Hope Bay Mining Ltd.

Incinerator Management Plan

Hope Bay, Nunavut, Canada

FINAL

Prepared for:

Hope Bay Mining Ltd.

Prepared by:

SRK Consulting
Engineers and Scientists

Project Reference Number
SRK 1CH008.009.500

July 2009

Hope Bay Mining Limited

Incinerator Management Plan

Hope Bay, Nunavut, Canada

Hope Bay Mining Ltd.

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1 Introduction

1.1 Reason for Submission

Hope Bay Mining Limited (HBML) is currently further developing the infrastructure for the Hope Mining Project in Hope Bay, Nunavut, Canada. Part of this infrastructure development is for the effective incineration of appropriate waste in accordance with the Water Licence No: 2AM-DOH0713 issued to HBML by the Nunavut Water Board (NWB).

HBML are required under the Type A Water Licence (Parts G) to submit to the NWB an Incineration Management Plan (Section 5) in conjunction with a revised Landfill Management Plan (Section 9). The plan, as defined in the License shall consider the following:

a) Recycling/segregation waste program
b) Incineration technology selected
c) Waste audit – amount and types of wastes to be incinerated or otherwise disposed
d) Consolidation of wastes
e) Operational and maintenance records
f) Operator Training
g) Emission measurements
h) Incinerator Ash disposal
i) Consideration for disposal of used oil and waste fuel
j) Monitoring, characterization, and disposal of incinerator ash.

This Incinerator Management Plan has been prepared and is being submitted by Hope Bay Mining Limited to address the requirement specified in Part G, Section 5 of the Water Licence No: 2AM-DOH0713. The plan addresses all relevant aspects of the operation, maintenance and monitoring of the Westland Model CY-100-CA-D-O incinerator located at the Roberts bay site, and the management of all residual materials (ash) generated by the operation of the incinerator. This incinerator services the Doris North Camp.

1.2 Project Location

The Hope Bay Gold Mining Project located on Inuit Owned Land in the West Kitikmeot region of Nunavut approximately 125 km southwest of Cambridge Bay and 75 km northeast of Umingmaktok (Figure 1). The various elements of Hope Bay Project are centred at approximately 680 09’ N and 1060 40’ W and extend from the head of Roberts Bay (an extension of Melville Sound) in the north to the Boston site located approximately 70 km to the south (Figure 1).

1.3 Incinerators at Hope Bay

There are currently two incinerators at the Doris North Project at Hope Bay. The location, operational state and model type of the incinerators are identified below and in Figure 2.

- Doris Camp incinerator is located at Roberts Bay at: N 68 10.470' W 106 37.111' (In service) (Model CY 100- CA- D-O) (Dual Chamber)

- Incinerator at Roberts Bay Roberts Bay, Coordinates: N 68 10.476' W 106 37.322' (Not in service) (Model CY-1020 FA).

1.4 Operator

The Hope Bay Project is owned and operated by:

Project Operator: Hope Bay Mining Ltd.
Suite 300 -899 Harbourside Drive
North Vancouver, B.C. V7P 3S1

Hope Bay Project Contacts:

Corporate: Mr. William Patterson
Environmental Compliance Manager
Hope Bay Mining Ltd.
Tel. 303 837 5661

Hope Bay Site: Mr. Fred Penner
Site Manager
Hope Bay Mining Ltd.
Tel. 604 759 4708

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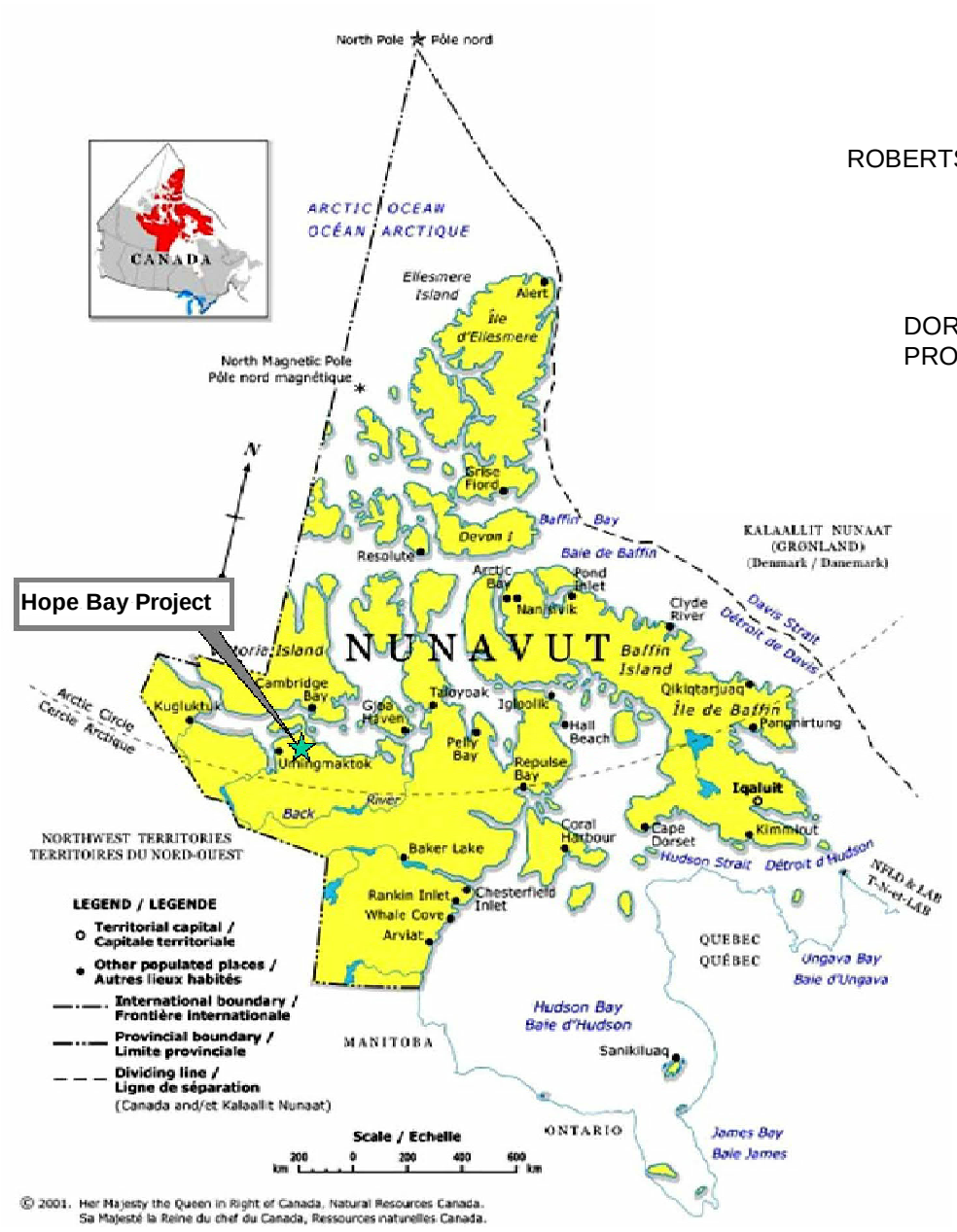
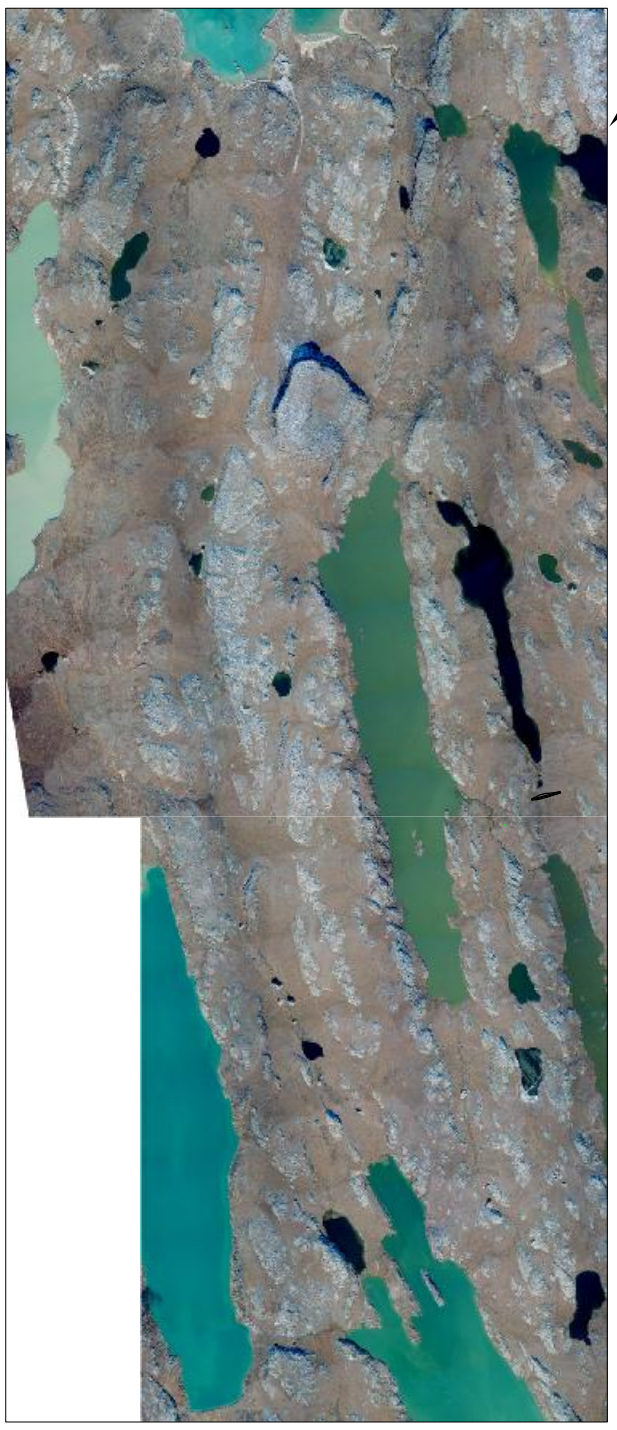
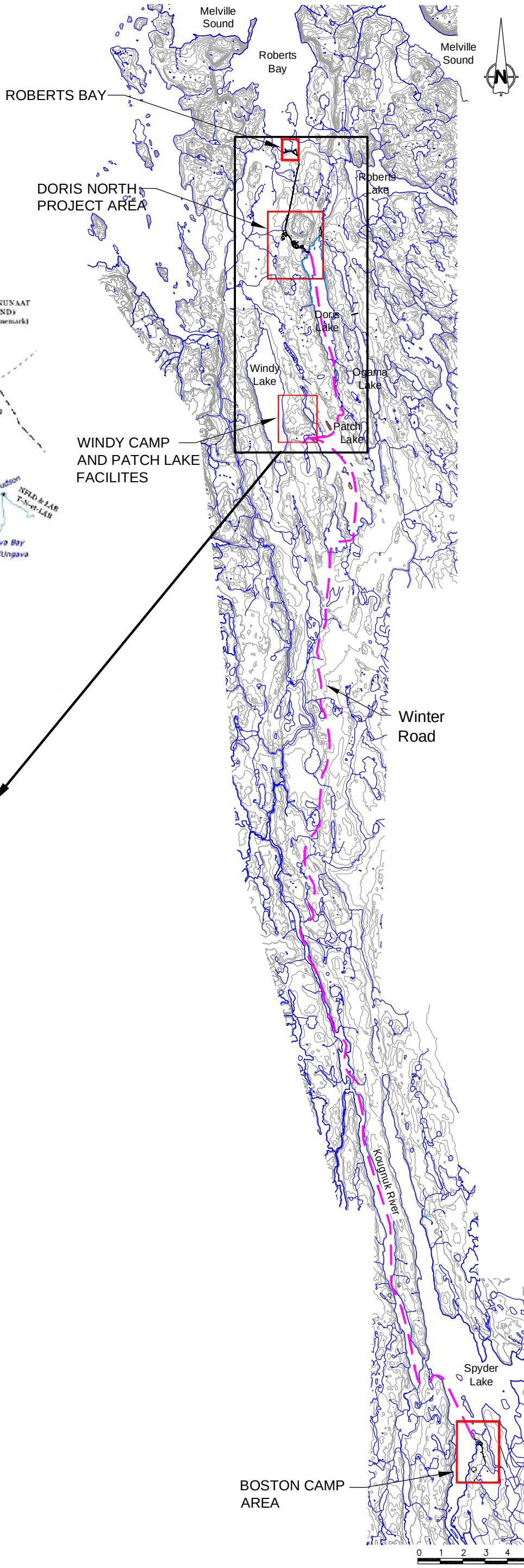


LOCATION MAP



ROBERTS BAY TO WINDY CAMP



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HOPE BAY MINING LTD.

