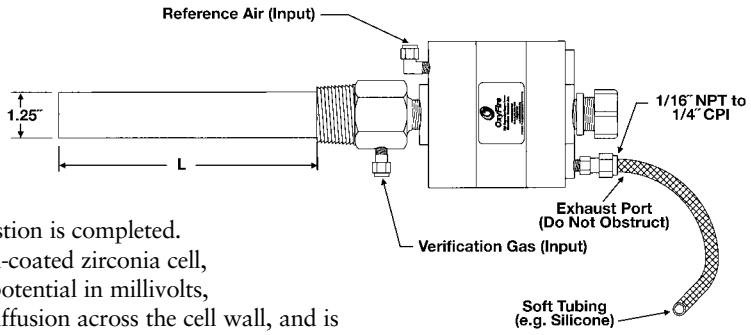
- High temperature capability (550°C-1600°C)
- Most accurate/rapid response
- Integral T/C
- On-line verification
- Patented high temperature ceramic "boot"
- No external power, calibration or artificial heating required
- Intrinsically safe*
- TÜV certified
- CE marked
- Wet O_2 reading vs. dry reading

Marathon Sensors Inc.

Oxyfire

Operation

Oxyfire works by precisely measuring the net concentration of oxygen in a process; i.e. the amount of oxygen that remains after combustion is completed. At its core is the platinum-coated zirconia cell, which measures the emf potential in millivolts, that is generated by the diffusion across the cell wall, and is logarithmically proportional to the oxygen concentration. Also included is a required "B" type (R and S types optional) thermocouple which provides the sensor temperature needed for the O_2 calculation.



Specifications

Net 0_2 Range	PPM to 21%
Accuracy	± 1.5% of observed process variable or 0.05% 0_2, whichever is greater
Control System Interface	Marathon VersaPro-O or Smart Transmitter panel
Response Time	Less than one second for 98% of final value.
Stability	Less than 1% deviation in signal output over the life of the sensor.
Temperature Limits:	
Process	550°C - 1600°C, (1022°F - 2912°F)
Terminal Head	Ambient to 149°C, (300°F)
Mounting	Vertical or horizontal
Construction:	
Inner Tube	Zirconia
Outer Protection Sheath	Alumina, Silicon Carbide, HR-160 high temperature alloy, Zirconia
Sensor Head	Air-tight, machined 6061-T6 aluminum, (cast aluminum, Class 1 available)
Integral T/C	Type "B" standard, "R" and "S" optional
Integral Verification Port/Fitting	
Sensor Insertion Lengths	6˝, 12˝, 18˝, 24˝, 30˝, 36˝, 42˝, 48˝ (non-std)
Speed of Insertion	1 inch (25.4mm) per 5 minutes
Reference Air Requirement	50 – 150 cc per minute (less than 2 psi) clean, dry air 1/4˝ tubing fittings
Cabling	Shielded four conductor, stranded, twisted-pair. Belden #89418 or equivalent.

* *The Oxyfire oxygen sensor is a "simple apparatus" and thereby intrinsically safe per EN50 14 (1977) Clause 1.3.*

Oxyfire is industry's Ultimate Answer to precise combustion trim. It is a powerful, proven cost-savings tool that will instantly and permanently reduce fuel use, and maintenance, while it improves productivity.

- If you're a steelmaker, Oxyfire offers another advantage, in that it can substantially reduce process scale.
- Helps reduce costs for fuel and "air" in Oxy-Fuel fired systems.

To find out what Oxyfire can do for YOU, talk with Marathon at (800) 547-1055 or visit

www.MARATHONSENSORS.com

Marathon Sensors Inc.

3100 E. Kemper Rd.

Cincinnati, OH 45241-7007

(800) 547-1055

(513) 772-1000

fax (513) 326-7090

A HALMA GROUP COMPANY

Marathon Sensors Inc.

Oxymit™ Transmitter
Operators Manual

Marathon
Sensors Inc.

F200060

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01 04/23/2001
02 05/08/2001
03 09/19/2001
04 11/01/2001
05 11/21/2001
06 04/19/2002
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10 12/03/2003
11 09/30/2004
12 04/04/2005
13 04/11/2005
14 11/14/2006

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3100 East Kemper Road, Cincinnati, Ohio 45241
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Table of Contents

NOTE:

Please specify the following parameters when ordering a transmitter; process type, process range (%, ppm), thermocouple type, temperature scale F/C, analog output 1 process and scale, analog output 2 process and scale.

Typical Oxygen Transmitter Calibration
(F840030)

Calibration Function	Measured Value or Input	Output / Units
Cold Junction	Room Temp	°F
Thermocouple min	800°F (B type) standard t/c type	°F
Thermocouple max	3000°F (B type) standard t/c type	°F
Millivolt	0.0 mV	Millivolts
Millivolt	2000 mV	Millivolts
Analog 1 Zero	0% O2	4.0 mA +/- 0.1
Analog 1 Span	20.9% O2	20.0 mA +/- 0.1
Analog 2 Zero	800°F +/- 5°	4.0 mA +/- 0.1
Analog 2 Span	3000°F +/- 5°	20.0 mA +/- 0.1

Typical Carbon Transmitter Calibration
(F840031)

Calibration Function	Measured Value or Input	Output / Units
Cold Junction	Room Temp	°F
Thermocouple Min	MUST BE SPECIFIED	°F
Thermocouple Max	MUST BE SPECIFIED	°F
Millivolt	0.0 mV	Millivolts
Millivolt	2000 mV	Millivolts
Analog 1 Zero	0% Carbon	4.0 mA +/- 0.1
Analog 1 Span	2.55% Carbon	20.0 mA +/- 0.1
Analog 2 Zero	MUST BE SPECIFIED	4.0 mA +/- 0.1
Analog 2 Span	MUST BE SPECIFIED	20.0 mA +/- 0.1

General Description

The Oxymit™ Transmitter has been designed to work as an analog or digital interface for any zirconia based oxygen probe used to track dew point, carbon potential, or oxygen. The transmitter connects to the temperature and millivolts outputs of an oxygen probe and can produce analog outputs proportional to the selected process value.

The features available are:

- Isolated inputs for thermocouple and probe millivolt
- 24 bit Sigma-Delta ADC for inputs.
- Serial EEPROM to store setup and calibration values.
- Two isolated self-powered 4-20mA outputs for process value and temperature.

The transmitter makes a carbon or oxygen probe an intelligent stand alone sensor. The transmitter is located near the probe, preferably mounted in an enclosure. The transmitter mounts onto a DIN rail and requires a 24VDC power supply. It measures the probe temperature and millivolts. At the time of order the transmitter can be configured to calculate percent carbon, dewpoint, or percent oxygen from these inputs. The results of any of these calculations are made available via two 4-20mA loop outputs. Typically one first loop is set up for the process value the second loop transmits probe temperature.

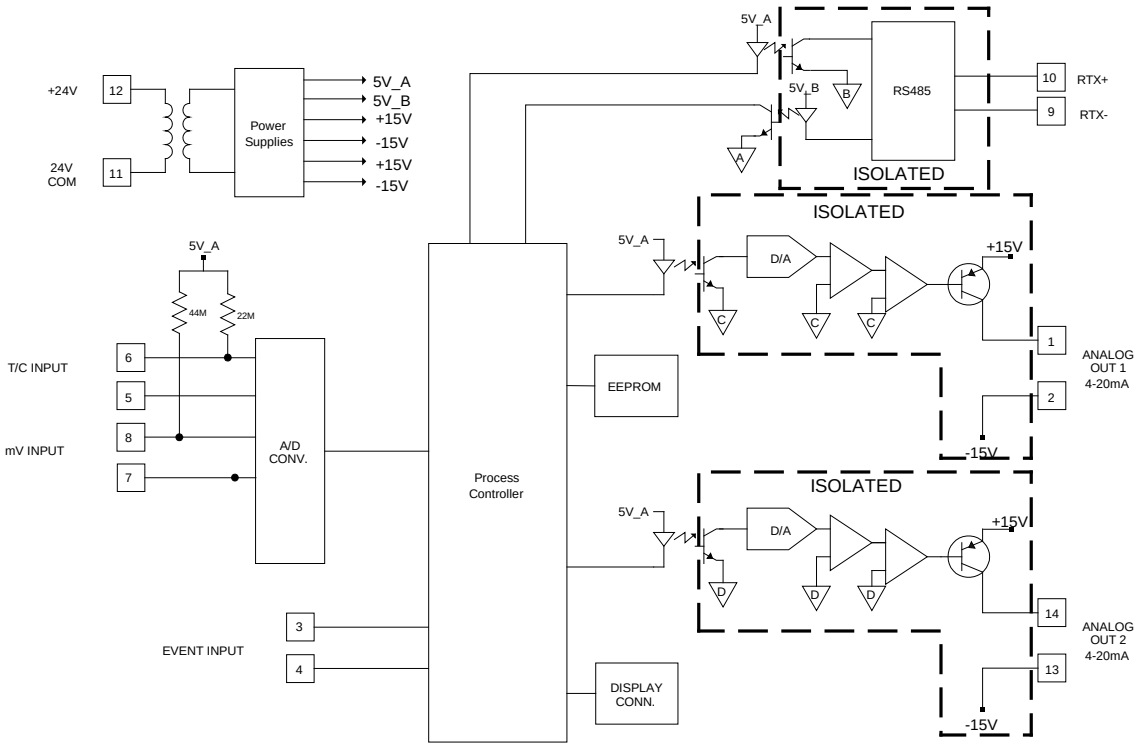


Figure 1 BLOCK DIAGRAM

Safety Summary

All cautions and instructions that appear in this manual must be complied with to prevent personnel injury or damage to the Probe Transmitter or connected equipment. The specified limits of this equipment must not be exceeded. If these limits are exceeded or if this instrument is used in a manner not intended by Marathon Sensors Inc., damage to this instrument or connected devices could occur.

Do not connect this device directly to AC motors, valves, or other actuators. All AC alarm functions must be connected through an interposing DC coil relay with a maximum coil load of 0.5 amps DC. The Probe Transmitter is not rated to act as a safety device. It should not be used to provide interlocking safety functions for any temperature or process functions. Alarm capabilities are provided for probe test and input faults only and are not to be considered or used as safety contacts in any application.

Connections

The Probe Transmitter has four removable terminal blocks grouped with four terminals each. Each terminal is a wire clamp type with a standard slot screw. Each clamp can accommodate AWG 24 to 12 flexible stranded wire. Maximum torque on the terminal screws should not exceed 0.8 Nm.

The figure below shows the arrangement of the terminals.

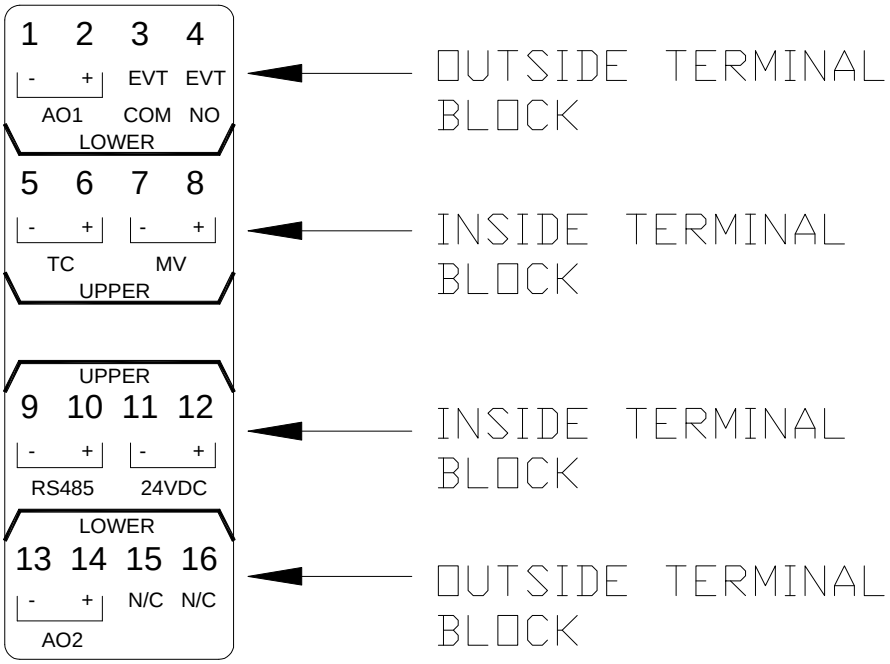


Figure 2 Terminal Layout

The next figure shows a schematic representation of the Probe Transmitter and typical connections required in the field.