Hope Bay Project

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Hope Bay Project Location

DATE:	APPROVED:	FIGURE:
June 2009	MV	1

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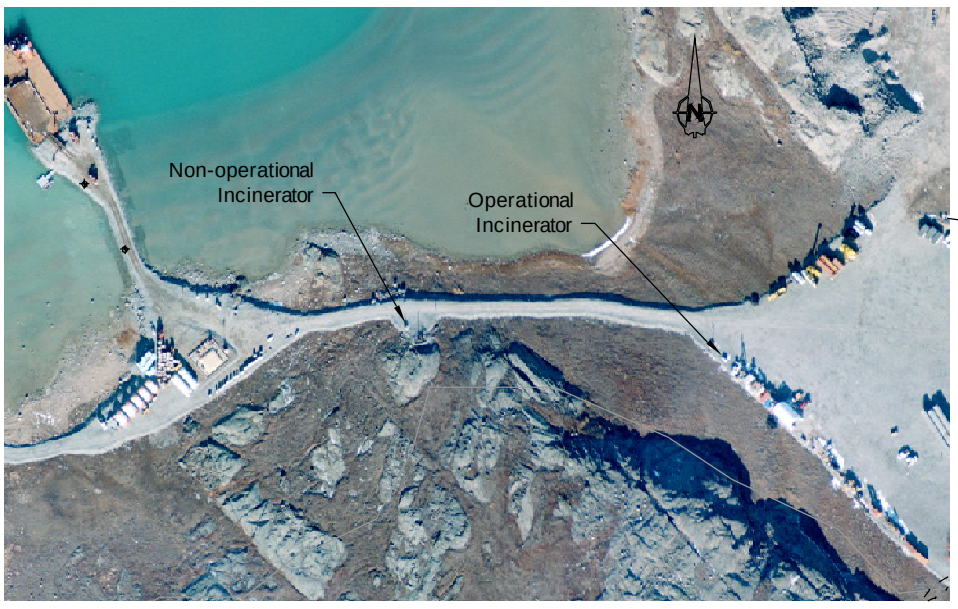
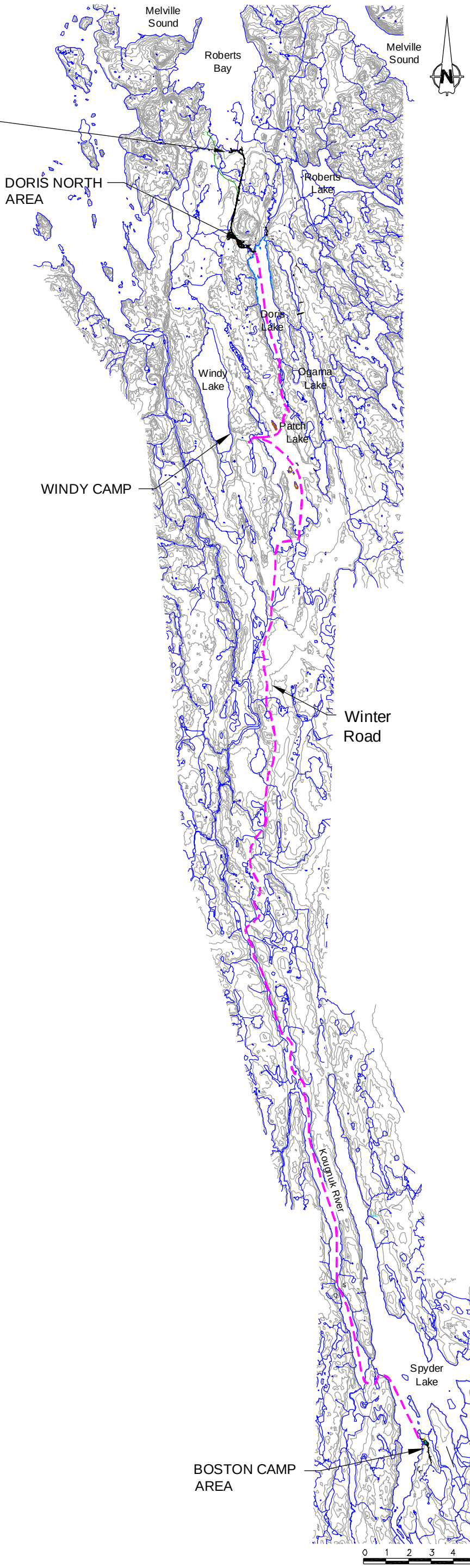


Roberts Bay Area



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FILE NAME: Incinerator Plan-1.dwg

HOPE BAY MINING LTD.

Hope Bay Project

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Incinerator Locations

DATE:	APPROVED:	FIGURE:
June 2009	MV	2

1.5 Plan Objectives

The objectives of managing and appropriate incinerations of wastes are numerous. Consistent with HBML's intent to be a responsible operator these objectives are described as follows:

- Compliance with regulatory and permit requirements
- Prevention of public health risk
- Protection of the operator
- Protection of surface water
- Protection of groundwater
- Protection of land
- Protection of local species
- Conservation of resources
- Protection of community amenity.

This Incinerator Management Plan has been developed to ensure that these factors are built into the HBML operational approach to working at Hope Bay.

1.6 History of Incinerator Management Plan

This, the Hope Bay mining Limited Incinerator Management Plan – Revision 0 will be reviewed on a regular basis (at least once per calendar year) and revised as required. Each revision will be recorded in Table 1.

Table 1: History of Incinerator Management Plan Revisions

Revision Number	Review Date	Description of Revisions	Revised By
0	May 2009	Initial issuance of Incinerator Management Plan	Not applicable

1.7 Responsibility

The Site Manager has overall responsibility for this management plan and will be the party to provide the resources to operate and maintain the Westland Model CY-100-CA-D-O Incinerator located at the Roberts Bay site. The Site Manager will have site responsibility for the implementation of this management plan and will be responsible to provide the on-site resources to operate, manage and maintain the Incinerator in accordance with the manual; conduct regular inspections of the incinerators; and provide input on modifications in design and operational procedures to improve operational performance of the facilities. The Site Manager, will provide daily supervision to site operational personnel on the operation of the incinerator.

The site Environmental Coordinator has responsibility to regularly review and keep this management plan up-to-date; provide technical expertise to the site operational personnel and maintenance of the incinerator, reporting on the performance of the incinerator, residuals (ash) management; conduct annual audits of the waste management and incineration; and provide an audit report to the Site Manager.

2 Applicable Legislation, Licensing and Guidelines

2.1 Water License

With regard to waste management and incineration, Part G of Water License No: 2AM-DOH0713 states:

5. *The Licensee shall dispose of all food waste in an incinerator designed for this purpose.*
6. *The Licensee shall ensure that any on-site incinerator meets the requirements of the Canada-Wide Standards for Dioxins and Furans and Canada-Wide Standards for Mercury Emissions.*
7. *The Licensee shall submit to the Board for review by May 1, 2008 an Incineration Management Plan in conjunction with Part G, Item 9.*
8. *The Licensee is restricted to the open burning of paper products, paperboard packing and untreated wood waste in accordance with the Government of Nunavut policy Municipal Solid Wastes Suitable for Open Burning.*
9. *The Licensee shall submit to the Board for review by May 1, 2008, a revised Landfill Management Plan. The Plan shall consider the following:*

Recycling/segregation waste program:

a) Incineration technology selected
b) Waste audit – amount and types of wastes to be incinerated or otherwise disposed
c) Consolidation of wastes
d) Operational and maintenance records
e) Operator Training
f) Emission measurements
g) Incinerator Ash disposal
h) Consideration for disposal of used oil and waste fuel
i) Monitoring, characterization, and disposal of incinerator ash.

10. *The Licensee is authorized to dispose of and contain all non-hazardous solid wastes at the Landfill or as otherwise approved by the Board.*

2.2 Canada-Wide Standards for Dioxins, Furans and Mercury

Canada has identified dioxins, furans and mercury as emission products that need to be controlled as they pose a potentially significant health and environmental threat. This section presents an extract of the Canada Wide Standards which are made available in full in Appendix A and B.

2.2.1 Dioxin and Furans

Polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs), commonly known as dioxins and furans, are toxic, persistent, bioaccumulative, and result predominantly from human activity. Due to their extraordinary environmental persistence and capacity to accumulate in biological tissues, dioxins and furans are slated for virtual elimination under the *Canadian Environmental Protection Act* (CEPA), the Federal *Toxic Substances Management Policy (TSMP)* and the CCME *Policy for the Management of Toxic Substances*.

Dioxin and furan contamination found in soil, water, sediments, and tissues (in situ contamination), is the subject of national guidelines for dioxins and furans. These guidelines outline ambient or "alert levels" which may be used by jurisdictions as benchmarks for the management and monitoring of dioxins and furans already present in the environment.

The Canada-wide Standards process has focussed on anthropogenic sources that are releasing dioxins and furans to the atmosphere and soil in a continuous process. Waste incineration has historically been responsible for a significant portion of the dioxins and furans emitted in Canada. The total release of dioxins and furans from this sector amounts to 44.9 g/ TEQ/y or 22.5% of the total releases to the atmosphere. Improved exhaust gas controls to reduce emissions of acid gases and fine particulates or activated carbon injection systems have decreased emissions of both mercury and dioxins and furans from the municipal solid waste (MSW) sector.

The following standards are a step towards achieving virtual elimination for dioxins and furans. For new or expanding facilities of any size, application of best available pollution prevention and control techniques, such as a waste diversion program, to achieve a maximum concentration[1] in the exhaust gases from the facility as follows:

- Municipal waste incineration 80pg I-TEQ/m^3
- Medical waste incineration 80pg I-TEQ/m^3
- Hazardous waste incineration[2] 80pg I-TEQ/m^3
- Sewage sludge incineration 80pg I-TEQ/m^3

For existing facilities application of best available pollution prevention and control techniques, to achieve a maximum concentration[1] in the exhaust gases from the facility as follows:

- Municipal waste incineration:
  > 26 Tonnes/year 3 80pg I-TEQ/m^3
  < 26 Tonnes/year 4 80pg I-TEQ/m^3
- Medical waste incineration:

[1] Stack concentrations of dioxins and furans will be corrected to 11% oxygen content for reporting purposes.
[2] Hazardous waste incinerators include all facilities that burn hazardous waste including low level radioactive waste; however they do not include facilities that use waste derived fuel or used oil.

> 26 Tonnes/year3 80pg I-TEQ/m^3
< 26 Tonnes/year4 80pg I-TEQ/m^3

- Hazardous waste incineration 2 80 pg I-TEQ/m^3
- Sewage sludge incineration 100 pg I-TEQ/m^3

Any new or expanding facility will be required to design for and achieve compliance immediately upon attaining normal full scale operation, compliance to be confirmed by annual stack testing. Based on determined efforts in working towards virtual elimination, existing facilities will be required to meet the standards on the following schedule:

- Municipal waste incineration 2006
- Medical waste incineration 2006
- Hazardous waste incineration 2006
- Sewage sludge incineration 2005

In addition to the continuing efforts of waste incinerator operators to destroy or capture emissions of dioxin and furans, emphasis will be placed on identifying and implementing opportunities to prevent the creation of dioxins and furans as well as emissions of air pollutants and ash quality generally. As an initial action with shared responsibility by all jurisdictions, strategies identifying opportunities to minimize waste incineration emissions of air pollutants including dioxins and furans will be developed through a multi-stakeholder process by December 31, 2001 to provide a framework for continual progress towards the elimination of dioxin and furans. Recognizing that many opportunities for minimizing air pollutant and ash emissions and specifically avoiding the creation of dioxins and furans fall beyond the exclusive influence of the operators of waste incinerators, preparation of this strategy must engage a wide range of stakeholders.