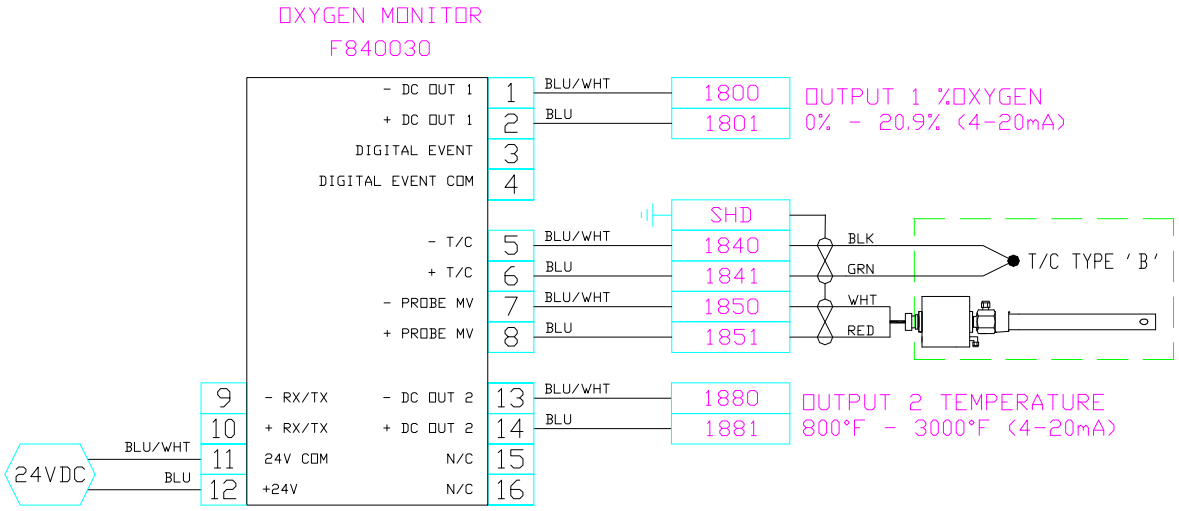


Figure 3 Schematic Connections

Grounding and Shielding

To minimize the pick-up of electrical noise, the low voltage DC connections and the sensor input wiring should be routed away from high-current power cables. Where it is impractical to do this, use shielded cables with the shield grounded at the Probe Transmitter enclosure ground as show above.

Parameter Selections

The following tables list the parameters available in the Probe Transmitter. Default values are also listed. The default values are loaded if a reset is force in the device. Changes to these parameters must be specified at the time of order.

Process Parameters

The following table shows the process selections and other parameters that effect the process value.

Table 1 Process Parameters

Parameter Name	Selection Default	Units or Options	Range
PROCESS TYPE	%O2	CARBON, DPT, %O2, MV	
CARB PROC FACT	150		0 to 1000
DEWPT PROC FACT	150		0 to 1000
OXYGEN EXPON	0002	POWER OF TEN	0 to 31
TC TYPE	B	B, C, E, J, K, N, NNM, R, S, T	

Process Type

Selecting the process type determines what type of calculation the Smart Transmitter is going to do based on the probe millivolt and probe temperature inputs. The default process value for the Smart Transmitter is %O2 with an exponent selection of 2. This is the selection most often used in Boiler control and Combustion applications.

Percent Carbon and dew point are typically processes that are used in steel treating applications. Percent Carbon is the process value most often used for the control of case depth or the percent of carbon in a steel hardening furnace. Dew Point is used in the control for endothermic generators.

Carbon Process Factor

The carbon process factor can be used to adjust the % carbon value. This number takes into account a number of assumptions that the carbon value is based on. Primary among these is the assumed level of CO in the atmosphere. See the Theory of Process Calculation section for a complete explanation of this value.

It maybe necessary to change the apparent furnace carbon as measured by the oxygen probe if this value is different than actual load samples, shim stocks, or gas analysis. The basic rule of thumb is that an increase is the carbon process factor will decrease the apparent carbon level in the furnace. The default value is 150. Typical values can very from 50 to 400. Increase or decrease the process factor until the desired carbon level is achieved. A process factor that is drastically different than normal may be an indication of a failing probe, water or air leak in the furnace, or excess methane present. Refer to probe troubleshooting guides to determine what other factors maybe effecting the carbon value.

Dew Point Process Factor

The dew point process factor is similar to the carbon process factor but is used to adjust the dew point value if dew point is selected as the process value. This number takes into account a number of assumptions that the dew point value is based on. Primary among these is the assumed level of hydrogen in the atmosphere. See the Theory of Process Calculation section for a complete explanation of this value.

Oxygen Exponent

The range of oxygen is factory configured using the oxygen exponent number. Percent oxygen is the standard setting where the oxygen exponent is set to 2 and the output range is 0.00% to 20.9%. For a part per million (ppm) range the exponent would be set to 6 and the output range of 0.00 X 10^{-6} to 99.99 X 10^{-6}.

TC Type

The following table shows the available thermocouple types and the ranges. BOLD indicates the typical oxygen default.

Thermocouple type	Zero ºF	Zero °C	Span ºF	Span °C
B	**800**	**425**	**3000**	**1650**
C	32	0	3000	1650
E	32	0	1300	700
J	32	0	1300	700
K	32	0	2300	1260
N	32	0	2300	1260
NNM	32	0	2000	1090
R	300	150	3000	1650
S	300	150	3000	1650
T	32	0	700	370

The Cold Junction correction is applied to all thermocouple types.

Analog Output Channels

The analog outputs are factory configured to provide 4 to 20mA signals proportional to selectable process values.

NOTE
The Analog Output Channels are isolated self-powered current sources and do not require an external supply.

If a chart recorder is to be used, it should have input specifications within 4 to 20 mA. If the recorder only responds to VDC inputs it will be necessary to add a 250 ohm dropping resistor across its input terminals.

The ideal location of the recorder is adjacent to the instrument but it may be located remotely if the connecting wires are properly shielded. For best results, the chart recorder input(s) should be isolated from ground.

Table 2 Analog Outputs

Parameter Name	Oxygen Default	Possible Options	Possible Ranges
OUTPUT 1 MODE	O2 0–20.9% 4-20mA	O2, CARBON, DEWPT, TEMP, LIN, PROG	O2 = 0 – 9999 %C = 0.00 – 2.55 DP = -99.9 – 212.0 Temp = -999 – 3000 LIN = -999 – 9999 PROG = 0 – 4095
OUTPUT 2 MODE	TEMP 800-3000°F 4-20mA	O2, CARBON, DEWPT, TEMP, LIN, PROG	O2 = 0 – 9999 %C = 0.00 – 2.55 DP = -99.9 – 212.0 Temp = -999 – 3000 LIN = -999 – 9999 PROG = 0 – 4095

NOTE: SEE PAGE 4 FOR TYPICAL CALIBRATION VALUES.

Calibration

The Smart Transmitter is factory calibrated. The calibration can be verified once a year or according to customer calibration schedules. The instrument should be returned to the factory if calibration is required.

Process Variable Calculations

The transmitter has a selectable process calculation for percent carbon, percent oxygen, or dewpoint. The following equations are used to derive these values;

Percent Oxygen

$$\%O2 = \frac{20.95}{e^{(E/0.0215*Tk)}}$$

Where: E = probe millivolts, Tk = probe temperature in degrees Kelvin.

The 20.95 is the %O2 in air.

Percent Carbon

$$\%C = 5.102 \frac{e^{((E-786)/(0.043102*Tk))}}{(29*PF + 400) + e^{((E-786)/(0.043102*Tk))}}$$

Where: E = probe millivolts, Tk = probe temperature in Kelvin, and PF is the process factor.

Dewpoint

$$DP = \frac{4238.7}{6.281216 + \log((29*PF+400)+(E-1267.8)/(0.05512*Tr)} - 459.69$$

Where: E = probe millivolts, Tr = probe temperature in Rankin, PF is the process factor, and DP is the dewpoint in Fahrenheit.

Communications

The Transmitter is capable of digital communications using the Modbus protocol. This is possible by connecting to the half duplex RS-485 terminals using a shielded twisted pair.

Modbus

The MODBUS protocol describes an industrial communications and distributed control system (DCS) that integrates PLCs computers, terminals, and other monitoring, sensing, and control devices. MODBUS is a Master/Slave communications protocol, whereby one device, (the Master), controls all serial activity by selectively polling one or more slave devices. The protocol provides for one master device and up to 247 slave devices on a RS-485 half duplex twisted pair line. Each device is assigned an address to distinguish it from all other connected devices. All instruments are connected in a daisy-chain configuration.

The instrument communicates with baud rate settings 1200, 2400, 4800, 9600, or 19.2K. The default baud rate is 19.2Kbuad. The default address is 1. Changes to these values can be made by writing to the appropriate memory register.

The Transmitter communicates in Modbus RTU (Remote Terminal Unit) protocol using 8-bit binary data characters. Message characters are transmitted in a continuous stream. The message stream is setup based on the following structure:

Number of bits per character:	
Start bits	1
Data bits (least significant first)	8
Parity	None only (no bits for no parity)
Stop bits	1
Error Checking	CRC (Cyclical Redundancy Check)

The Transmitter recognizes three RTU commands. These are: read single I registers (command 4), read a single H register (command 3), and preset a single H register (command 6)

In Modbus mode, the Transmitter can be only be configured for the 'none' parity option.

The instrument never initiates communications and is always in receive mode unless responding to a query.

RTU Framing

Frame synchronization can be maintained in RTU transmission mode only by simulating a synchronous message. The instrument monitors the elapsed time between receipt of characters. If three and one-half character times elapse without a new character or completion of the frame, then the instrument flushes the frame and assumes that the next

byte received will be an address. The follow command message structure is used, where T is the required character delay. Response from the instrument is based on the command.

T1,T2,T3	ADDRESS 8-BITS	FUNCTION 8-BITS	DATA N X 8-BITS	CHECKSUM 16-BITS	T1,T2,T3

Address Field

The address field immediately follows the beginning of the frame and consists of 8-bits. These bits indicate the user assigned address of the slave device that is to receive the message sent by the attached master.

Each slave must be assigned a unique address and only the addressed slave will respond to a query that contains its address. When the slave sends a response, the slave address informs the master which slave is communicating.

Function Field

The Function Code field tells the addressed slave what function to perform. MODBUS function codes are specifically designed for interacting with a PLC on the MODBUS industrial communications system. Command codes were established to manipulate PLC registers and coils. As far as the Transmitter is concerned, they are all just memory locations, but the response to each command is consistent with Modbus specifications.

The high order bit in this field is set by the slave device to indicate an exception condition in the response message. If no exceptions exist, the high-order bit is maintained as zero in the response message.

Data Field

The data field contains information needed by the slave to perform the specific function or it contains data collected by the slave in response to a query. This information may be values, address references, or limits. For example, the function code tells the slave to read a holding register, and the data field is needed to indicate which register to start at and how many to read.

Error Check Field (CRC)

This field allows the master and slave devices to check a message for errors in transmission. Sometimes, because of electrical noise or other interference, a message may be changed slightly while it is on its way from one device to another. The error checking assures that the slave or master does not react to messages that have changed during transmission. This increases the safety and the efficiency of the MODBUS system.

The error check field uses a CRC-16 check in the RTU mode.

The following is an example of a function 03 call for data at memory location 03. The value returned by the instrument is the hex value 1E.

Transmit from Host or Master

Address	Cmd	Reg HI	Reg LO	Count HI	Count LO	CRC HI	CRC LO
01	03	00	03	00	01	74	0A

Response from Transmitter

Address	Cmd	Byte Count HI	Byte Count LO	Data HI	Data LO	CRC HI	CRC Lo
01	03	00	02	00	1E	38	4C

Note that all the values are interpreted as hexadecimal values. The CRC calculation is based on the A001 polynomial for RTU Modbus. The function 04 command structure is similar to the 03 structure.

The following is an example of a function 06 call to change data in register 01 to 200. The response from the instrument confirms the new value as being set.

Transmit from Host or Master

Address	Cmd	Reg HI	Reg LO	Data HI	Data LO	CRC HI	CRC LO
01	06	00	01	00	C8	D9	9C

Response from Transmitter

Address	Cmd	Reg HI	Reg LO	Data HI	Data LO	CRC HI	CRC LO
01	06	00	01	00	C8	D9	9C

The Transmitter will respond to several error conditions. The three exception codes that will generate a response from the instrument are:

01 – Illegal Function
02 - Illegal Data Address
03 – Illegal Data Value
04 – Slave Device Failure

The response from the Transmitter with an exception code will have the most significant bit of the requested function set followed by the exception code and the high and low CRC bytes.

Memory Map

NOTE: Modbus refers to the hexadecimal register location. These parameters are formatted as unsigned 16 bit integers. Any real number such as temperature can be evaluated as a signed number, other parameters are bit mapped words that must be evaluated as single bits are bit groups.

BLOCK 0				
HEX	DEC	PARAMETER	DESCRIPTION	READ/WRITE
00	0	Not used		READ ONLY
01	1	TIME CONTROL SIOSET	**LOW BYTE - TIMER CONTROL** BIT 0 – Timer Disabled (0), Timer Enabled (1) BIT 1 – 7 SPARE **HIGH BYTE – SIO SETUP** BITS 8 – 9 PARITY SETTING 00 = Even Parity, 7 bits, 1 Stop bit 01 = No Parity, 8 bits, 1 Stop bit 10 = Odd Parity, 7 bits, 1 Stop bit BITS 10 – 11 RESPONSE DELAY 0 = No delay applied to response 1 = 10ms delay applied to response 2 = 20ms delay applied to response 3 = 30ms delay applied to response BITS 12 – 14 BAUD SELECT 000 = 76.8K 001 = 38.4K 010 = 19.2K (DEFAULT) 011 = 9600 100 = 4800 101 = 2400 110 = 1200 111 = 600 BIT 15 HOST FORMAT 0 = MSI (PROP) 1 = MODBUS (DEFAULT)	READ/WRITE
02	2	TC_ZERO TC_SPAN	**LOW BYTE - TC ZERO CALIBRATION NUMBER** **HIGH BYTE – TC SPAN CALIBRATION NUMBER**	READ/WRITE
03	3	MV_ZERO MV_SPAN	**LOW BYTE – MV ZERO CALIBRATION NUMBER** **HIGH BYTE – MV SPAN CALIBRATION NUMBER**	READ/WRITE
04	4	PF	PROCESS FACTOR FOR CARBON OR DEWPOINT RANGE = 0 to 4095	READ/WRITE

BLOCK 0				
HEX	DEC	PARAMETER	DESCRIPTION	READ/WRITE
			DEFAULT = 150	
05	5	EVENT LDLN	**LOW BYTE – INPUT EVENT** CONFIGURATION Bits 0 – 3 0000 = None 0001 = Auto Mode Selected 0010 = Remote Setpoint Selected 0011 = Acknowledge alarms 0100 = Timer Hold 0101 = Timer End 0110 = Timer Start 0111 = Start probe test 1000 = Process hold Bits 4 – 7 not used. **UPPER BYTE – LOAD LINE**	READ/WRITE
06	6	CJTRM HADR	**LOW BYTE – COLD JUNCTION TRIM** COLD JUNCTION TRIM (unsigned integer) RANGE = –128 TO +127 WHERE 1 COUNT = 1 DEG (C or F) and –128 = 65408 **HIGH BYTE – HOST ADDRESS** BITS 0-7 RANGE = 0 – 255	
07	7	SPARE	SPARE	
08	8	CONFIG0	Input Configuration **BITS 0-3 TC Input TYPE** 0000 = B (DEFAULT) 0001 = E 0010 = J 0011 = K 0100 = N 0101 = R 0110 = S 0111 = T 1000 = SPARE 1001 = SPARE 1010 = SPARE 1011 = SPARE 1100 = SPARE 1101 = SPARE 1110 = SPARE 1111 = SPARE BIT 4 = SPARE BIT 5 0 = NO CJ APPLIED, 1 = CJ APPLIED BIT 6 0 = °F, 1 = °C BIT 7 0 = 60HZ FILTER BIT 8 – 11 Millivolt Input TYPE 0000 = LINEAR (DEFAULT) All other bit combinations are spare BITS 12 – 15 are spare	READ/WRITE
09	9	CONFIG2	SETUP VALUES	

BLOCK 0				
HEX	DEC	PARAMETER	DESCRIPTION	READ/WRITE
			BITS 0 - 4 OXYGEN EXPONENT RANGE = 0 to 31, where 2 = % and 6 = ppm DEFAULT = 2 **BITS 5 - 6 DISPLAY DECIMAL PLACE** where: 0 = no decimal point in display 1 = Display XXX.X 2 = Display XX.XX 3 = Display X.XXX DEFAULT = 0 **BITS 8 – 12 REDOX METAL NUMBER** RANGE = 0 – 14 DEFAULT = 0 **BITS 13 – 15 SPARE**	
0A	10	FAULT	FAULT BIT MAP BIT 0 = Temperature Input Open BIT 1 = MV Input Open BIT 2 = Range of input is low BIT 3 = Range of input is high BIT 4 = Timer End BIT 5 = Probe Care Fault BITS 6 – 7 = SPARE BIT 8 = CPU Fault BIT 9 = Min Idle counter = 0 BIT 10 = Keyboard failure, stuck key or a key was pressed during power up. BIT 11 = Flash Erase Failed BIT 12 = Flash Checksum Failed BIT 13 = EEPROM Checksum Failed BIT 14 = Flash/EEPROM Size Fault BIT 15 = ADC Fault	READ ONLY
0B	11	ASRC	ANALOG OUT SOURCES **LOW BYTE, ANALOG OUTPUT 1** BITS 0 – 3 0000 = N/A 0001 = Temperature 0010 = Linear Input A 0011 = Carbon value 0100 = Dewpoint value 0101 = Oxygen value 0110 = Redox value 0111 = Output Power 1000 = Control Output 1 1001 = Control Output 2 1010 = Linear Input B 1011 = Programmable* *For Programmable, write required output value into DACV1, where DACV1 = 0 is minimum output and DACV1 = 4096 is maximum output. BITS 4 – 7 SPARE	READ/WRITE

BLOCK 0				
HEX	DEC	PARAMETER	DESCRIPTION	READ/WRITE
			HIGH BYTE, ANALOG OUTPUT 2 BITS 8 – 12 0000 = N/A 0001 = Temperature 0010 = Linear Input A 0011 = Carbon value 0100 = Dewpoint value 0101 = Oxygen value 0110 = Redox value 0111 = Output Power 1000 = Control Output 1 1001 = Control Output 2 1010 = Linear Input B 1011 = Programmable* *For Reference Number and Programmable , write required output value into DACV2, where DACV2 = 0 is minimum output and DACV2 = 4096 is maximum output. BITS 13 – 15 SPARE Special case: If Analog Output 1 = CONTROL OUTPUT 1 and Analog Output 2 = CONTROL OUTPUT 2 and the Control Mode is dual, then Analog Output 1 is 4-20ma for 0 to +100% PO and Analog Output 2 is 4-20ma for 0 to -100% PO.	
0C	12	DAC_OFFSET_1	DAC 1 OFFSET CALIBRATION	READ/WRITE
0D	13	DAC_SPAN_1	DAC 1 SPAN CALIBRATION	READ/WRITE
0E	14	DAC_OFFSET_2	DAC2 OFFSET CALIBRATION	READ/WRITE
0F	15	DAC_SPAN_2	DAC2 SPAN CALIBRATION	READ/WRITE
10	16	AOUTOF1	ANALOG OUTPUT 1 OFFSET Minimum source value that correlates to minimum Analog Output of 4 mA. The source value is based on the selection in ASRC lower byte	READ/WRITE
11	17	AOUTRN1	ANALOG OUTPUT 1 RANGE Maximum source value that correlates to maximum Analog Output of 20 mA. The source value is based on the selection in ASRC lower byte where	READ/WRITE
12	18	AOUTOF2	ANALOG OUTPUT 2 OFFSET Minimum source value that correlates to minimum Analog Output of 4 mA. The source value is based on the selection in ASRC upper byte	READ/WRITE
13	19	AOUTRN2	ANALOG OUTPUT 2 RANGE Maximum source value that correlates to maximum Analog Output of 20 mA. The	READ/WRITE

BLOCK 0				
HEX	DEC	PARAMETER	DESCRIPTION	READ/WRITE
			source value is based on the selection in ASRC upper byte where	
14	20	SPARE	SPARE	READ/WRITE
15	21	SPARE	SPARE	READ/WRITE
16	22	SPARE	SPARE	READ/WRITE
17	23	TEMPFIL	Temperature Input Filter in seconds Range = 0 to 3276. The higher the number the faster the reading update. DEFAULT = 1000	READ/WRITE

BLOCK 1				
HEX	DEC	PARAMETER	DESCRIPTION	READ/WRITE
18	24	MVFIL	Millivolt Input Filter in seconds Range = 0 to 3276. The higher the number the faster the reading update. DEFAULT = 1000	READ/WRITE
19	25	AZERO	LINEAR OFFSET, Y INTERCEPT LINEAR SCALING FOR INPUT A	READ/WRITE
1A	26	ANUM	LINEAR SPAN VALUE FOR INPUT A	READ/WRITE
1B	27	BZERO	LINEAR OFFSET, Y INTERCEPT LINEAR SCALING FOR INPUT B	READ/WRITE
1C	14	BNUM	LINEAR SPAN VALUE FOR INPUT B	READ/WRITE
1D	15	PROC	This value is the calculated process value shown as an integer. The decimal point and exponent values are required to determine the actual scaled value. Range = -999 to 9999. For example: If the process = oxygen, display decimal point = 2, and exponent = 6, and PROC = 1234, then the actual value and displayed as 12.34 ppm.	READ ONLY
1E	16	COLDJCT	COLD JUNCTION Where 1 COUNT = 1°F (°C), RANGE = -99 TO 255°F (°C). Note this parameter is an unsigned integer.	READ ONLY
1F	17	TEMP	MEASURED TEMPERATURE Where temperature is presented in degrees C or F, based on the C/F setting. Note this parameter is an unsigned integer of temperature -2721 = 62815 Range = max / min range of selected thermocouple.	READ ONLY
20	18	MV	MEASURED MILLIVOLT Where this value is scaled in 0.1 mV increments, i.e. 10001 = 1000.1. Range = 0 to 2000 mV.	READ ONLY
21	19	DACV1	ANALOG OUTPUT 1 0 to 4095 is 4 to 20 mA In dual mode 4mA = -100, 12mA = 0, 20mA = +100	READ/WRITE

BLOCK 1				
HEX	DEC	PARAMETER	DESCRIPTION	READ/WRITE
22	20	DACV2	ANALOG OUTPUT 2 0 to 4095 is 4 to 20 ma In dual mode 4mA = -100, 12mA = 0, 20mA = +100	READ/WRITE
23	35	SPARE	SPARE	
24	36	SPARE	SPARE	
25	37	SPARE	SPARE	
26	38	SPARE	SPARE	
27	39	SPARE	SPARE	
28	40	SPARE	SPARE	
29	41	SPARE	SPARE	
2A	42	SPARE	SPARE	
2B	43	SPARE	SPARE	
2C	44	SPARE	SPARE	
2D	45	SPARE	SPARE	
2E	46	SPARE	SPARE	
2F	47	SPARE	SPARE	

Operational Specifications

Power input 21.6 to 26.4 volts DC / 130mA

Thermocouple input

Thermocouple type	Zero ºF	Span ºF
B	**800**	**3000**
C	32	3000
E	32	1300
J	32	1300
K	32	2300
N	32	2300
NNM	32	2000
R	300	3000
S	300	3000
T	32	700

Bold shows default
Accuracy after linearization +/- 1 deg F

Millivolt input -200 to 2000 millivolts +/- 0.1 millivolt

Input Impedance 25 Megohm

Cold junction compensation +/- 1 deg F

DC outputs (Isolated) 0 to 20mA (650Ω max).