2.2.2 Mercury

Waste incineration has historically been responsible for a significant portion of the mercury emitted in Canada, however reductions in emissions have been apparent. Improved exhaust gas controls to reduce emissions of acid gases and fine particulates or activated carbon injection systems have decreased emissions of both mercury and dioxins and furans from the municipal solid waste4 sector. At the same time, action has been taken by many product manufacturers to reduce the mercury content of consumer goods which could end their life cycle in domestic solid waste (e.g., alkaline batteries) and thus have reduced the mercury available in the waste stream. Mercury from this sector is estimated to be 446 kg/year. Many medical waste incinerators5 have closed for economic or environmental reasons, but a range of medium- to small-sized facilities remain which alone are small sources, but as a sector are considerable, emitting an estimated 250 kg/yr. Two sectors in which emission reductions are not apparent, hazardous waste6 (550 kg/yr) and sewage sludge (285 kg/yr) incineration, can achieve reductions either through source control or gas-controls.

Emission limits are expressed as a concentration in the exhaust gas exiting the stack of the facility. New or expanding facilities will be expected to comply immediately with the standard, and it will be up to individual jurisdictions to determine what constitutes a significant expansion to trigger the standard. The limits for existing facilities are capable of being met using generally available technology (or waste diversion). Larger facilities will be subject to annual stack testing to verify compliance with the limit and smaller (medical, municipal) facilities will have the option of reporting on a successful mercury diversion plan or of conducting a one-time stack test, to illustrate progress towards the standard.

For new or expanding facilities of any size, application of best available pollution prevention and control techniques, such as a mercury waste diversion program, to achieve a maximum concentration in the exhaust gases from the facility as follows:

- Municipal waste incineration 20 μg/Rm^3
- Medical waste incineration 20 μg/Rm^3
- Hazardous waste incineration 50 μg Rm^3
- Sewage sludge incineration 70 μg/Rm^3

For existing facilities application of best available pollution prevention and control techniques, to achieve a maximum concentration in the exhaust gases from the facility as follows:

- Municipal waste incineration
  > 120 Tonnes/year 9 20 μg/Rm^3
  < 120 Tonnes/year10 20 μg/Rm^3
- Medical waste incineration
  > 120 Tonnes/year 9 20 μg/Rm^3
  < 120 Tonnes/year10 40 μg/Rm^3
- Hazardous waste incineration 50 μg/Rm^3
- Sewage sludge incineration 70 μg/Rm^3

Stack concentrations of mercury will be corrected to 11% oxygen content for reporting purposes.

Timeframe for achieving the targets are defined as any new or expanding facility will be required to design for and achieve compliance immediately upon attaining normal full scale operation, compliance to be confirmed by annual stack testing or an equivalent emission rate as confirmed by an audit of a waste diversion program.

Existing facilities will endeavour to meet the standards on the following schedule:

- Municipal waste incineration 2006
- Medical waste incineration 2006
- Hazardous waste incineration 2003
- Sewage sludge incineration 2005

2.2.3 Waste Management under the CWS

Canada has also recognized that to minimize air pollutant and ash emissions the best strategy is to specifically avoiding the creation of dioxins and furans. Various mechanisms to give effect to the reduction are:

- Waste diversion to minimize generation of waste
- Waste reduction
- Material reuse
- Waste segregation
- Combustion control
- Alternative disposal or treatment technologies.

2.2.4 Water License Emission Testing Requirements

The following parameters are required to be monitored based on the conditions specified in the water licences:

- Dioxin
- Furan
- Mercury emissions
- Vol. Flow rate (out of stack)
- Stack gas Temp
- Moisture content.

Optional:

- SO_2
- NO_2
- O_2
- Particulates.

3 Waste Management at Hope Bay

Waste at Hope Bay is currently handled and processed in a variety of ways, with all resulting in material being backhauled to Yellowknife for disposal. This is not necessarily an ideal situation as there is a significant environmental and economic cost to hauling waste. To be consistent with the Canada Wide Standards (CWS) presented above, opportunities for local processing of waste at Hope Bay should be investigated. This includes the composting of vegetable matter from kitchens, if it can be shown not to attract bears, and UV processed sewage sludge. These two components represent the bulk of the material that needs to be incinerated and also a potential source of dioxins, furans and mercury which cannot easily be diverted from the incineration process. The water licence however requires all food waste to be incinerated, which is directly at odds with the requirement of the CWS. The reduction of the volumes of waste that need incineration and maximising the amount of waste that can be processed via composting on site would be the ideal for waste management.

The sewage management plans that have been prepared for Hope Bay also identify compositing of sewage sludge as a key opportunity for the management of waste. Furthermore there is untreated wood waste which is currently being backhauled to Yellowknife. This wood could be chipped and added to the composting process to increase the cellulose content of the compost. This would create a ready supply of compost for the future remediation of areas that have been disturbed. The potential for composting has been confirmed in Northern areas by work done in Iqaluit my Mr Jim Little and reported by the Composting Council of Canada. In their test composting schemes they achieved temperatures of 59°C in summer, which is adequate to destroy many of the harmful pathogens. This temperature would probably be higher with an increased cellulose load. The heat makes the composting season longer than just the short summer period and creates the opportunity for using the heat in space heating.

In order to minimise volumes of waste in all parts of the life cycle and reduce the potential for it to cause harm in processing or transport, the following is recommended but may require changes to the water license and operations at Hope Bay:

Waste Minimisation

- Reduction of packaging sent to Hope Bay
- Use of bulk supplies only
- Use of non PVC based medical devices

Composting

- Vegetable based food waste
- Sewage sludge
- Untreated wood waste

Incineration

- Medical waste (Minimising plastics and PVC)
- Sewage course filter
- Meat and bone products from food supply

Waste Backhaul, Recycling and Disposal

- All metal waste (Recycle)
- All glass waste (Recycle)
- All painted or treated wood waste (Dispose)
- All plastic materials (Especially PVC) (Recycle/Dispose)
- All hazardous chemical waste (Dispose)
- All used hydrocarbons (Oils etc) (Process)
- All contaminated soil material (Remediate).

The broad philosophy underpinning the management of Waste at Hope Bay is:

- **Eliminate non useable goods:** Prevent non useable material from being sent to Hope Bay
- **Reduce waste volumes:** Bulk supply tends to reduce the amount of waste from packaging
- **Recycle products on-site:** Find second life for packaging items etc on site
- **Recovery of Waste:** On-site composting etc
- **Process hazardous and non compostable waste:** Incineration on-site and backhauling for safe disposal and recycling.

Hope Bay Mining Limited are in the process of producing a more comprehensive Waste Management Plan for the site. This is an extract from that document. The Waste Management Plan is not repeated here, although incineration forms a key part of the current waste management strategy.

Waste management is an important part of maintaining a high level of performance in operations and to ensure this for incinerator operations, Hope Bay Mining Limited has had the supplier of the equipment train all operators. The training has been focussed on explaining the principles of incineration as well as the safe and efficient operation of the incinerators.

4 Hope Bay Incinerator Emission Management

Incineration is essentially combusting material (thermal oxidation) under controlled conditions so as to render it less harmful and reduce volume by on average 95%. During combustion to ash, potentially harmful medical waste and sewage sludge can be sterilized and eliminated, medical sharps eliminated and the general waste significantly reduced in volume. The main products of incineration are:

- Heat
- Ash
- Gaseous emissions.

Incineration was initially considered to be an elegant solution to waste problems, but as understanding has grown, it has become apparent that both the ash and gaseous emissions can have potentially negative impacts as well as pose a health risk. This section of the incinerator management plan has been developed so the potential risks can be understood and that the information can be used to better manage the incinerators and waste at Hope Bay.

4.1 Ash Management

Ash from waste incinerators is known to contain heavy metals and potentially dioxins and furans. The ash at Hope Bay is placed into drums, sealed and transported to Yellowknife for safe disposal at a permitted hazardous waste landfill site. In Appendix C, waste manifests of this disposal are provided.

In essence the only way to improve the ash composition is to remove items that are not wanted as residuals in the ash. To reduce the ash volume incineration volume needs to be reduced. Both these options are explored in greater detail below.

4.2 Emission Management

Dioxins and Furans are some of the most dangerous by-products of incineration and can occur in waste ash as well as emission products from incinerators. Understanding how they are formed and how they can be minimised is an important part of incinerator management. The term “dioxins” refers to the family of compounds comprising polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) and are frequently grouped together simply as dioxins.

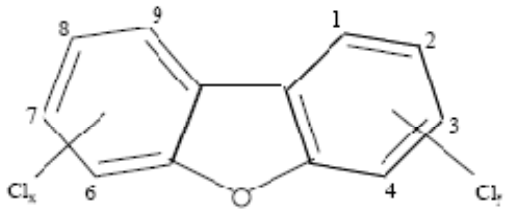
Dioxin and furan control is important to minimise the potential health effects of incinerator operation, but analytical costs are high, so most operators only conduct testing where it is a regulatory requirement. Air emissions are most frequently monitored, but incineration waste streams such as the bottom ash, scrubber sludge, fly ash material and wet scrubber effluent discharged to sewer may also contain dioxins and furans. Due to the cost involved in monitoring the dioxins and

furans, the focus is frequently placed on minimising their formation by careful operational control and careful waste separation to eliminate products that tend to increase the availability of catalysts and chlorine compounds.

4.2.1 Description of Dioxins and Furans

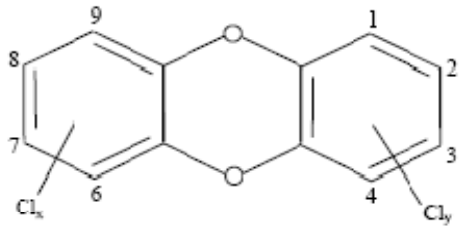
Polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) are a group of tricyclic aromatic hydrocarbons substituted with one to eight chlorine atoms. These compounds, commonly known as 'dioxins' or 'dioxins and furans', are found virtually everywhere on earth, with the main transport mechanism being atmospheric dispersion and deposition.

In molecular structure, a dioxin consists of two benzene rings connected by a pair of oxygen atoms and a furan consists of two benzene rings connected by a single oxygen atom and a C-C bond. Each of the eight carbon atoms on the rings that is not bonded to an oxygen atom or another carbon atom can bond with atoms of other elements. By convention these positions are assigned the numbers 1 through 4 and 6 through 9. PCDDs and PCDFs are bonded with 1 - 8 chlorine atoms. Figure 3 and Figure 4 show the molecular structures of PCDDs and PCDFs, respectively.



$X = 0$ to 4, $Y = 0$ to 4, $X + Y \geq 1$

Figure 3: Molecular structure of Polychlorinated Dibenzo-p-Dioxins (Unilabs)



$X = 0$ to 4, $Y = 0$ to 4, $X + Y \geq 1$

Figure 4: Molecular structure of Polychliorinated Dibenzofurans (Unilabs)

4.2.2 Environment and Health Effects

Dioxins and furans are highly stable compounds and extremely persistent in nature. They are virtually insoluble in water but are soluble in lipids, a combination of factors that encourage dioxins to enter fatty tissue and accumulate in food chains. Dioxins enter the general population almost exclusively from ingestion of food, specifically through the consumption of fish, meat, and dairy products since dioxins are fat-soluble and bio-accumulate upwards in the food chain.

Dioxins are known to be highly toxic to animals and humans, with laboratory animal tests indicating the following health effects:

- Teratogenic effects (malformations of the foetus)
- Liver damage
- Decreased reproduction and growth rates
- Cancer promotion
- Behavioural changes.