Isolation 1000V DC/AC
Power input to signal inputs
Power input to communications

No Isolation Thermocouple input to Millivolt input, inputs must be differential.

Calculations Percent carbon 0 – 2.55%, no CO compensation
Dewpoint -99°F (-72.8°C) – 212 °F (100°C), no hydrogen compensation
Percent oxygen. 0 – 20.9% (default)

CAUTION
DO NOT CONNECT ANY AC SOURCE OR LOAD TO INSTRUMENT CONTACTS

Calibration Setups Millivolt Null
Millivolt Span

Thermocouple Null
Thermocouple Span
Cold Junction Trim

Communications port RS-485 Half Duplex Only

Protocol	Modbus RTU
Baud rates	1200, 2400, 4800, 9600, 19.2K **(19.2K default**)
Parity	None
Address	1 – 254 (**Address 1 is default**)

Housing

Material	Polyamide PA non-reinforced
Inflammability	Evaluation Class V0 (UL94)
Temperature Range	-40 to 100°C
Dielectric Strength	600 kV/cm (IEC243-1)
Mounting	Snaps on to EN 50022 top hat (T) style DIN rail.

Terminals

Wire clamp screw terminals on four position removable terminal blocks.

Wire Size	AWG 24 – 12 flexible stranded, removable terminal blocks.
Max. Torque	0.8 Nm

CAUTION: DO NOT CONNECT OR DISCONNECT HOUSING PLUGS WHILE MODULE IS POWERED OR UNDER LOAD.

Weight 10 oz

Environmental Conditions

Operating Temperature	-20 °C to 55 °C (-4 to 130 F)
Storage Temperature	-40 °C to 85 °C (-40 to 185 F)
Operating and Storage Humidity	85% max relative humidity, noncondensing, from –20 to 65°C

Certifications and Compliance (PENDING)

Safety EN 61010-1, IEC 1010-1
Safety requirement for electrical equipment for measurement, control, and laboratory use, Part 1

Electromagnetic Compatibility
Immunity as specified by EN 50082-2

Electrostatic discharge	EN 61000-4-2	Level 3: 8 kV air
Electromagnetic RF fields	EN 61000-403	Level 3: 10 V/m 80 MHz – 1 GHz

Fast Transients	EN 61000-4-4	Level 4: 2 kV I/O Level 3: 2 kV power
RF conducted interference	EN 61000-4-6	Level 3: 10 V/rms 150 KHz – 80 MHz
Emissions as specified by EN 50081-2		
RF Interference	EN 55011	Enclosure class A Power main class A

Note: This instrument is designed for installation inside a grounded metal enclosure. Always observe anti-static precautions when installing or servicing any electronic device. Ground your body to discharge any static field before touching the body or terminals of any electronic device.

This specification can change without notification.

MATERIAL SAFETY DATA SHEET

Product Name:	INTERMIX EPOXY PRIMER - Colours Component A

SECTION 01: CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Manufacturer/Supplier: Endura Manufacturing Co. Ltd.
12425 - 149 Street
Edmonton, Alberta
T5L 2J6
Ph: (780) 451-4242 Fax: (780) 452-5079

24-Hour Emergency Number:..... (613) 996-6666 (Canutec)
Product Name:..... INTERMIX EPOXY PRIMER - Colours
Item Number:..... UN 1263 Cl 3 PG II
Chemical Family:..... Aromatic Hydrocarbons, Ketones, Alcohols, Glycol ethers, Pigments
Material Use:..... 2 component Epoxy Primer – intermix system.

SECTION 02: COMPOSITION / INFORMATION ON INGREDIENTS

HAZARDOUS INGREDIENTS	C.A.S.	LD/50, ROUTE, SPECIES	LC/50, ROUTE, SPECIES	TLV	% WT
methyl ethyl ketone	78-93-3	>4 g/kg o-r >6 g/kg d-rbt	>5000 ppm/8h i-r	200 ppm	5 – 10
xylene	1330-20-7	4.3 g/kg o-r >2 g/kg d-rbt	5000 ppm/4h i-r	100 ppm	5 – 15
butanol	71-36-3	.79 g/kg o-r	8000 ppm/4h i-r	50 ppm	1 – 5
ethyl benzene	100-41-4	3.5 g/kg o-r 17.8 g/kg d-rbt	N/A	100 ppm	1 – 5
methyl amyl ketone	110-43-0	1670mg/kg o-r, 12600mL/kg d-rbt	N/A	50 ppm	1 – 10
quartz	14808-60-7	N/A	N/A	0.05 mg/m³	10 – 20
Some colours contain					
lead chromate	7758-97-6	12000 mg/kg o-r	N/A	.05 ppm	0 – 30
lead sulphate	7446-14-2	2000 mg/kg o-r	N/A	.15 ppm	0 – 5
molybdenum compounds n.o.s.	-	N/A	N/A	N/A	0 – 5
carbon black	1333-86-4	>15.4 g/kg o-r >3 g/kg d-rbt	N/A	3.5 mg/m³	0 – 5
antimony trioxide	1309-64-4	N/A	N/A	N/A	0 – 5
titanium dioxide	13463-67-7	>25 g/kg o-r >10 g/kg d-rbt	>6.82 mg/l/4h	10 mg/m³/8h	0-30
legend: o=oral	d=dermal	i=inhalation	rbt=rabbit	r=rat	p=intraperitoneal	g=guinea pig

See Sax, N.I. "Dangerous Properties of Industrial Materials" for more information.

SECTION 03: HAZARDS IDENTIFICATION

Eye Contact:..... Moderately irritating to eyes and can cause tissue damage.
Skin Contact:..... Low toxicity by skin absorption, but extended contact can cause irritation and dermatitis. Can cause allergic skin reaction.
Inhalation:..... Vapors are of low to moderate toxicity when inhaled and are irritating to nose, throat and other respiratory passages, especially in higher concentrations. Extended exposure can cause headaches, dizziness, nausea or even loss of muscular control and coordination, narcosis or unconsciousness.
Ingestion:..... Liquid is of low to moderate toxicity when ingested, but can be hazardous if aspirated into lungs during swallowing or vomiting.
Additional Information:..... Chronic hazards include narcosis, specific organ damage, permanent brain and nervous system damage or coma if extensively abused. MEK has shown teratogenic effects in laboratory animals. Lead chromate and carbon black are possible carcinogens.

MATERIAL SAFETY DATA SHEET

Product Name:	INTERMIX EPOXY PRIMER - Colours Component A

SECTION 04: FIRST AID MEASURES

Inhalation (acute):	Remove to fresh air and if necessary restore breathing by giving artificial respiration. Administer oxygen if victim is breathing with difficulty. GET IMMEDIATE MEDICAL HELP.
Ingestion:	DO NOT INDUCE VOMITING. Seek medical help. Give 1 or 2 glasses water or milk, BUT ONLY IF VICTIM IS CONSCIOUS.
Eye Contact:	Check for and remove any contact lenses. Flush eyes IMMEDIATELY with water for 15 minutes and get immediate medical help.
Skin Contact:	Wash with soap and water. Clean contaminated clothing before reuse.
Notes to Physician:	Treatment is symptomatic. There is no specific antidote. See list of ingredients.

SECTION 05: FIRE FIGHTING MEASURES

Flash Point (°C) (TCC):	-9
Auto Ignition Temperature (°C):	244
Upper Explosive Limit (% Vol):	7
Lower Explosive Limit (% Vol):	1
Extinguishing Media:	CO_2, foam, dry chemical. Avoid using water except as a fog.
Hazardous Combustion Products:	CO, CO_2, Various hydrocarbons, NO_x, Ammonia gas, Toxic or irritating products.
Sensitivity To Mechanical Impact:	None
Sensitivity To Static Discharge:	Can ignite vapors
Special Fire Fighting Procedures:	Wear self-contained breathing apparatus and full protective clothing. Extreme heat may cause pressure build-up in containers and possibly explosion, therefore use water to keep containers cool.
Conditions of Flammability:	Sparks, open flame, static discharge or extreme temperature. Vapors from this product are heavier than air and may travel or be moved by air currents and be ignited by pilot lights, other flames, smoking, sparks, heaters, electrical equipment, static discharges or other ignition sources at locations distant from the point of handling.

SECTION 06: ACCIDENTAL RELEASE MEASURES

Leak / Spill:	Remove all sources of ignition. The product should be contained and absorbed with inert materials and placed into a container. Do not seal the containers until any gas, which might form, has done so.
Clean up:	

SECTION 07: HANDLING AND STORAGE

Handling Procedures:	Avoid static charges, sparks, flames, ignition sources, excessive heat. Keep containers tightly closed and upright when not in use. Do not allow contact with skin or eyes, and don't breathe vapors. Electrical and mechanical equipment should be explosion-proof.
Storage Needs:	Store in a cool, dry place.

SECTION 08: EXPOSURE CONTROLS / PERSONAL PROTECTION

PROTECTIVE EQUIPMENT

Eye/Type:	Personnel should wear liquid chemical goggles or a full-face shield.
Respiratory/Type:	Personnel should wear a suitable air supplied respirator.
Gloves/Clothing/Footwear/Type:	Personnel should wear chemical-resistant clothing, gloves and footwear.
Other/Type:	A safety shower and eye wash facility should be available.
Ventilation Requirements:	Adequate ventilation must be assured to prevent the accumulation of dangerous amounts of vapor or mist.

MATERIAL SAFETY DATA SHEET

Product Name:	INTERMIX EPOXY PRIMER - Colours Component A

SECTION 09: PHYSICAL AND CHEMICAL PROPERTIES

Physical State (appearance):	Colored liquid
Odor:	Solvent
Density (g/ml):	1.48 – 1.77
Odor Threshold (ppm):	N/A
Vapor Pressure (@20°C):	77 mm Hg
Vapor Density (Air=1):	Heavier than air
Evaporation Rate:	N/A
Boiling Point (°C):	80
pH:	N/A
Solubility in Water (% W/W):	N/A
Coefficient of Water/Oil Distribution:	N/A
Freezing Point (°C):	N/A
VOC:	345 – 430 g/l or 2.87 – 3.58 lbs/gal

SECTION 10: STABILITY AND REACTIVITY

Reactivity Conditions:	Will react dangerously with oxidizing materials

SECTION 11: REGULATORY INFORMATION

WHMIS Classification:	B-2, D-2A, D-2B

SECTION 12: DISPOSAL CONSIDERATIONS

Waste Disposal:	Dispose of waste according to local, provincial and federal regulations. Utilize authorized centers for disposal of combustible chemical material.

SECTION 13: TRANSPORT INFORMATION

T.D.G. Classification:	Shipping name: Paint. UN 1263, Cl 3, PG II.

SECTION 14: OTHER INFORMATION

Note:	
Prepared By:	Technical Department
Preparation Date:	August 1, 2006

MATERIAL SAFETY DATA SHEET

Product Name:	INTERMIX EPOXY PRIMER 3:1 COMPONENT "B"

SECTION 01: CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Manufacturer/Supplier:

Endura Manufacturing Co. Ltd.
12425 - 149 Street
Edmonton, Alberta
T5L 2J6
Ph: (780) 451-4242 Fax: (780) 452-5079

24-Hour Emergency Number:..... (613) 996-6666 (Canutec)
Product Name:..... INTERMIX EPOXY PRIMER 3:1 COMPONENT "B"
Item Number:..... UN 1263 Cl 3 PG II
Chemical Family:..... Aromatic Hydrocarbons, Alcohols, Glycol ethers.
Material Use:..... 2 component Epoxy Primer –intermix system.

SECTION 02: COMPOSITION / INFORMATION ON INGREDIENTS

HAZARDOUS INGREDIENTS	C.A.S.	LD/50, ROUTE, SPECIES	LC/50, ROUTE, SPECIES	TLV	% WT
nonylphenol	84852-15-3	.58 g/kg o-r	N/A	10 ppm	5 – 15
tris(dimethylaminomethyl)phenol	90-72-2	1.2 g/kg o-r 1.28 g/kg d-rbt	N/A	N/A	1 – 5
butanol	71-36-3	.79g/kg o-r	8000 ppm/8h i-r	50 ppm	5 - 10
xylene	1330-20-7	4.3 g/kg o-r >2 g/kg d-rbt	5000 ppm/4h i-r	100 ppm	10 - 20
Ethylene glycol monobutyl ether acetate	112-07-2	2400 mg/kg rat	450 ppm rat	20 ppm	5 - 10
toluene	108-88-3	636 mg/kg 0-r	8000ppm 4 hr. i-r	50 ppm	25 - 35

legend: o=oral d=dermal i=inhalation rbt=rabbit r=rat p=intraperitoneal g=guinea pig

See Sax, N.I. "Dangerous Properties of Industrial Materials" for more information.

SECTION 03: HAZARDS IDENTIFICATION

Eye Contact:..... Moderately irritating to eyes and can cause tissue damage. Can cause burning to eyes.
Skin Contact:..... Low toxicity by skin absorption, but extended contact can cause irritation and dermatitis. Can cause burning to skin.
Inhalation:..... Vapors are of low to moderate toxicity when inhaled and are irritating to nose, throat and other respiratory passages, especially in higher concentrations. Extended exposure can cause headaches, dizziness, nausea or even loss of muscular control and coordination, narcosis or unconsciousness.
Ingestion:..... Liquid is of low to moderate toxicity when ingested, but can be hazardous if aspirated into lungs during swallowing or vomiting. Can cause burning to gastrointestinal passages.
Additional Information:..... Chronic hazards include narcosis, specific organ damage, permanent brain and nervous system damage or coma if extensively abused.

MATERIAL SAFETY DATA SHEET

Product Name:	INTERMIX EPOXY PRIMER 3:1 COMPONENT "B"

SECTION 04: FIRST AID MEASURES

Inhalation (acute):	Remove to fresh air and if necessary restore breathing by giving artificial respiration. Administer oxygen if victim is breathing with difficulty. GET IMMEDIATE MEDICAL HELP.
Ingestion:	DO NOT INDUCE VOMITING. Seek medical help. Give 1 or 2 glasses water or milk, BUT ONLY IF VICTIM IS CONSCIOUS.
Eye Contact:	Check for and remove any contact lenses. Flush eyes IMMEDIATELY with water for 15 minutes and get immediate medical help.
Skin Contact:	Wash with soap and water. Clean contaminated clothing before reuse.
Notes to Physician:	Treatment is symptomatic. There is no specific antidote. See list of ingredients.

SECTION 05: FIRE FIGHTING MEASURES

Flash Point (°C) (TCC):	14
Auto Ignition Temperature (°C):	244
Upper Explosive Limit (% Vol):	7
Lower Explosive Limit (% Vol):	1
Extinguishing Media:	CO_2, foam, dry chemical. Avoid using water except as a fog.
Hazardous Combustion Products:	CO, CO_2, Various hydrocarbons, NO_x, Ammonia gas, Toxic or irritating products.
Sensitivity To Mechanical Impact:	None
Sensitivity To Static Discharge:	Can ignite vapors
Special Fire Fighting Procedures:	Wear self-contained breathing apparatus and full protective clothing. Extreme heat may cause pressure build-up in containers and possibly explosion, therefore use water to keep containers cool.
Conditions of Flammability:	Sparks, open flame, static discharge or extreme temperature. Vapors from this product are heavier than air and may travel or be moved by air currents and be ignited by pilot lights, other flames, smoking, sparks, heaters, electrical equipment, static discharges or other ignition sources at locations distant from the point of handling.

SECTION 06: ACCIDENTAL RELEASE MEASURES

Leak / Spill:	Remove all sources of ignition. The product should be contained and absorbed with inert materials and placed into a container. Do not seal the containers until any gas, which might form, has done so.

SECTION 07: HANDLING AND STORAGE

Handling Procedures:	Avoid static charges, sparks, flames, ignition sources, excessive heat. Keep containers tightly closed and upright when not in use. Do not allow contact with skin or eyes, and don't breathe vapors. Electrical and mechanical equipment should be explosion-proof.
Storage Needs:	Store in a cool, dry place.

SECTION 08: EXPOSURE CONTROLS / PERSONAL PROTECTION

PROTECTIVE EQUIPMENT

Eye/Type:	Personnel should wear liquid chemical goggles or a full-face shield.
Respiratory/Type:	Personnel should wear a suitable air supplied respirator.
Gloves/Clothing/Footwear/Type:	Personnel should wear chemical-resistant clothing, gloves and footwear.
Other/Type:	A safety shower and eye wash facility should be available.
Ventilation Requirements:	Adequate ventilation must be assured to prevent the accumulation of dangerous amounts of vapor or mist.

MATERIAL SAFETY DATA SHEET

Product Name:	INTERMIX EPOXY PRIMER 3:1 COMPONENT "B"

SECTION 09: PHYSICAL AND CHEMICAL PROPERTIES

NOTE: Differences between Component "B" and the Mixture of A and B are specified as B and M

Physical State (appearance):	Amber liquid
Odor:	Solvent
Density (g/ml):	0.895
Odor Threshold (ppm):	N/A
Vapor Pressure (@20°C):	16 mm Hg
Vapor Density (Air=1):	Heavier than air
Evaporation Rate:	N/A
Boiling Point (°C):	118
pH:	N/A
Solubility in Water (% W/W):	N/A
Coefficient of Water/Oil Distribution:	N/A
Freezing Point (°C):	<0
VOC:	B 535 g/l or 4.44 lbs/gal M 418 g/l or 3.48 lbs/gal

SECTION 10: STABILITY AND REACTIVITY

Reactivity Conditions: Will react dangerously with oxidizing materials

SECTION 11: REGULATORY INFORMATION

WHMIS Classification: B-2, D-2A, D-2B, E

SECTION 12: DISPOSAL CONSIDERATIONS

Waste Disposal: Dispose of waste according to local, provincial and federal regulations. Utilize authorized centers for disposal of combustible chemical material.

SECTION 13: TRANSPORT INFORMATION

T.D.G. Classification: Shipping name: Paint. UN 1263, Cl 3, PG II.

SECTION 14: OTHER INFORMATION

Note:	
Prepared By:	Amanda Dixon
Preparation Date:	August 2, 2006

MATERIAL SAFETY DATA SHEET

Product Name:	EX-2C TOPCOAT and CLEAR Component A

SECTION 01: CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Manufacturer/Supplier: Endura Manufacturing Co. Ltd.
12425 - 149 Street
Edmonton, Alberta
T5L 2J6
Ph: (780) 451-4242 Fax: (780) 452-5079

24-Hour Emergency Number:..... (613) 996-6666 (Canutec)
Product Name:..... EX-2C TOPCOAT and CLEAR. Component A.
Item Number:..... UN 1263 Cl 3 PG II
Chemical Family:..... Ester, Aromatic Hydrocarbon, Ketone, Pigments
Material Use:..... 2 Component Plastic Coating – EX-2C Component "A" must be mixed with an EX-2C Component "B"

SECTION 02: COMPOSITION / INFORMATION ON INGREDIENTS

HAZARDOUS INGREDIENTS	C.A.S.	LD/50, ROUTE, SPECIES	LC/50, ROUTE, SPECIES	TLV	% WT
***Component A* - Polyester Solution**					
n-butyl acetate	123-86-4	14 g/kg o-r	2000 ppm/4h i-r	150 ppm	20 – 40
xylene	1330-20-7	4.3 g/kg o-r >2 g/kg d-rbt	5000 ppm/4h i-r	100 ppm	1 – 5
pm acetate	108-65-6	8.5 g/kg o-fr >5 g/kg d-rbt	N/A	N/A	1 – 5
ethyl 3-ethoxypropionate	763-69-9	5 g/kg o-r 10 ml/kg d-rbt	>1000 ppm/6h i-r	N/A	1 – 5
acetone	67-64-1	>9.7 g/kg o-r >20 ml/kg d-rbt	>16000 ppm/4h i-r	500 ppm	1 – 5
Some colours contain		***(*) these colours may be reformulated with no lead content when required.***			
chromium hydroxide	1308-14-1	N/A	N/A	.05 mg/m³	0 – 1
lead chromate (*)	7758-97-6	12000 mg/kg o-r	N/A	.05 ppm	0 – 50
lead sulphate (*)	7446-14-2	2000 mg/kg o-r	N/A	.15 ppm	0 – 15
molybdenum compounds n.o.s. (*)	-	N/A	N/A	N/A	0 – 5
mica	12001-26-2	N/A	N/A	3 mg/m³	0 – 15
aluminum flake	7429-90-5	N/A	N/A	10 mg/m³	0 – 15
carbon black	1333-86-4	>15.4 g/kg o-r >3 g/kg d-rbt	N/A	3.5 mg/m³	0 – 5
tin oxide	18282-10-5	>20000 mg/kg o-r	N/A	2 mg/m³	0 – 1
ferric oxide	1309-37-1	>5000 mg/kg o-r	N/A	10 mg/m³	0 – 50
antimony trioxide	1309-64-4	N/A	N/A	N/A	0 – 5
titanium dioxide	13463-67-7	>25 g/kg o-r >10 g/kg d-rbt	>6.82 mg/l/4h	10 mg/m³/8h	0 – 60
titanium dioxide	1317-80-2	N/A	N/A	10 mg/m³	0 – 10
aromatic solvent	64742-95-6	>5 g/kg o-r >3160 mg/kg d-rbt	N/A	N/A	0 – 2
stoddard solvent	8052-41-3	>5 g/kg o-r >3160 mg/kg d-rbt	N/A	100 ppm	0 – 2
dichloro dimethyl silane	68611-44-9	>5000 mg/kg o-r	N/A	10 mg/m³	0 – 1
silica-amorphous, precip.	112926-00-8	>10000 mg/kg o-r	N/A	10 mg/m³	0 – 15

legend: o=oral d=dermal i=inhalation rbt=rabbit r=rat p=intraperitoneal fr=female rat
See Sax, N.I. "Dangerous Properties of Industrial Materials" for more information.

SECTION 03: HAZARDS IDENTIFICATION

Eye Contact:..... Moderately irritating to eyes and can cause tissue damage.
Skin Contact:..... Low toxicity by skin absorption, but extended contact can cause irritation and dermatitis. Skin sensitization or reddening, swelling or blistering can occur.
Inhalation:..... Vapors are of low to moderate toxicity when inhaled and are irritating to nose, throat and other respiratory passages, especially in higher concentrations. Extended exposure can cause headaches, dizziness, nausea or even loss of muscular control and coordination, narcosis or unconsciousness.
Ingestion:..... Liquid is of low to moderate toxicity when ingested, but can be hazardous if aspirated into lungs during swallowing or vomiting.
Additional Information:..... Chronic hazards include narcosis, specific organ damage, permanent brain and nervous system damage or coma if extensively abused. Lead chromate and carbon black are possible carcinogens.

MATERIAL SAFETY DATA SHEET

Product Name:	EX-2C TOPCOAT and CLEAR Component A

SECTION 04: FIRST AID MEASURES

Inhalation (acute):	Remove to fresh air and if necessary restore breathing by giving artificial respiration. Administer oxygen if victim is breathing with difficulty. GET IMMEDIATE MEDICAL HELP.
Ingestion:	DO NOT INDUCE VOMITING. Seek medical help. Give 1 or 2 glasses water or milk, BUT ONLY IF VICTIM IS CONSCIOUS.
Eye Contact:	Check for and remove any contact lenses. Flush eyes IMMEDIATELY with water for 15 minutes and get immediate medical help.
Skin Contact:	Wash with soap and water. Clean contaminated clothing before reuse.
Notes to Physician:	Treatment is symptomatic. There is no specific antidote. See list of ingredients.