4.2.3 Dioxin and Furan Sources

Dioxins and furans can form through natural processes such as bush fires, volcanic eruptions, but the toxic forms of the compound are primarily from anthropogenic sources. Dioxins and furans are not manufactured, but form as unwanted by-products in the manufacture of organochlorine chemicals including herbicides and PVC, various combustion and metallurgical processes and chlorine bleaching of paper. Dioxins and furans are produced in small concentrations when organic material such as sewage sludge, is burned in the presence of chlorine, whether the chlorine is present as chloride ions or as organochlorine compounds. Incineration of solid waste, medical waste, sewage sludge, and hazardous waste all potentially produce dioxin emissions.

It is probable that many of these waste streams will be incinerated on site. Of particular interest in this management plan is the incineration of sewage sludge that is produced on the site. Sewage sludge is known to contain both chlorine compounds and the metals that catalyze the formation of dioxins and furans. Medical waste, including PVC devices (PVC contains approximately 60% w/w chlorine), metal and chlorine in organic material are prime feedstock for producing dioxins and furans. Dioxin and furan formation can be expected to form at the Hope Bay incineration complex if these materials are incinerated on site.

4.2.4 Dioxin and Furan Formation in Incinerators

Incineration is the rapid oxidation of material with the formation of heat and typically solid ash and gaseous waste products. The exact mechanism of dioxin and furan formation in incinerators is poorly understood, but generally they form from the thermal breakdown of organic materials in the presence of transition metals and chlorinated compounds. Dioxin formation takes place as the flue gas from the incineration process cools from the initial 1000°C down to about 250°C, with peak

dioxin and furan formation occurring in the range of 650°C to 250°C. It is thought that metals such as copper (Cu), iron (Fe), lead (Pb), cadmium (Cd), arsenic (As), nickel (Ni), zinc (Zn) and mercury (Hg) need to be present in the flue gas to catalyze the formation of dioxins and furans.

There are three generally accepted theories for dioxin and furan formation:

- Contaminated feedstock: feed material possibly contains dioxins and some portion of this survives the thermal stress of combustion and is subsequently emitted from the stack.
- Thermal breakdown of 'precursor' compounds such as chlorinated aromatic hydrocarbons such as PCBs. Dioxin and furan formation may occur after the precursor molecule is adsorbed onto the surface of fly ash. A temperature range of between 250 – 400ºC is needed.
- De novo synthesis of dioxins and furans occurs when completely different molecules react to form precursors and, eventually, dioxin-like molecules. A temperature range of between 250 – 400ºC is needed.

4.2.5 Control of Dioxins from Incinerators

Control of dioxin emissions from incinerators may be undertaken in any of the following five ways:

- Restricting chlorinated feed materials
- Combustion control
- Flue gas cooling
- Formation restriction
- Flue gas scrubbing.

4.2.6 Restricting Chlorinated Feed Materials

Chlorine in almost any form is the key component required for dioxin and furan formation. Reducing or removing the chlorinated material that enters incinerators is the first minimization strategy to possibly reduce the formation of dioxins and furans. To remove all chlorine compounds is extremely difficult as it is used in the manufacture of many products and in many cases there are no substitutes. PVC containing products should however, be eliminated from the incinerator waste stream as far as is possible as it is such a significant source of chlorine. If sewage sludge is being incinerated it is particularly difficult to eliminate, as chlorinated compounds are always present in sewage sludge.

Logically the elimination of a compound from a waste stream is sensible, but may not be practical in this case. It also needs to be borne in mind that there are some studies which suggest that this will have limited impact as it is impossible to eliminate all chlorine compounds and that dioxins and furans will still form.

4.2.7 Combustion Control

Combustion control during incineration typically requires temperatures of over 1000°C and residence times at that temperature of greater than 2 seconds. Under these conditions thermal destruction of dioxins and furans appears to occur and chlorine compounds are broken down to the extent that the precursors for later de novo synthesis post combustion is minimized.

4.2.8 Flue Gas Cooling

During the incineration process, after combustion and typically in the cooling flue gas dioxins and furans can reform or form de novo in the atmosphere above the stack. The thermal window for dioxin and furan formation is 650°C to 200°C as the exhaust gases cool. Typically a rapid cooling is sought, 30 millisecond (ms), to minimise the opportunity for furan formation. As the incinerator is in Nunanvut where the ambient air temperatures are low, the rapid cooling will be favoured, though the cooling of the flue gas through that window is likely to take longer than 30ms. In addition it also suggests that if ambient conditions are warm during the summer that a higher amount of dioxins and furans will likely form.

4.2.9 Dioxin and Furan Formation Restricting

Sulphur dioxide (SO_2) in the flue gas appears to have a significant inhibition mechanism in the control of dioxin formation. Sulphur reduces formation rather than destroy dioxins and furans. The presence of SO_2 depletes molecular chlorine and in fly ash reportedly deactivates copper catalysis. The choice of fuel, using higher sulphur fuels, may therefore also reduce dioxin and furan formation, however this may create noncompliance on the sulphur emissions from the facility. Currently low sulphur fuels are being used in the incinerator.

4.3 Dioxin and Furan Control at Hope Bay

Hope Bay Mining limited has selected incinerator technology that should reduce the extent to which dioxins and furans can form. This is achieved through the following mechanisms:

- **Burn Control:** The site is using double chamber incinerator technology with a clear burn process defined which eliminates spurious burn conditions and operator error.
- **Temperature and Residence Time:** The dual chamber system has a residence time of two seconds or greater at 1000°C. This should allow all the materials to be combusted completely so that no precursors are available for dioxin and furan formation during cooling.
- **Rapid Emission Cooling:** The stack is lined and the exit gas temperature is 1000°C. The elevated emission point and the velocity of exit into the generally below 0°C ambient air should see the emissions drop through the 650°C to 200°C window for dioxin and furan formation very rapidly. The arctic climate and cool temperatures are ideal for cooling the emission gas stream rapidly.

- **Elevated Stack Mixing:** The elevated stack will allow for adequate mixing and higher wind speeds which will enhance cooling.

The most important control of emissions that can be effected without using technology however, is based on an option that controls the waste stream that is put into the incinerator. If materials that act as the precursors or building blocks to dioxin and furan formation can be reduced, the potential for the formations of the compounds should also be reduced. Waste stream management is considered in the remainder of this section.

4.3.1 Waste Composition

The waste composition as identified by Westland Environmental Services, the suppliers of the waste incinerator, is provided in Table 2 below. Understanding the typical waste stream composition is important as it leads to one of the key opportunities for waste management generally and specifically for incineration control on the site. The typical waste streams from Boston and Windy Camps are used as indicative of the waste stream that will occur at Doris Camp.

Table 2: Typical Waste Stream Composition at Hope Bay

Waste Type	Boston Camp Percentage of waste by weight	Windy Camp Percentage of waste by weight
Food waste	70	65
Paper	25	28
Plastic	3	4
Inorganic	2	3

Food Waste: Plate scrapings, vegetable peelings, meat scraps, bread, bones, etc.
Paper: Napkins, cardboard or office paper products, insulated coffee cups, etc.
Plastics: Food containers/wrapping, plastic bottles and lids, coffee cup lids, knives, forks, kitchen grease, etc.
Inorganic: Metal cans, foil, etc.

4.3.2 Waste Separation

The following components of the waste stream must be removed before incineration to reduce the presence of potential catalysts and to reduce the presence of materials that may form or act as precursors for the formation of dioxins and furans.

- Eliminate Metals: The inorganic component of the waste is largely made of metal containing wastes. On combustion it is possible for these metals to become catalysts for the formation of dioxins and furans and it is therefore important that all metal be eliminated from the waste stream destined for incineration. The metals include, foils, batteries, nails and screws, painted wood products, aerosol cans, etc.
- Eliminate Plastics: Plastics, particularly PVC should be eliminated from the waste stream to be incinerated as far as is possible. The chlorine compounds contained in PVC are an ideal building block for the formation of dioxins and furans.
- Burn Medical Waste Separately: Medical waste can potentially be the biggest source of dioxin and furan forming material. By burning the medical waste separately, better combustion control of this waste is assured. Medical waste will contain a mix of sharps made of metal, plastics (frequently PVC) and organic material which frequently contain chlorine compounds. This is an ideal mix for forming dioxins and furans. Ideally Hope Bay should look to purchase non-PVC based medical equipment and supplies. Most medical waste is currently being returned to Yellowknife for safe disposal and is not being incinerated on site.
- Burn Sewage Sludge Separately: Although the incinerators are not specifically designed for the combustion of sewage sludge the material will combust at the right temperatures if it is adequately dry and placed in the incinerator. It is important that plastics and metals are not combusted at the same time as the sewage sludge. Sewage sludge tends to concentrate up heavy metals and is known to contain chlorine and sulphur compounds. Again an ideal mix for dioxin and furan formation. Proper combustion of the sludge is required to ensure that dioxins and furans do not form in the chamber. The sulphur present in the waste stream should also reduce the formation of dioxin and furans as the exit gases cool through the formation window.

By following these waste separation guidelines the extent of dioxin and furan formation will be reduced, although it is unlikely that it will be totally eliminated. As there will likely be some formation of dioxin and furans at the various incinerators it is important to also consider ambient weather conditions when incinerators are operated.

4.4 Weather and Incineration

The climate of the arctic is dominated by a near surface inversion for most of the year (Kahl et al, 1992). These inversions are particularly important in pollution management as they do not favour active pollutant dispersion. Maximum inversion depth and temperature difference across the inversion layer occurs in February and March, while the minimum occurs in August and September. The annual progression of inversion characteristics closely follows the annual pattern of clear-sky

percentages. This reflects the controlling influence of cloud and clear-sky radiative forcing on the inversion layer.

Pollution in the air tends to concentrate at the top of the inversion layer, which suggests that any potential toxic or harmful gaseous emissions from the incinerators may be dispersed from the immediate site of the incinerator but potentially affect areas further from the site with a greater dose of pollutants.

4.4.1 Base Height and Depth of Inversions

Based on data by Khan et al, surface-based inversions can occurring at least 50% of the time from September or October until April. Inversions were based at or within a few metres of the surface at least 75% of the time during these winter months in their study. During the summer the inversions still occur, but less frequently with a minimum of 50% of days in their study. During the summer months, solar radiation warms the surface and, subsequent to snowmelt, warms the atmosphere near the ground. This heating, in conjunction with turbulent mixing lifts the inversion layer above the surface. Under the elevated and weakened inversion conditions emission dispersal is enhanced.

In the Khan et al study, the inversion depth peaked at all stations in February or March, with median values ranging from 545 m 1177 m at the various stations they monitored. The median temperature difference across the inversion reached an annual maximum in February or March, ranging from 14°C to 5°C. Minimum median values of inversion depth ranging from 212 m at Cambridge Bay to 457 m at Arctic Bay were reached in September in their study. Minimum median values of temperature difference across the inversion, 1-2°C were typically found in August and September.

For Hope Bay incineration operations, this suggests that materials that contain high levels of PVC such as medical waste, should be destroyed by preference in the summer months as the dispersion of any dioxins and furans which may form post stack will be dispersed rapidly. Winter incineration is possible as the ambient temperatures are very low and cooling of the gaseous emissions will occur rapidly through the 650°C to 200 °C window.

Of paramount importance for the incineration operations at Hope Bay , that will likely occur every day is to ensure that the wind direction is such that the incinerator will not be directly upwind of any camp or place where people congregate. The wind roses for the site indicate that the predominant wind direction for the Hope Bay area is WNW. This suggests that the Roberts Bay and Boston Camp incinerators will have minimal effect on Doris Camp and the Boston Camp Residential Camp for the bulk of the time. The Roberts Bay incinerator is however directly upwind from the laydown area at Roberts Bay, and people working in this area could be exposed to emissions for the bulk of the time.

The location of the incinerators is therefore optimal but the wind direction varies regularly and incineration should not be started if the wind is likely to blow emissions towards camps.