SECTION 05: FIRE FIGHTING MEASURES

Flash Point (°C), (TCC):	-18
Auto Ignition Temperature (°C):	N/A
Upper Explosive Limit (% Vol):	N/A
Lower Explosive Limit (% Vol):	N/A
Extinguishing Media:	CO_2, foam, dry chemical. Avoid using water except as a fog.
Hazardous Combustion Products:	CO, CO_2. Possibly Oxides of Nitrogen, Sulphur, Lead, Chromium, Antimony or Aluminum.
Sensitivity To Mechanical Impact:	None
Sensitivity To Static Discharge:	Can ignite vapors
Special Fire Fighting Procedures:	Wear self-contained breathing apparatus and full protective clothing. Extreme heat may cause pressure build-up in containers and possibly explosion, therefore use water to keep containers cool.
Conditions of Flammability:	Sparks, open flame, static discharge or extreme temperature.

SECTION 06: ACCIDENTAL RELEASE MEASURES

Leak / Spill:	Remove all sources of ignition. The product should be contained and absorbed with inert materials and placed into a container. Do not seal the containers until any gas, which might form, has done so.
Clean up:	

SECTION 07: HANDLING AND STORAGE

Handling Procedures:	Avoid static charges, sparks, flames and excessive heat. Keep containers tightly closed and upright when not in use. Do not allow contact with skin or eyes, and don't breathe vapors.
Storage Needs:	Store in a cool, dry place.

SECTION 08: EXPOSURE CONTROLS / PERSONAL PROTECTION

PROTECTIVE EQUIPMENT

Eye/Type:	Personnel should wear liquid chemical goggles or a full-face shield.
Respiratory/Type:	Personnel should wear a suitable air supplied respirator.
Gloves/Clothing/Footwear/Type:	Personnel should wear chemical-resistant clothing, gloves and footwear.
Other/Type:	A safety shower and eye wash facility should be available.
Ventilation Requirements:	Adequate ventilation must be assured to prevent the accumulation of dangerous amounts of vapor or mist.

MATERIAL SAFETY DATA SHEET

Product Name:	EX-2C TOPCOAT and CLEAR Component A

SECTION 09: PHYSICAL AND CHEMICAL PROPERTIES

Physical State (appearance):	Coloured or clear liquid
Odor:	Solvent like
Density (g/ml):	1 – 1.6
Odor Threshold (ppm):	N/A
Vapor Pressure (@20°C):	180 mm Hg
Vapor Density (Air=1):	Heavier than air
Evaporation Rate:	5.7
Boiling Point (°C):	57
pH:	N/A
Solubility in Water (% W/W):	N/A
Coefficient of Water/Oil Distribution:	N/A
Freezing Point (°C):	N/A
Melting Point (°C):	N/A
VOC:	Please refer to each product MSDS

SECTION 10: STABILITY AND REACTIVITY

Reactivity Conditions:	Will react with oxidizing materials.

SECTION 11: REGULATORY INFORMATION

WHMIS Classification:	B-2, D-2A, D-2B

SECTION 12: DISPOSAL CONSIDERATIONS

Waste Disposal:	Dispose of waste according to local, provincial and federal regulations. Utilize authorized centers for disposal of combustible chemical material.

SECTION 13: TRANSPORT INFORMATION

T.D.G. Classification:	Shipping name: Paint. UN 1263, Cl 3, PG II.

SECTION 14: OTHER INFORMATION

Note:	
Prepared By:	Technical Department
Revision Date:	July 26, 2006

MATERIAL SAFETY DATA SHEET

Product Name:	EX-2C COMPONENT B

SECTION 01: CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Manufacturer/Supplier:..... Endura Manufacturing Co. Ltd.
12425 - 149 Street
Edmonton, Alberta
T5L 2J6
Ph: (780) 451-4242 Fax: (780) 452-5079

24-Hour Emergency Number:..... (613) 996-6666 (Canutec)
Product Name:..... EX-2C COMPONENT B
Item Number:..... UN 1263 Cl 3 PG II
Chemical Family:..... Ester, Ketone, HDI
Material Use:..... 2 component plastic coating – mix 1 part Component "A" and 1 part Component "B" by volume

SECTION 02: COMPOSITION / INFORMATION ON INGREDIENTS

HAZARDOUS INGREDIENTS	C.A.S.	LD/50, ROUTE, SPECIES	LC/50, ROUTE, SPECIES	TLV	% WT
Methyl Amyl Ketone	110-43-0	1.67 g/kg o-r 12.6 ml/kg d-rbt	4000 ppm/4h i-r	100 ppm	10-15
Ethyl Acetate	141-78-6	5.6 g/kg o-r 20 ml/kg d-rbt	16000 ppm/6h i-r	400 ppm	10-15
n-butyl acetate	123-86-4	14 g/kg o-r	2000 ppm/4h i-r	150 ppm	20 – 30
hexamethylene diisocyanate	822-06-0	710 mg/kg o-r 570 mg/kg d-rbt	310-350 mg/m³/1-4 h i-r	.005 ppm	**
homopolymer of HDI	28182-81-2	>10 g/kg o-r		N/A	30-50

** Free HDI monomer <0.15% of mixed solution (comp. A & comp. B) at time of manufacture. The monomer content may rise to 0.35% after 3-6 months storage.

legend: o=oral d=dermal i=inhalation rbt=rabbit r=rat fr=female rat g=guinea pig

See Sax, N.I. "Dangerous Properties of Industrial Materials" for more information.

SECTION 03: HAZARDS IDENTIFICATION

Eye Contact:..... Moderately irritating to eyes and can cause tissue damage.

Skin Contact:..... Low toxicity by skin absorption, but extended contact can cause irritation and dermatitis. Skin sensitization or reddening, swelling or blistering can occur.

Inhalation:..... Vapors are of low to moderate toxicity when inhaled and are irritating to nose, throat and other respiratory passages, especially in higher concentrations. Extended exposure can cause headaches, dizziness, nausea or even loss of muscular control and coordination, narcosis or unconsciousness. In addition to causing lung irritation, coughing, breathlessness and chest discomfort, isocyanates can cause a reduction in lung function or even bronchitis, bronchial spasm or pulmonary edema in extreme concentrations. Any of these effects can be immediate or delayed. Any pre-existing impairment in lung function will be magnified or sensitization of the lungs can occur, and those in either condition should not be exposed to any level of isocyanate vapor.

Ingestion:..... Liquid is of low to moderate toxicity when ingested, but can be hazardous if aspirated into lungs during swallowing or vomiting.

Additional Information:..... Chronic hazards include narcosis, specific organ damage, permanent brain and nervous system damage or coma if extensively abused. Component B (and therefore the mixture) contains an isocyanate compound, which carries additional hazards. The vapor's odor is not detectable until dangerous levels have already been reached.

MATERIAL SAFETY DATA SHEET

Product Name:	EX-2C COMPONENT B

SECTION 04: FIRST AID MEASURES

Inhalation (acute):	Remove to fresh air and if necessary restore breathing by giving artificial respiration. Administer oxygen if victim is breathing with difficulty. GET IMMEDIATE MEDICAL HELP.
Ingestion:	DO NOT INDUCE VOMITING. Seek medical help. Give 1 or 2 glasses water or milk, BUT ONLY IF VICTIM IS CONSCIOUS.
Eye Contact:	Check for and remove any contact lenses. Flush eyes IMMEDIATELY with water for 15 minutes and get immediate medical help.
Skin Contact:	Wash with soap and water. Clean contaminated clothing before reuse.
Notes to Physician:	Treatment is symptomatic. There is no specific antidote. See list of ingredients.

SECTION 05: FIRE FIGHTING MEASURES

Flash Point (°C) (TCC):	-4
Auto Ignition Temperature (°C):	N/A
Upper Explosive Limit (% Vol):	N/A
Lower Explosive Limit (% Vol):	N/A
Extinguishing Media:	CO_2, dry chemical, foam. Avoid using water except as a fog.
Hazardous Combustion Products:	CO, CO_2. Oxides of Nitrogen. Hydrogen Cyanide. HDI
Sensitivity To Mechanical Impact:	None
Sensitivity To Static Discharge:	Can ignite vapors
Special Fire Fighting Procedures:	Wear self-contained breathing apparatus and full protective clothing. Extreme heat may cause pressure build-up in containers and possibly explosion, therefore use water to keep containers cool.
Conditions of Flammability:	Sparks, open flame, static discharge or extreme temperature.

SECTION 06: ACCIDENTAL RELEASE MEASURES

Leak / Spill:	Remove all sources of ignition. The product should be contained and absorbed with inert materials and placed into a container. Do not seal the containers until any gas, which might form, has done so.

SECTION 07: HANDLING AND STORAGE

Handling Procedures:	Avoid static charges, sparks, flames and excessive heat. Keep containers tightly closed and upright when not in use. Do not allow contact with skin or eyes, and don't breathe vapors.
Storage Needs:	Store in a cool, dry place.

SECTION 08: EXPOSURE CONTROLS / PERSONAL PROTECTION

PROTECTIVE EQUIPMENT

Eye/Type:	Personnel should wear liquid chemical goggles or a full-face shield.
Respiratory/Type:	Personnel should wear a suitable air supplied respirator.
Gloves/Clothing/Footwear/Type:	Personnel should wear chemical-resistant clothing, gloves and footwear.
Other/Type:	A safety shower and eye wash facility should be available.
Ventilation Requirements:	Adequate ventilation must be assured to prevent the accumulation of dangerous amounts of vapor or mist.

MATERIAL SAFETY DATA SHEET

Product Name:	EX-2C COMPONENT B

SECTION 09: PHYSICAL AND CHEMICAL PROPERTIES

Physical State (appearance):	Clear, slightly yellow liquid
Odor:	Solvent like
Density (g/ml):	0.964
VOC:	570 g/l 4.74 lbs/gal
Odor Threshold (ppm):	N/A
Vapor Pressure (20°C):	76 mm Hg
Vapor Density (Air=1):	Heavier than air
Evaporation Rate:	4.0
Boiling Point (°C):	77
pH:	N/A
Solubility in Water (% W/W):	N/A
Coefficient of Water/Oil Distribution:	N/A
Freezing Point (°C):	N/A

SECTION 10: STABILITY AND REACTIVITY

Incompatibility:	
Reactivity Conditions:	Reacts with water, alcohols, amines, and strong bases to give a variety of products, some gaseous. Both components and their mixture will react dangerously with oxidizing materials. If component B or the mixture comes into contact with any of the above materials, a potentially explosive mixture can form. Therefore, contaminated solutions must never be resealed in the can.
Hazardous Products of Decomposition:	

SECTION 11: REGULATORY INFORMATION

WHMIS:	B-2, B-3,D-1A, ,D-1A , D-2B

SECTION 12: DISPOSAL CONSIDERATIONS

Waste Disposal:	Dispose of waste according to local, provincial and federal regulations. Utilize authorized centers for disposal of combustible chemical material.

SECTION 13: TRANSPORT INFORMATION

T.D.G. Classification:	Shipping name: Paint. UN 1263, Cl 3, PG II.

SECTION 14: OTHER INFORMATION

Note:	
Prepared By:	Technical Department
Revision Date:	June 8, 2007

AIRDEX CORPORATION

AIR MAKE-UP UNITS

AMU Series

Construction
Welded steel housing finished in grey enamel.

Application
Available in a wide range of sizes handling 75 c.f.m. to 1100 c.f.m.

Designed to use as Air Replacement and Air Make-Up Units, for permanent installation.

To exhaust foul air and replace with fresh outside air.

By drawing on its wide range of tooled, standard parts, **Airdex** engineers can design a blower to meet your specific needs whether high or low air flow. AC motors, high or low resistance, single or double inlet.

Performance Data

			Air Delivery (CFM) at R.P.M. Specified							
Description	H.P.	R.P.M.	Free Air	1/8" SP	1/4" SP	3/8" SP	1/2" SP	3/4" SP	1" SP	1 1/4" SP
AMU 75	1/60	3000	75	61	54	43	-	-	-	-
AMU 130	1/70	1550	130	107	87	30	-	-	-	-
AMU 160	1/40	1600	165	150	135	120	104	-	-	-
AMU 245	1/20	1550	245	225	210	190	162	-	-	-
AMU 265	1/20	1610	265	250	233	215	185	-	-	-
AMU 400	1/12	1550	400	380	365	340	315	200	-	-
AMU 465	1/15	1530	465	430	397	357	308	-	-	-
AMU 525	1/4	1725	525	500	480	460	420	240	120	-
AMU 625	1/4	1725	625	600	560	540	500	420	280	100
AMU 845	1/2	1725	845	825	790	760	730	650	570	425
AMU 1100	1/3	1140	1100	1050	1000	950	B60	700	-	-

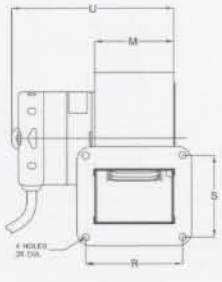
Tested by The Nozzle Chamber Method as directed in A.M.C.A. Bulletin #210. Figure #4.