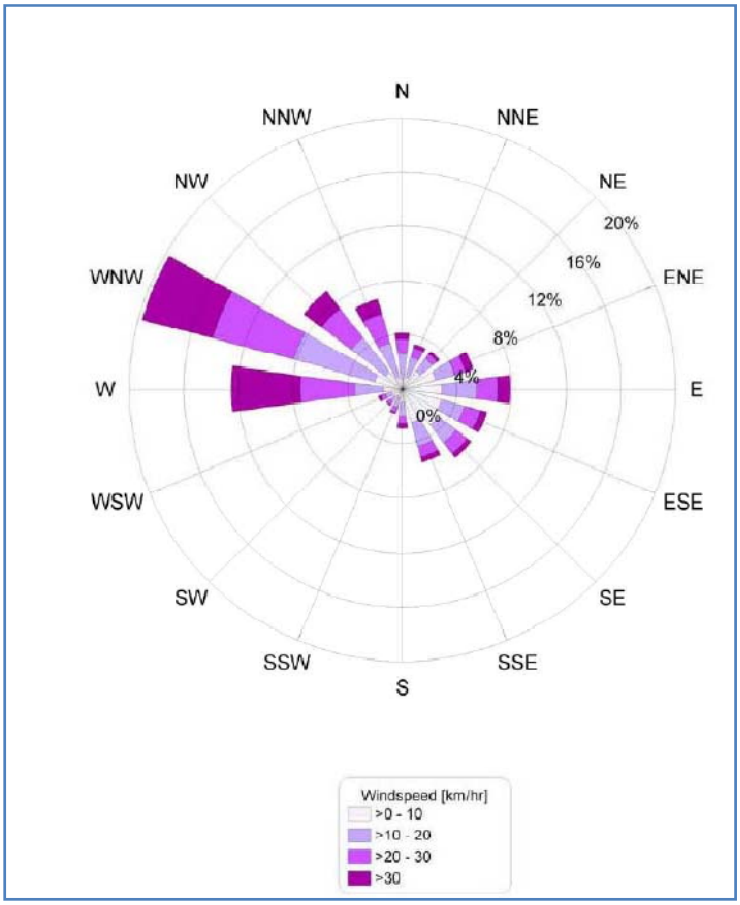


Figure 5: May 2004 to May 2008 Wind Rose for the Doris North Weather Station

5 Description of Model CY-100-CA-D-O Incinerator

The Westland Model CY-100-CA-D-O incinerator has a manufacturer's stated capacity of 100 kg/h using diesel as the auxiliary fuel. Figure 6, 7 and 8 provides a overview of major components of the Westland Model CY-100-CA-D-O incinerator. A more detailed discussion of individual components, features and functions of the incinerator can be found in Appendix D.

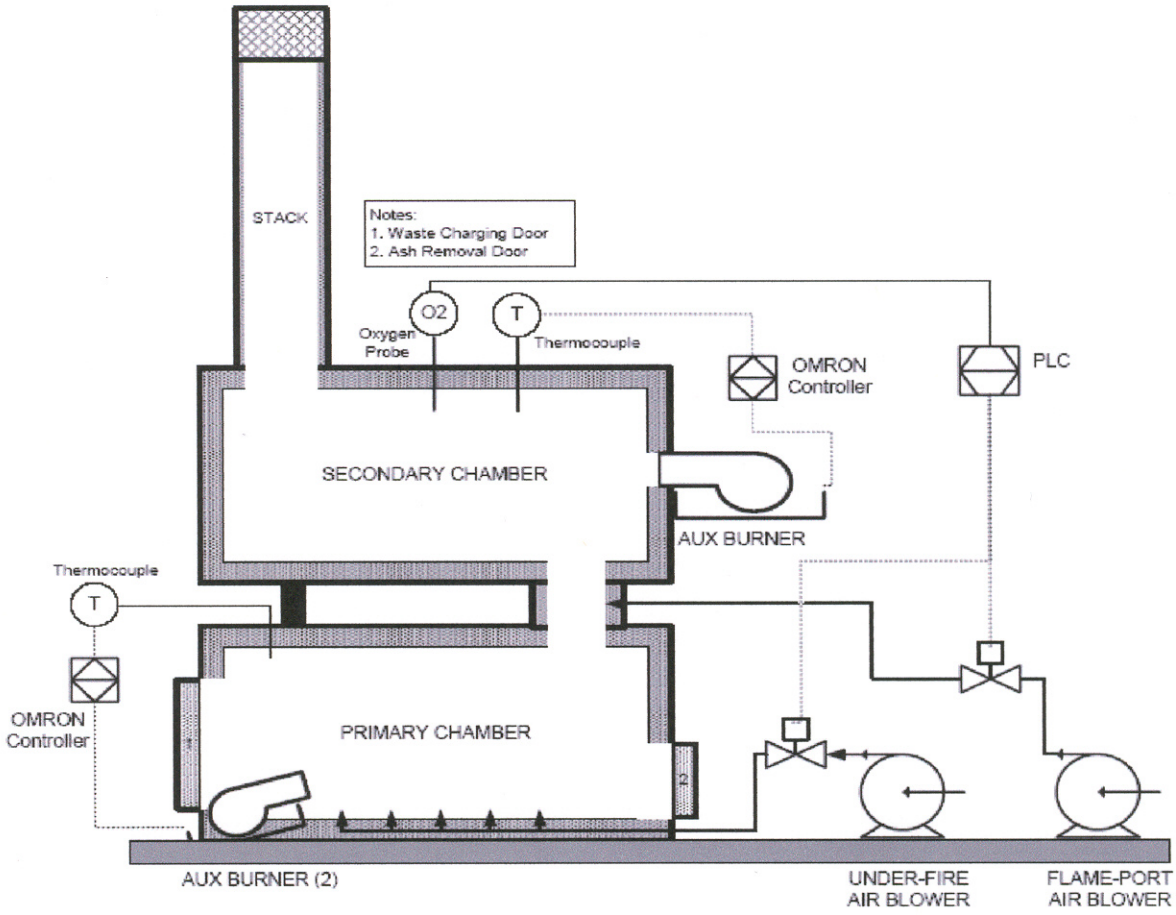


Figure 6: Schematic of Incineration System - Model CY-100-CA-D-O Incinerator

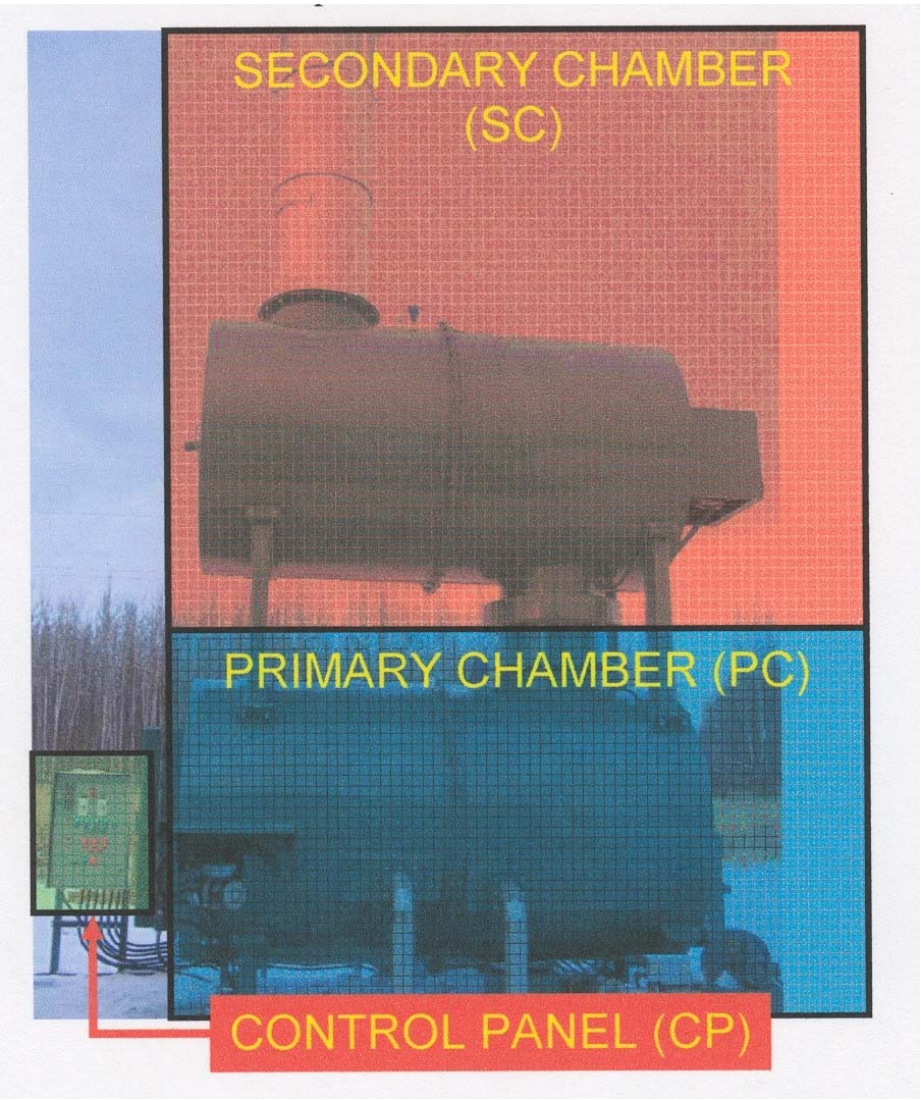


Figure 7: Overview of Model CY-100-CA-D-O Incinerator

Figure 8: Major Components of Primary & Secondary Chambers - Model CY-100-CA-D-O Incinerator

5.1 Model CY-100-CA-D-O Incinerator Operations & Maintenance

5.1.1 Introduction

This section provides a discussion of operational procedures related to the operation of Westland Model CY-100-CA-D-O incinerator and is more fully described in Appendix E and F.

5.1.2 Personal Protective Equipment

Prior to initiating any activities related to the operation of the Westland Model CY-100-CA-D-O incinerator, the operator will equip themselves with all required Personal Protective equipment. This will include, but not necessarily be limited to the following.

The following personal protective equipment will 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 related to the operations of the incinerator are as follows:

- Ash removal and handling: NIOSH N85 respirator
- Waste charging:
  - heat protective clothing and gloves, and
  - CSA/ANSI approved full face shield.

5.1.3 Operational Procedures

The safe and effective operation of the Westland Model CY-100-CA-D-O incinerator is described by sequential steps provided in Figure 9. The operator will diligently follow these steps.

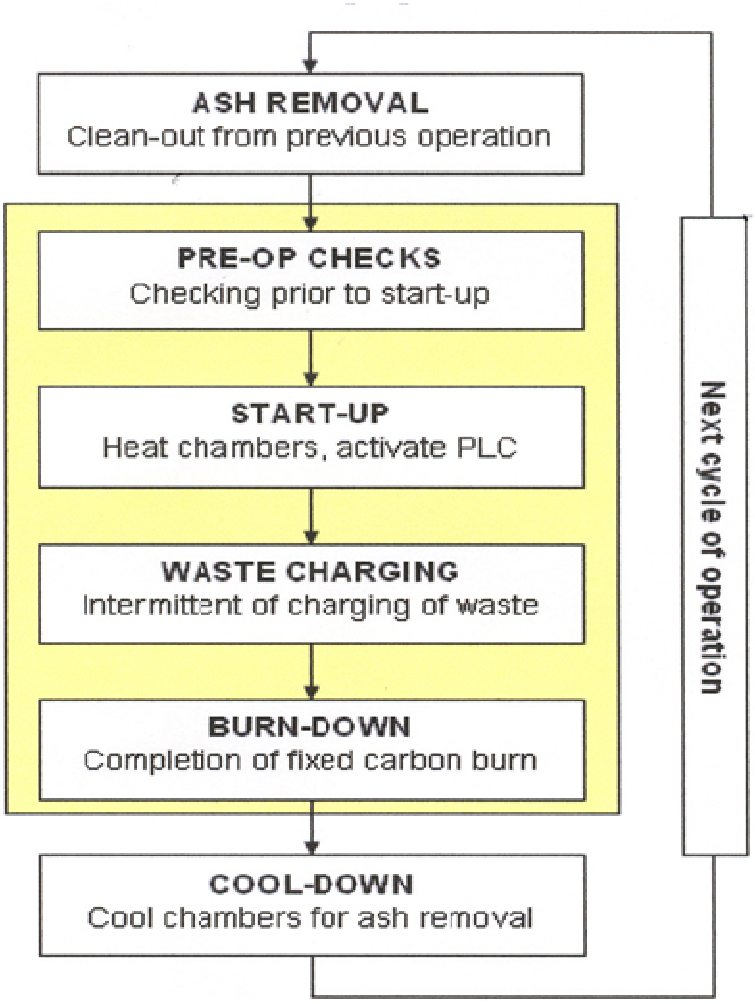


Figure 9: Model CY-100-CA-D-O Incinerator Operations Sequence

5.1.4 Waste Batch Preparation

Waste should be prepared to remove as much metal and plastic as possible before incineration. Painted items should also be removed from the waste stream. Sewage sludge and medical should not be mixed with other waste. Medical waste must be carefully handles to ensure that sharps do not cause injury.

The following cautionary notes must be followed:

- **NO** explosives, aerosol cans or sealed containers containing combustible liquids shall be placed in the incinerator
- 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 inform them about the maximum batch size
- Do not open batches and "rearrange" the contents.

5.1.5 Pre-operational Checks

The following pre-operational checks will be conducted by the operator:

- Check for easily accessible fire extinguisher
- Inspect fire extinguisher to ensure charged and functional
- Conduct inspection of fuel tank for leaks and containment integrity
- Check fuel tank to ensure sufficient fuel for operations
- Open fuel valve
- Inspect combustion chamber to ensure chamber is empty and combustion air holes are clear
- Inspect power connection.

When diesel is used, it may be necessary to bleed the diesel lines (to the burners) if required.

5.1.6 Ash Removal

Typically the ash from previous operation was left to cool, and ash removal is done first prior to current operation. The following actions will be undertaken by the operator;

- Make sure combustion chamber is sufficiently cool
- 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
- The use of a "remote" thermometer is recommended to check the temperatures in the various places in the primary chamber

- Minimize dust generation – a light water spraying on ash in the container is recommended to minimize dust generation
- Remove ash and place in appropriate container
- Appropriate disposal of ash.

5.1.7 Incinerator Start-up

The following procedures (Figure 10) shall be followed in order to initiate incineration sequence.

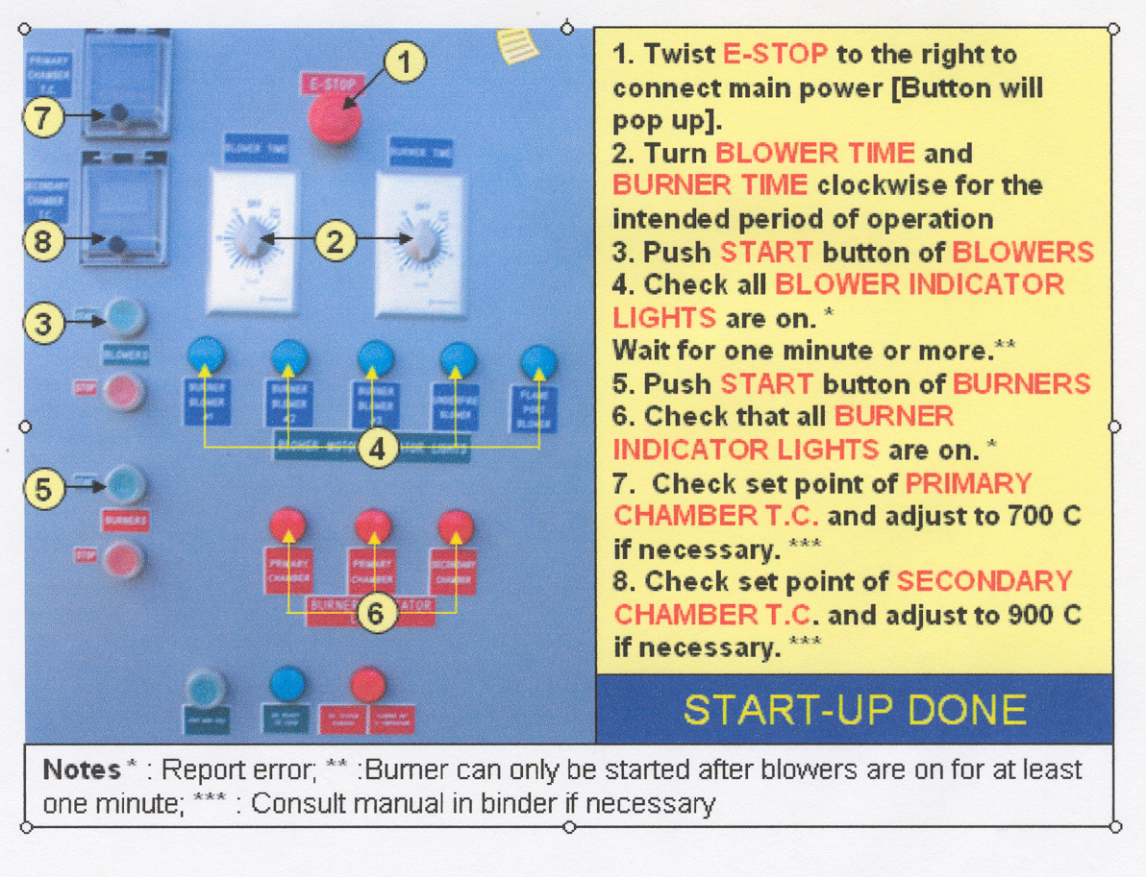


Figure 10: Model CY-100-CA-D-O Incinerator Procedures for Start-Up

Note: Temperatures in Steps 7 and 8 may be regulated: If so, the operator is required to SET THE TEMPERATURE TO THE REGULATED VALUES

5.1.8 Waste Charging of Incinerator

The operator shall charge the incinerator in the following manner (Figure 11).

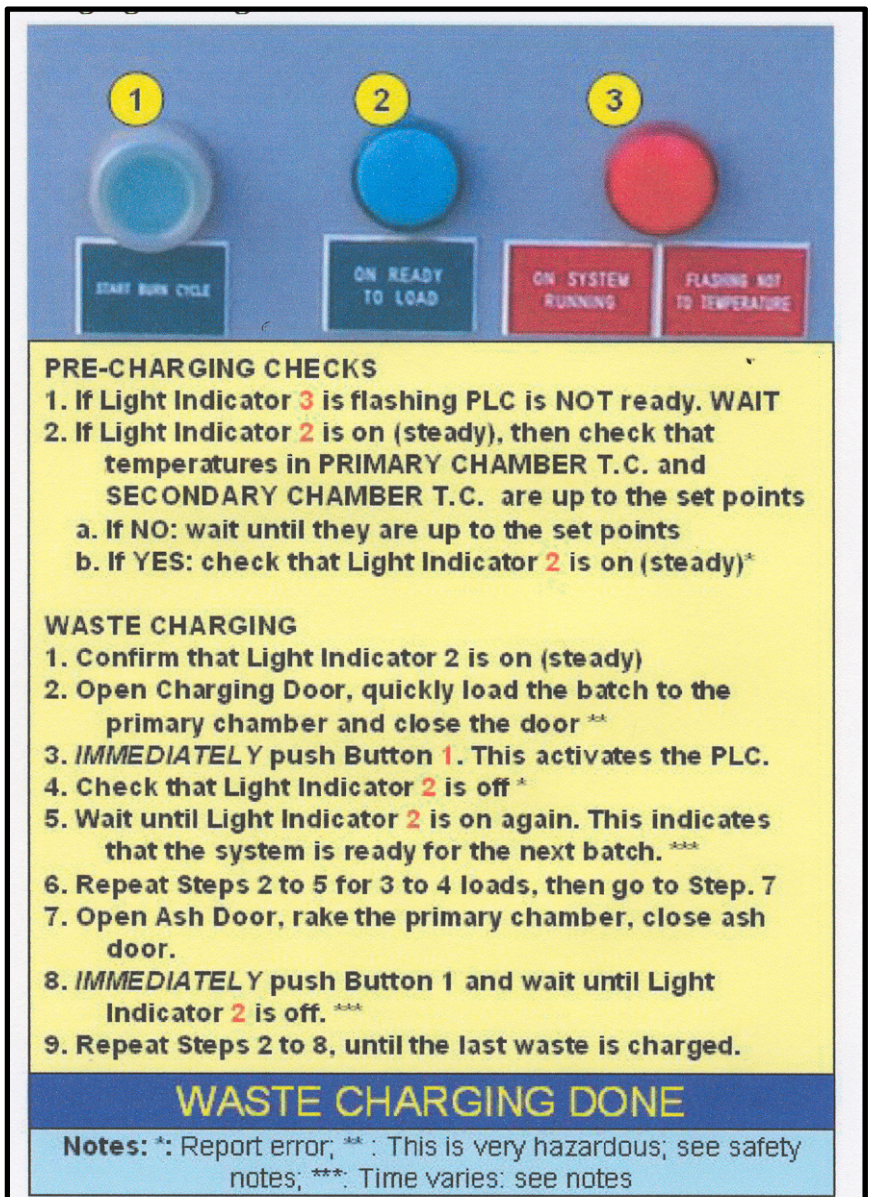


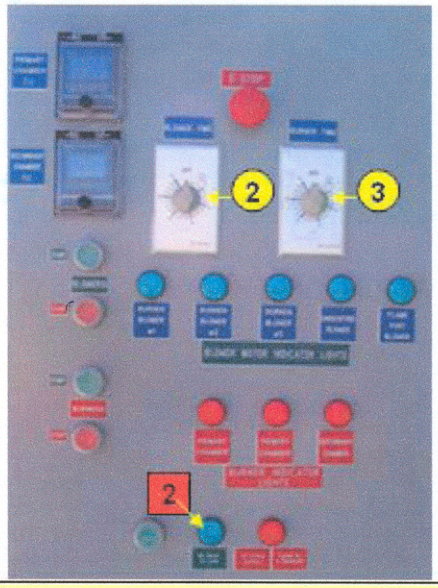
Figure 11: Model CY-100-CA-D-O Incinerator Procedures for Waste Charging

NOTE: ** : 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].

5.1.9 Incinerator Burn-Down

The following procedure will be followed by the incinerator operator during burn down (Figure 12).



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 12: Model CY-100-CA-D-O Incinerator Procedures for Burn Down

5.1.10 Incinerator 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 prior to the next operation of the incinerator.

6 Model CY-100-CA-D-O Incinerator Performance and Monitoring

6.1 Operator Training

Person charged with the responsibility of operating the Westland Model CY-100-CA-D-O incinerator will be required to read and comprehend this plan and the *Westland Model CY-100-CA-D-O Operating and Maintenance Manual and SoP* (Appendix D and E). In addition, an on- site training program will be developed to cover all aspects of the infrastructure associated with incinerator management , its operation, maintenance, monitoring, sample collection, preservation and record keeping. The training will also include an identification of activity related risks, knowledge and use of job specific Personal Protective Equipment (PPE), as well as training in the proper handling, storage, and disposal of all ash generated from the facility.

The training will be both job-specific and equipment specific and will be provided to any site personnel assigned the responsibility to oversee, inspect, maintain , monitor, assess performance and report on the facilities, its discharges and discharge location. The training program will be reviewed as required by site management, with a full review of the training program completed as least once per calendar year.

6.1.1 Routine Inspection and Maintenance

Routine inspections of the incinerator and associated facilities will be conducted by a qualified individual prior to every use of the incinerator. The inspection will include, but not necessarily be limited to:

- Inspecting all fuel lines, fuel storage facilities and secondary containment for leaks and check connections
- Inspection of the spark arrestor to ensure no plugging

During ash removal, the inspection will include, but not necessarily be limited to:

- Inspect refractory for large cracks (not expansion cracks)
- Check combustion air hole for plugging
- Inspect door gaskets for damages.

6.1.2 Additional Maintenance and Inspection

In addition to the routine inspection and maintenance discussed in 6.1.1, the burner(s) and the blower(s) require maintenance as specified in the Westland Model CY-100-CA-D-O Operating and Maintenance Manual (Appendix D).

Table 3 provides a summary of inspections which will be conducted and the frequency of such inspections.