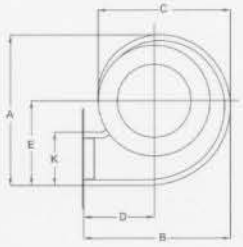
Features

115 Volt, 60 Hz

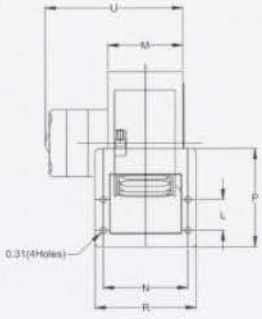
- Thermal overload protection
- Conduit wiring box
- Permanently lubricated bearings
- Horizontal or vertical operation
- Counter clockwise rotation drive side
- AMU 245, 400, 525, 625, 845 and 1100 supplied with inlet collars.
- Sleeve bearings with oilers
- 4 discharge positions

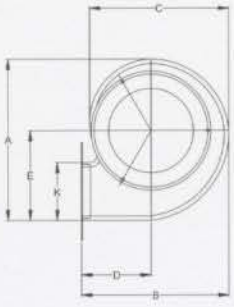
Specification Charts



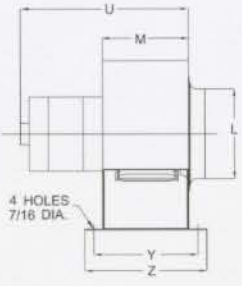


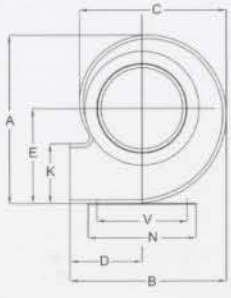
Description	A	B	C	D	E	K	M	R	S	U	Weight (lbs)
AMU 75	5.34	5.17	4.68	2.50	3.02	1.92	2.75	3.38	2.88	5.35	3.4
AMU 130	7.59	7.09	6.58	3.31	4.30	2.72	3.75	4.69	3.75	6.75	4





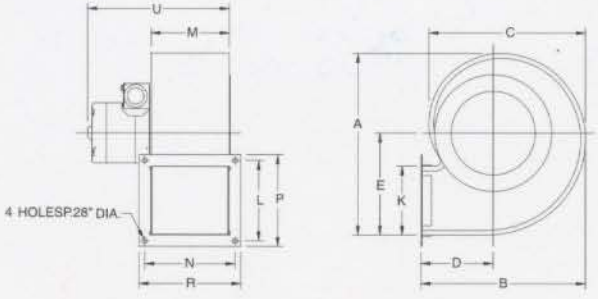
Description	A	B	C	D	E	K	L	M	N	P	R	U	Weight (lbs)
AMU 160	7.80	7.08	6.69	3.34	4.34	2.80	1.50	3.60	4.05	4.75	4.85	6.40	5.4



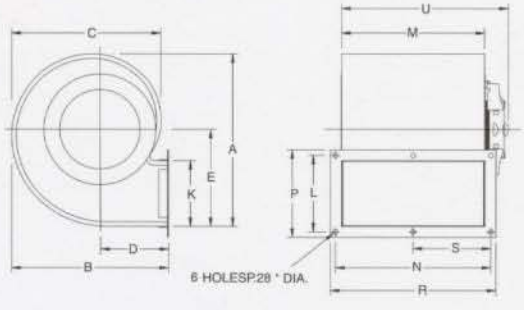


Description	A	B	C	D	E	K	L	M	N	U	V	Y	Z	Weight (lbs)
AMU 245	9.41	8.73	8.17	4.0	5.33	3.36	5.0	4.75	6.0	9.0	5.0	5.75	6.75	8
AMU 400	10.61	9.76	9.24	4.44	6.01	3.79	6.0	5.25	6.0	10.75	5.0	6.25	7.25	13

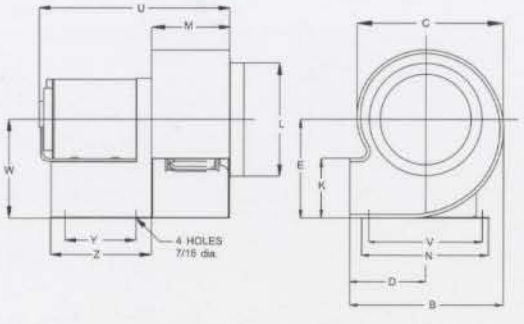
Specification Charts



Description	A	B	C	D	E	K	L	M	N	P	R	S	U	Weight (lbs)
AMU 265	9.93	9.0	8.46	3.9	5.55	3.75	4.37	4.22	4.87	5.0	5.5	-	7.65	8.05



Description	A	B	C	D	E	K	L	M	N	P	R	S	U	Weight (lbs)
AMU 465	9.93	9.0	8.46	3.9	5.55	3.75	4.37	8.12	8.82	5.0	9.4	4.41	9.46	11.0

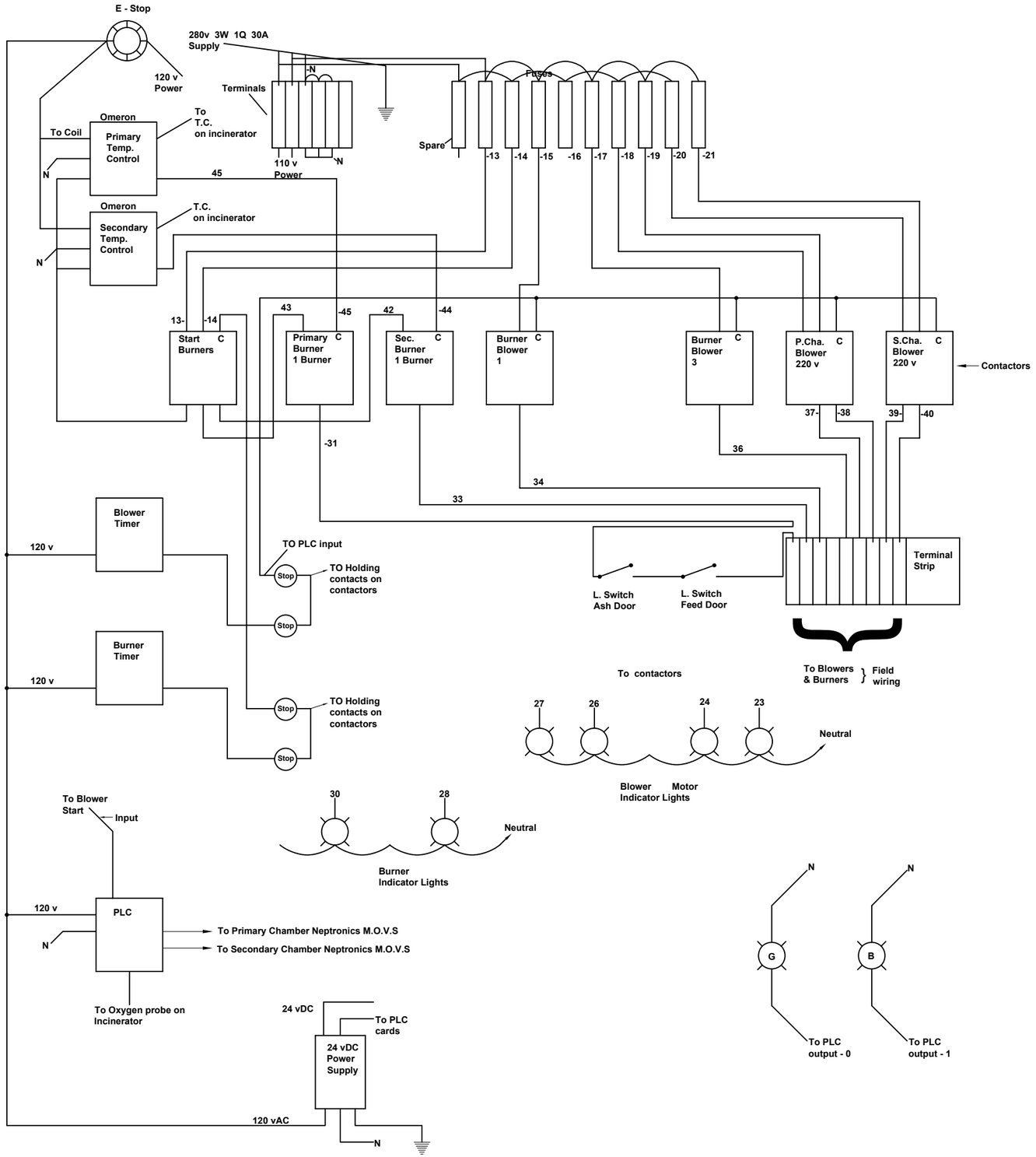


Description	A	B	C	D	E	K	L	M	N	U	V	W	Y	Z	Weight (lbs)
AMU 525	11.91	10.85	10.36	4.88	6.98	4.24	8.0	5.5	9.0	13.6	8.0	7. 23	5.0	7.02	24
AMU 625	11.91	10.85	10.36	4.88	6.98	4.24	8.0	6.0	9.0	14.1	8.0	7.23	5.0	7.02	24
AMU 845	13.43	12.19	11.66	5.44	7.60	4.76	8.0	6.0	9.0	14.8	8.0	7.85	5.0	7.02	30
AMU 1100	16.58	14.62	14.06	6.34	9.51	6.28	9.0	7.0	9.0	16.6	8.0	9.81	5.0	7.02	53

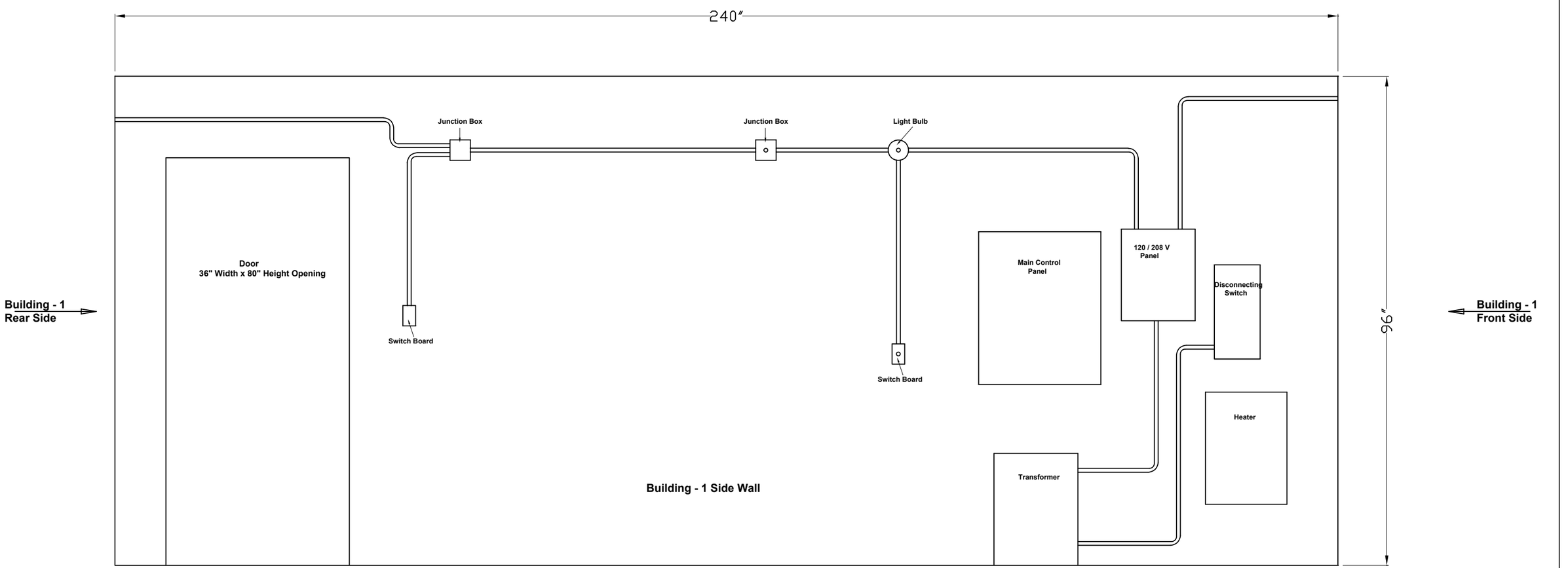
Approved by Shop:

Date:_____

Signature:_____



WESTLAND ENVIRONMENTAL SERVICES INC.			
Model:	**Incinerator CY-50-CA-'D'-'O'**		
Date:	02-09-2008	**Electrical Wiring Diagram**	
Drawn By:	YP		
Rev. :		**Dwg-No:**	9 - 3
Scale:			



Approved by Shop:

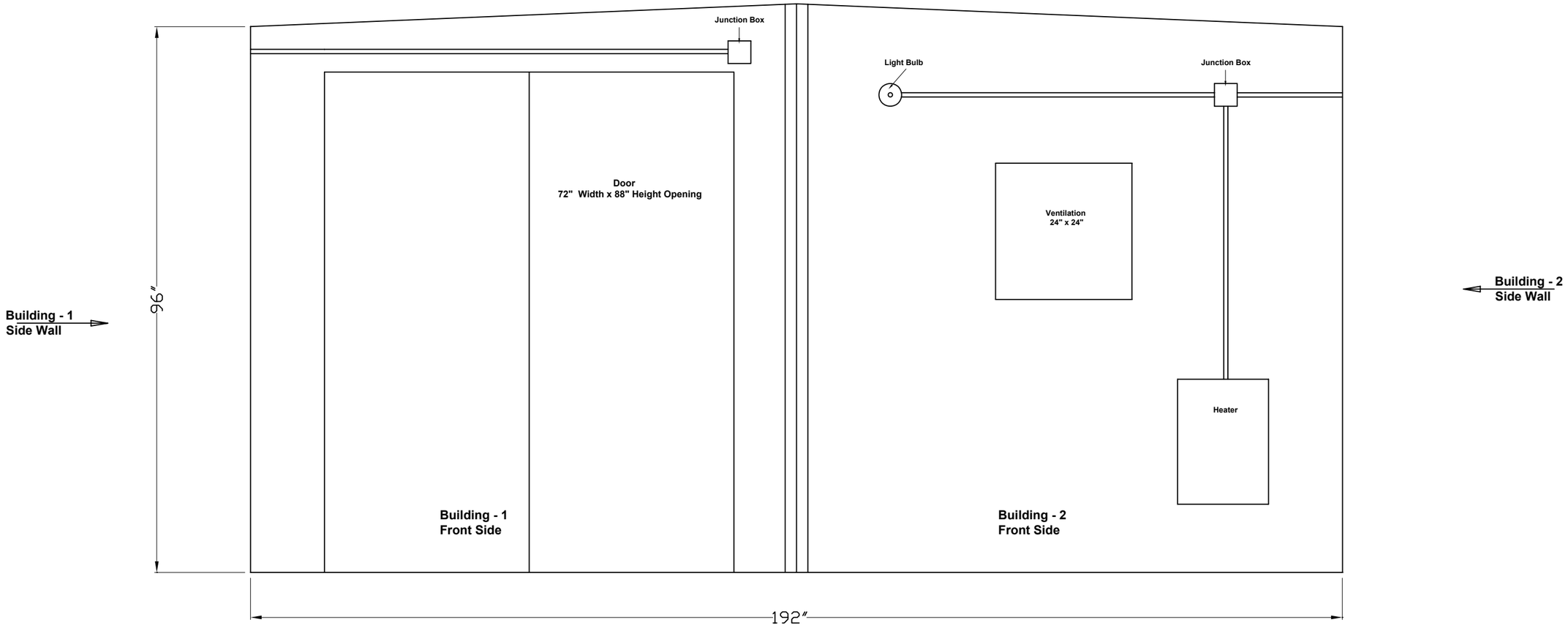
Date:_____

Signature:_____

Project : Eureka

WESTLAND
ENVIRONMENTAL SERVICES INC.

Model:	**Incinerator CY-50-CA-'D'-'O'**		
Date:	May-26-08	**Electrical Diagram (Inside the Building)**	
Drawn By:	YP		
Rev. :	Ø		
Scale:	NTS	**Dwg-No:**	8 - 1



Approved by Shop:

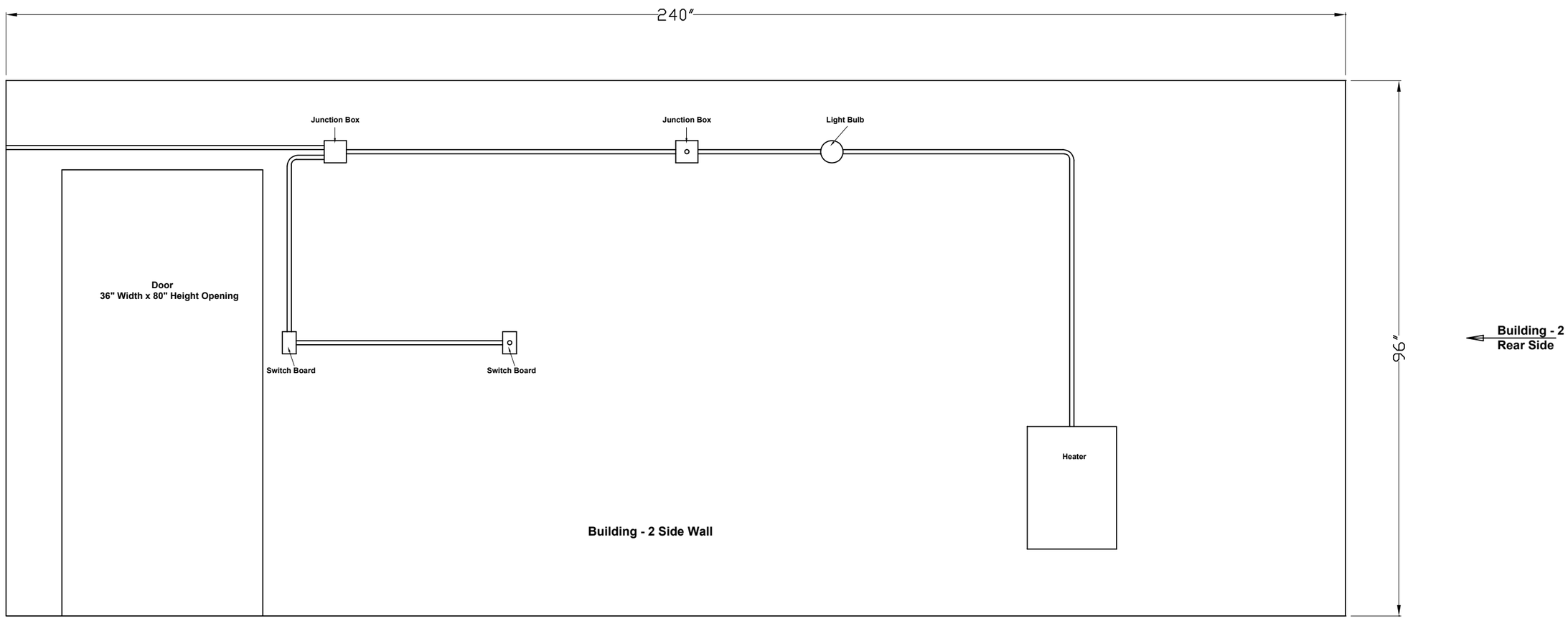
Date:_____

Signature:_____

Project : Eureka

WESTLAND
ENVIRONMENTAL SERVICES INC.

Model:	**Incinerator CY-50-CA-'D'-'O'**		
Date:	May-26-08	**Electrical Diagram (Inside the Building)**	
Drawn By:	YP		
Rev. :	Ø		
Scale:	NTS	**Dwg-No:**	8 - 2



Approved by Shop:

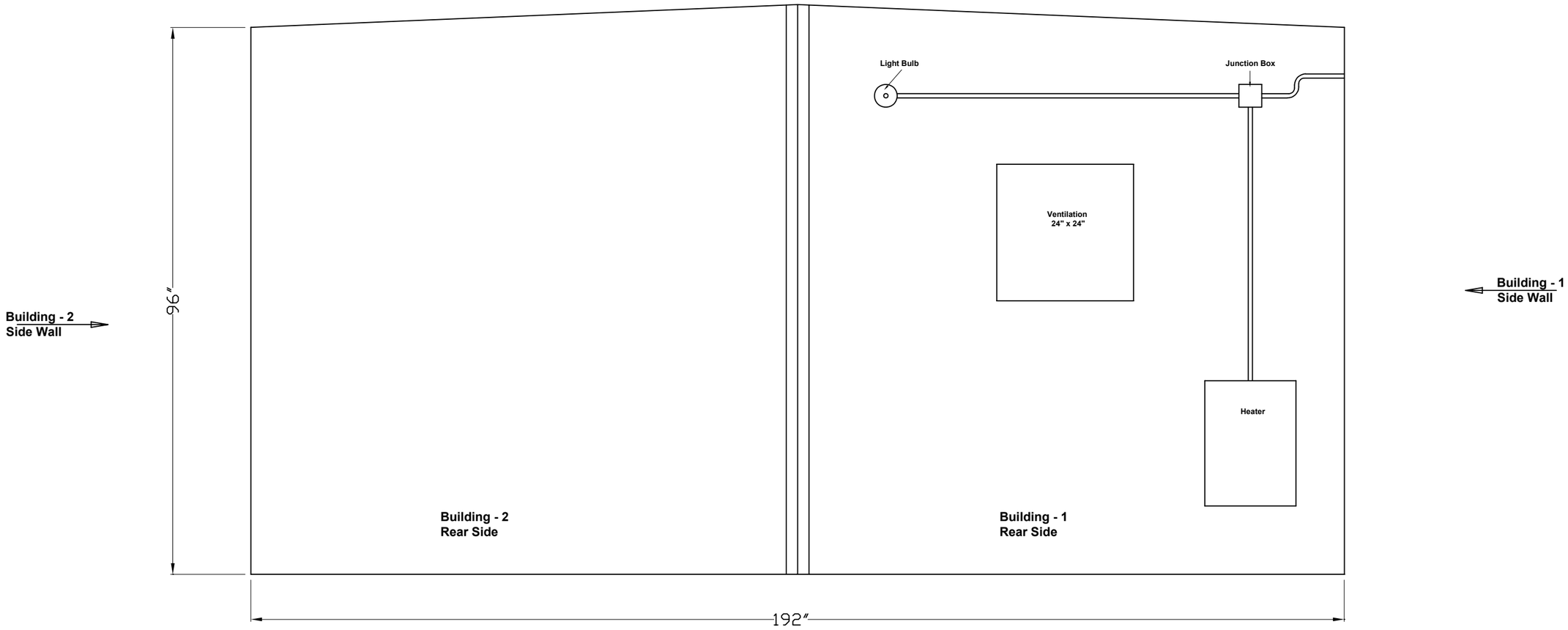
Date:_____

Signature:_____

Project : Eureka

WESTLAND
ENVIRONMENTAL SERVICES INC.

Model:	**Incinerator CY-50-CA-'D'-'O'**		
Date:	May-26-08	**Electrical Diagram (Inside the Building)**	
Drawn By:	YP		
Rev. :	Ø		
Scale:	NTS	**Dwg-No:**	8 - 3



Approved by Shop:

Date:_____

Signature:_____

Project : Eureka

WESTLAND
ENVIRONMENTAL SERVICES INC.

Model:	**Incinerator CY-50-CA-'D'-'O'**		
Date:	May-26-08	**Electrical Diagram (Inside the Building)**	
Drawn By:	YP		
Rev. :	Ø		
Scale:	NTS	**Dwg-No:**	8 - 4