Table 3: Model CY-100-CA-D-O Inspections

Frequency	Component	Inspection Activity
Daily	Thermocouples (Primary & Secondary chamber)	Ensure readings are within acceptable "norms" of the primary and secondary chamber temperatures
	Contact switches	Ensure free movement and no obstruction
	Gasket/Seal in both "charge" and "ash" door	Ensure proper sealing
	Actuators (Primary & Secondary chambers)	Ensure free movement during incineration
	Refractory and underfire air holes in primary chamber	Ensure no large cracks No restriction of air holes
Weekly	Air blowers (Primary & Secondary chambers)	Ensure clean, unobstructed intakes
Monthly	External surface (Primary & Secondary chambers)	Ensure no discolouration
	Refractory in Secondary Chamber	Ensure no large cracks

In the event that the inspection identifies an "action item", appropriate remediation activities will be undertaken as required.

7 Monitoring and Inspection

7.1 Emission Monitoring

HBML will implement a monitoring program related to the operation of the incinerator. HBML will do a one-time stack test to illustrate progress towards the emission monitoring requirements set in the water licence and the Canadian standards. A specialised service provider will be used for monitoring of emissions from the incinerators.

7.2 Fuel Storage

The Westland Model CY-100-CA-D-O incinerator is fuelled by diesel stored in a tank located near to the incinerator.

The fuel storage, secondary containment and fuel delivery lines will be subject to regular inspection as discussed previously.

7.3 Spill Response

A site wide materials management plan with a particular focus on all hazardous substances and waste dangerous goods that are or could potentially be located on the site is currently being developed. That plan will provide material specific Standard Operating Procedures (SOPs) for the handling, transportation, storage and spill response measures for all hazardous substances and waste dangerous goods on site, including those associated with the incinerator, its fuel source and ash management.

A incinerator, its fuel source and ash management specific “SOP” will be included in that site wide plan.

An appropriately stocked Spill Response Kit will also be located in close proximity to the fuel storage area, as will the relevant Material Safety Data Sheets (MSDS). The spill response kit will be inspected at least once every year to ensure that the materials are readily available and not stale dated. Any materials used from the spill kit will be replaced as soon as practical after use.

Although the potential for a spill is judged to be low, the potential does exist for such an event to happen. In any and all cases of an unanticipated discharge, spill or upset condition on the site, the policy is as follows:

1) Protect the health and safety of persons in the area
2) Protect the environment
3) Protect the facility and equipment.

In the event that an unanticipated discharge or spill does occur, personnel shall:

Respond Quickly Without Compromising Health and Safety

1. Identify spilled material.

BE ALERT – DO NOT COMPROMISE YOUR ON SAFETY OR THAT OF OTHERS.

1. Assess the hazard of persons in the vicinity
2. Attend to injured if possible and safe to do so
3. Assess the character of the spill
4. Inform immediate supervisor and Site Manager at Phone 604 759 4708 or ESR 604 759 4714**.**
5. Stop product f low if safe to do so
6. Contain and recover spilled material as soon as possible.

7.4 Off-Specification Emissions Quality

The potential does exist for isolated, short term emissions that do not meet the discharge limits due to equipment malfunction or operator error, however, incinerator design limits the potential for such occurrences. Notwithstanding this design feature and in order to minimize the potential for such an event to happen, specific site personnel will be properly trained and assigned to regularly inspect the incinerator and to oversee the effective operation and maintenance of the facility.

Response to such an event will to identify and correct the original cause and the implementation of additional monitoring of the environment to assess the level, if any, of the impact of the discharge.

In the unlikely event that analysis does indicate that a monitoring sample exceeded the specified discharge guidelines, HBMC will, as soon as possible upon receiving the analytical results:

- Re-sample the emissions and submit the sample for appropriate analysis
- Conduct a detailed inspection of the entire incinerator and waste stream and all associated facilities to identify the cause of the off specification discharge and ensure that the facility is operating within the prescribed parameters and operational limits
- Correct the original cause
- If necessary, implement additional monitoring to assess the level, if any, of the impact of the off specification discharge.

Due to the relatively short duration of such a condition, residual environmental effects resulting from such an event are likely to be negligible.

8 Record Keeping

The incinerator operator is to record the following for every operation of the incinerator units:

- Incinerator operators checklist (Appendix F)
- Operators name
- Condition of ash from last burn, noting any unburnt items
- The type and weight of waste to be incinerated
- The fuel level at the start of operations
- The fuel level at end of operations
- Nature of the emission plume and colour of smoke if any
- Date, time, weather conditions and direction of wind.

Records will need to be kept on file for each burn and should be reviewed by senior managers regularly to ensure that they are being filed and that the information is consistent with observations. Any out of specification situations need to be raised immediately and the incinerator should not be used until maintenance or remedial measures have been applied. A formal incident report needs to be completed if there are any out of specification conditions associated with the incinerator, its performance, waste or any of the emissions, ash or smoke.

9 Incinerator Management

The focus of management and operation of the incinerators will be safety and environmental responsibility.

Employees working with the facility will be trained prior to commencement of work so that they are aware of the health and safety risks associated with the incinerator and its operation.

9.1 Health and Safety General Requirements

9.1.1 Safety Equipment and Protocol

The following personal protective equipment will 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 related to the operations of the incinerator are as follows:

- Ash removal and handling: NIOSH N85 respirator
- Waste charging:
  - heat protective clothing and gloves
  - CSA/ANSI approved full face shield.

9.2 Specific Health and Safety Requirements for the Model CY-100-CA-D-O Incinerator

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.

Disclaimer

"This report and the opinions and conclusions contained herein ("Report") contains the expression of the professional opinion of SRK Consulting (Canada) Inc. ("SRK") as to the matters set out herein, subject to the terms and conditions of the agreement dated [insert agreement information] (the "Agreement") between Consultant and Hope Bay Mining Ltd. ("Hope Bay Mining"), the methodology, procedures and sampling techniques used, SRK's assumptions, and the circumstances and constraints under which Services under the Agreement were performed by SRK. This Report is written solely for the purpose stated in the Agreement, and for the sole and exclusive benefit of Hope Bay Mining, whose remedies are limited to those set out in the Agreement. This Report is meant to be read as a whole, and sections or parts thereof should thus not be read or relied upon out of context. In addition, this report is based in part on information not within the control of SRK. Accordingly, use of such report shall be at the user's sole risk. Such use by users other than Hope Bay Mining and its corporate affiliates shall constitute a release and agreement to defend and indemnify SRK from and against any liability (including but not limited to liability for special, indirect or consequential damages) in connection with such use. Such release from and indemnification against liability shall apply in contract, tort (including negligence of SRK whether active, passive, joint or concurrent), strict liability, or other theory of legal liability; provided, however, such release, limitation and indemnity provisions shall be effective to, and only to, the maximum extent, scope or amount allowable by law."

This report, "**Hope Mining Limited – Incinerator Management Plan, Hope Bay, Nunavut, Canada**", has been prepared by SRK (Consulting) Canada Inc.

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Appendix A

Canada Wide Standards for Dioxin and Furans

Canadian Council of Ministers of the Environment

CANADA-WIDE STANDARDS

for

DIOXINS AND FURANS

CANADA-WIDE STANDARDS
for
Dioxins and Furans

PREAMBLE

Dioxins and Furans

Polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs), commonly known as dioxins and furans, are toxic, persistent, bioaccumulative, and result predominantly from human activity. Due to their extraordinary environmental persistence and capacity to accumulate in biological tissues, dioxins and furans are slated for virtual elimination under the *Canadian Environmental Protection Act (CEPA*), the federal *Toxic Substances Management Policy (TSMP) and* the CCME *Policy for the Management of Toxic Substances*.

The presence of dioxins and furans in the Canadian environment can be attributed to three principle sources: point source discharges (to water, air and soil), contamination from *in situ* dioxins and furans, and loadings from the long-range transportation of air pollutants (LRTAP).

LRTAP is the focus of multilateral conventions and bilateral accords at the international level.

Dioxin and furan contamination found in soil, water, sediments, and tissues (*in situ* contamination), is the subject of national guidelines for dioxins and furans. These guidelines outline ambient or "alert levels" which may be used by jurisdictions as benchmarks for the management and monitoring of dioxins and furans already present in the environment.

Point source discharges to water have been the target of aggressive federal and provincial regulation, as well as industry innovation and change. Discharges of dioxins & furans to the aquatic environment reached non-measurable levels in 1995.

Development of the Canada-wide Standard

The Canada-wide Standards process has focussed on anthropogenic sources that are releasing dioxins and furans to the atmosphere and soil in a continuous process.

In January 1999, the Federal/Provincial Task Force on Dioxins and Furans released the *Dioxins and Furans and Hexachlorobenzene Inventory of Releases* which documented the current understanding of anthropogenic sources in Canada releasing dioxins and furans. The *Inventory of Releases* lists emissions from over 20 sectors by province and territory, and provides national summaries for each sector.

Initial efforts have focused on atmospheric releases, the most complete component of the Inventory. Six priority sectors, varying from regional to national in scope, accounting for about 80% of national emissions have been identified as priorities for early action. These are waste incineration (municipal solid waste, hazardous waste, sewage sludge and medical waste); burning salt laden wood in coastal pulp and paper boilers in British Columbia; residential wood combustion; iron sintering; electric arc furnace steel manufacturing; and conical municipal waste combustion in Newfoundland.

To date, CWSs have been developed for the coastal pulp and paper boiler and the incineration sectors. CWSs for the remaining priority sectors will be completed in 2001. Additional source sectors, many of which contribute very small amounts of dioxins and furans emissions, will also be addressed in 2001 as will releases to soil.

Development of CWSs for dioxins and furans has taken into consideration environmental benefits, available technologies, socio-economic impacts, opportunities for pollution prevention and collateral benefits from reductions in other pollutants.

In recognition of the ultimate goal of virtual elimination, pollution prevention is being encouraged as the preferred method for avoiding the creation of dioxins or reducing releases to the environment.

Wherever possible, work on the dioxins and furans CWSs has been coordinated with other ongoing processes (e.g. Mercury CWS and the Strategic Options Process). A multi-pollutant approach will be carried forward to the remaining sectors while ensuring that dioxins and furans issues are addressed and that the ultimate goal of virtual elimination is kept clearly in mind. Opportunities for a multi-pollutant approach will also be pursued as part of the implementation of the Dioxins and Furans Canada-wide Standard.

During development of the inventory, it was realized that the data on dioxins and furans is limited. The information in the dioxins and furans inventory will be refined and updated on a regular basis through a variety of sources including the National Pollutants Release Inventory (NPRI) as a means of tracking progress and as a means of identifying any future sources of releases that must be addressed.

PART 1:

Pulp and Paper Boilers Burning Salt Laden Wood

Rationale for standard

Unique to British Columbia, the burning of salt laden wood results in an annual release of 8.6 gTEQ/year to the atmosphere or 4.3 percent of the national total of dioxin and furans emissions documented in the inventory of releases prepared under the Canadian Environmental Protection Act.

As a result of mill closures and voluntary industry initiatives that have reduced atmospheric releases, the current total represents a 25% reduction from 1990 releases.

Dioxins and furans emitted from coastal pulp and paper mills are created through the burning of salt contaminated hogged fuel. Logs transported and stored in salt water take up chlorine into the bark. The bark is stripped from the logs and ground up to produce hogged fuel.

This material is then used as boiler fuel to produce heat and electrical energy for the pulp and paper process. Over 1.4 million oven dried tonnes of hogged fuel were used by the coastal pulp and paper industry in B.C. in 1998.

Nature and application:

The CWS for this sector consists of two components. The first component sets out numeric targets and timeframes for reducing emissions from new and existing boilers. This standard applies to boilers burning more than 10,000 oven dry metric tonnes per year of hogged fuel generated from wood transported or stored in salt water. All boilers currently reliant on hogged fuel generated from wood transported or stored in salt water currently consume in excess of 50,000 oven dry metric tonnes annually. As part of the implementation of this standard, procedures will be put in place to report on the salt content of the hogged fuel to ensure compliance with the standard.

The second component sets out a process for further examining pollution prevention opportunities to prevent the creation of dioxins and furans.

Numeric Target and Timeframe for Achieving Target

Dioxin and furan emissions will be less than 100 pg/m^3 TEQ for new boilers constructed after the effective date of this standard.

Dioxin and furan emissions will be less than 500 pg/m^3 TEQ for all existing boilers by 2006. "New" means a total replacement including firebox, heat transfer surfaces and air emission control equipment.

The standard for existing boilers is set pending the acquisition of further test data and controlled studies of boiler operation. Recognizing the ultimate objective of virtual elimination as set out in the Canadian Environmental Protection Act, the mill operators will voluntarily pursue further reductions in emissions during the period of the standard. In doing so the operators will conduct additional studies to identify the reasons for higher dioxin and furan emissions at some locations and explore and, as practicable, implement measures to achieve virtual elimination at all locations. Measures to be explored include physical and process modifications to prevent or reduce dioxin and furan formation as well as emission control upgrades and/or other pollution prevention measures.

Every boiler covered by this standard will be tested twice per year to determine the level of dioxin and furan air emissions for the years prior to 2003 and annually for the years 2003 and thereafter. Testing and reporting will be performed using methods and procedures acceptable to the responsible provincial ministry.

The standard for existing boilers will be reviewed in 2003 based on the results of the additional testing, the additional studies on dioxin and furan creation and opportunities to achieve virtual elimination and the examination of other pollution prevention opportunities.

Pollution Prevention Strategy

In addition to the continuing efforts of pulp and paper mill operators to capture emissions of dioxin and furans, emphasis will be placed on identifying and implementing opportunities to prevent the creation of dioxins and furans. A strategy identifying opportunities to eliminate the formation of dioxins and furans by the coastal pulp and paper industry will be developed through a multi-stakeholder process by December 31, 2001 to provide a framework for continual progress towards the elimination of dioxin and furans.

Recognizing that most opportunities for avoiding the creation of dioxins and furans fall beyond the exclusive influence of the coastal pulp and paper mill operators, preparation of this strategy must engage a wide range of stakeholders.

The range of issues to be addressed in developing the strategy could include:

- maximum allowable salt content for hogged fuel
- removal of chloride from logs
- hogged fuel washing and pressing
- options for blending hogged fuel of different salt levels
- alternatives to log handling, transportation and storage practices that rely on salt water
- impacts of the length of time entailed in transportation and storage on the salt content of hogged fuel
- inclusion of transportation modes and effects in eco-certification criteria
- in-plant opportunities to avoid creation of dioxins and furans
- alternative fuel opportunities and costs
- providing greater opportunities for market intervention by improving the understanding of the costs being imposed on the pulp and paper mills by current log handling and storage practices

Waste Incineration

Rationale for standard

Waste incineration has historically been responsible for a significant portion of the dioxins and furans emitted in Canada. The total release of dioxins and furans from this sector amounts to 44.9 g/ TEQ/y or 22.5% of the total releases to the atmosphere.

Improved exhaust gas controls to reduce emissions of acid gases and fine particulates or activated carbon injection systems have decreased emissions of both mercury and dioxins and furans from the municipal solid waste (MSW) sector. Dioxins and furans emissions from this sector are estimated to be approximately 8.4 g/yr. Many medical waste incinerators have closed for economic or environmental reasons. However, a range of medium-to small-sized facilities remain. Individually these are small sources, but as a sector they are significant, emitting an estimated 28.8 g/yr. Two additional incineration sectors, hazardous waste (7.6 g/yr) and sewage sludge (0.1 g/yr), are also addressed by the CWS.

A Canada-wide Standard for incineration of MSW in conical waste combusters in Newfoundland will be brought forward in 2001. Newfoundland has committed to reviewing the use of these facilities and to considering a phase-out strategy that will reduce emissions of dioxins and furans as well as mercury. These actions are also identified in the Mercury Canada-wide Standard accepted by the Council of Ministers in November 1999.

Actions to reduce national emissions require that any new facilities meet stringent limits, and that the bulk of the emissions from existing facilities be controlled through retrofits with control technology that is efficient at destroying dioxins and furans. Diverting waste from incinerators would result in less incineration overall and thus avoid creation of dioxins and furans. All facilities, and particularly smaller ones, may find that pollution prevention, waste segregation and diversion are options for either achieving the limit, or reducing "end-of-stack" expenditures, and during implementation all facilities should be encouraged to place a priority on reduced inputs rather than controlled releases.

Definitions:

Waste incinerator: a device, mechanism or structure constructed primarily to thermally treat (e.g., combust or pyrolyze) a waste for the purpose of reducing its volume, destroying a hazardous chemical present in the waste, or destroying pathogens present in the waste. This includes facilities where waste heat is recovered as a byproduct from the exhaust gases from an incinerator, but does not include industrial processes where fuel derived from waste is fired as an energy source as a matter incidental to the manufacture of the primary product. For the purpose of the Dioxins and Furans CWS, conical waste combusters are considered separately from other incineration sectors.

Municipal solid waste: any waste which might normally be disposed of in a non-secure landfill site if not incinerated (i.e., including non-hazardous solid wastes regardless of origin), but is not intended to include "clean" wood waste. Clean wood waste means waste from woodworking or forest product operations where the wood waste has not been treated with preservative chemicals (e.g., pentachlorophenol) or decorative coatings.

Medical waste: any waste which includes as a component any Biomedical Waste as defined in the February 1992 CCME Guidelines for the Management of Biomedical Waste in Canada, with the exception that animal wastes derived from animal health care or veterinary research and teaching establishments are excluded.

Determined efforts: Determined efforts include the ongoing review of opportunities for reductions and implementation of in-plant changes and/or emissions control upgrades that are technically and economically feasible and which confer on-going reductions in emissions. Where possible, dioxin and furan emission reductions will be determined by way of a one-time stack test conducted after implementation of the measures. Where testing is not possible or will not provide reliable results, an audit of the dioxin and furan emission reductions associated with waste diversion or other measures is an acceptable alternative. Opportunities for regional consolidation and/or phase-out of smaller facilities may also be considered.

Nature and application:
Emission limits are expressed as a concentration in the exhaust gas exiting the stack of the facility. New or expanding facilities will be expected to comply immediately with the standard, and it will be up to individual jurisdictions to determine what constitutes a significant expansion to trigger the standard. The limits for existing facilities are capable of being met using generally available technology or waste diversion. Larger facilities will be subject to stack testing as described in Annex 1 to verify compliance with the limit. Smaller medical and municipal facilities will have the option of reporting on an audit of the dioxin and furan emission reductions associated with waste diversion or other measures or conducting a one-time stack test, to illustrate progress towards the standard.

Numeric targets:
The following standards are a step towards achieving virtual elimination for dioxins and furans.

For new or expanding facilities of any size, application of best available pollution prevention and control techniques, such as a waste diversion program, to achieve a maximum concentration[1] in the exhaust gases from the facility as follows:

Municipal waste incineration	80pg I-TEQ/m^3
Medical waste incineration	80pg I-TEQ/m^3
Hazardous waste incineration[2]	80pg I-TEQ/m^3
Sewage sludge incineration	80pg I-TEQ/m^3

[1] Stack concentrations of dioxins and furans will be corrected to 11% oxygen content for reporting purposes.
[2] Hazardous waste incinerators include all facilities that burn hazardous waste including low level radioactive waste; however they do not include facilities that use waste derived fuel or used oil.

For existing facilities application of best available pollution prevention and control techniques, to achieve a maximum concentration[1] in the exhaust gases from the facility as follows:

Municipal waste incineration	
> 26 Tonnes/year[3]	80pg I-TEQ/m^3
< 26 Tonnes/year[4]	80pg I-TEQ/m^3
Medical waste incineration	
> 26 Tonnes/year[3]	80pg I-TEQ/m^3
< 26 Tonnes/year[4]	80pg I-TEQ/m^3
Hazardous waste incineration [2]	80 pg I-TEQ/m^3
Sewage sludge incineration	100 pg I-TEQ/m^3

Timeframe for achieving the targets:
Any new or expanding facility will be required to design for and achieve compliance immediately upon attaining normal full scale operation, compliance to be confirmed by annual stack testing..

Based on determined efforts in working towards virtual elimination, existing facilities will be required to meet the standards on the following schedule:

Municipal waste incineration	2006
Medical waste incineration	2006
Hazardous waste incineration	2006
Sewage sludge incineration	2005

Pollution Prevention Strategy:
In addition to the continuing efforts of waste incinerator operators to destroy or capture emissions of dioxin and furans, emphasis will be placed on identifying and implementing opportunities to prevent the creation of dioxins and furans as well as emissions of air pollutants and ash quality generally. As an initial action with shared responsibility by all jurisdictions, strategies identifying opportunities to minimize waste incineration emissions of air pollutants including dioxins and furans will be developed through a multi-stakeholder process by December 31, 2001 to provide a framework for continual progress towards the elimination of dioxin and furans.

Recognizing that many opportunities for minimizing air pollutant and ash emissions and specifically avoiding the creation of dioxins and furans fall beyond the exclusive influence of the operators of waste incinerators, preparation of this strategy must engage a wide range of stakeholders.

[3] Larger facilities must achieve this stack concentration as confirmed by annual testing.
[4] Smaller facilities must make determined efforts to achieve this stack concentration.

The range of issues to be addressed in developing the strategy could include:

- waste diversion initiatives to minimize the generation of wastes destined for disposal (waste reduction, material reuse options)
- waste segregation initiatives aimed at materials with greater potential to generate emissions of dioxins and furans or other air pollutants of concern (e.g., mercury, other heavy metals) and aimed at diverting those wastes to recycling or other non-incineration disposal options
- combustion control strategies to optimize performance of existing combustors at destroying pollutants of concern
- use of alternative disposal or treatment technologies (e.g., anaerobic digestion of wastes with material recovery and combustion of biogas)

PART 2:

Reporting on Progress:

Ministers will receive reports on progress in achieving the CWS by jurisdictions in Spring 2004 and Spring 2008. Ministers will ensure that a single public report is prepared and posted on the CCME web site for public access. The report in 2004 will reflect interim progress on achieving the CWSs. Progress on both implementation of the numeric targets and the activities applied as part of the determined efforts provisions for smaller medical waste and municipal solid waste facilities will be documented. The 2008 report will evaluate whether targets have been met and the effectiveness of the determined efforts with respect to smaller facilities. More details on reporting are available in Annex 1.

Each jurisdiction will detail the means of ensuring achievement of the CWS in a manner consistent with the typical or desired programs for the affected facility/sector, so as not to impose an unnecessary level of reporting duplication.

With a view to continuous improvement towards the goal of virtual elimination, an evaluation of the Dioxin and Furan Canada-wide Standards will be presented to Ministers in Spring 2006. The evaluation will consider new scientific, technical and economic information and provide an assessment of the need to develop the next set of CWS targets and timelines to continue progress toward virtual elimination.

ADMINISTRATION:

Jurisdictions will review and renew Part 2 and Annex 1 five years from coming into effect.

Any party may withdraw from these Canada-Wide Standards upon three month's notice.

These Canada-Wide Standards comes into effect on May 1, 2001.

Annex 1
Dioxins and Furans CWS Reporting Framework

Introduction

Under the Harmonization Accord and its Canada-wide Environmental Standards Sub-Agreement, all jurisdictions are to report to the public and to Ministers on their progress towards achieving the CWSs for dioxins and furans.

This reporting framework is intended to provide a transparent and consistent mechanism for reporting by jurisdictions in a fashion which minimizes resource requirements for government and industry alike, while maximizing the availability of information on achievement of these standards.

The framework addresses:

1) frequency, timing and scope of reporting
2) guidance as to the means of determining compliance/achievement of the CWS
3) common measurement parameters for reporting purposes
4) data management and public reporting

Frequency, timing and scope of reporting

The reporting schedule will be tied into assessing the performance of the governments in meeting the benchmarks and timelines relevant to the standards. A report in 2004 will provide a means for tracking interim progress and report on additional technical studies (e.g. technology feasibility and pollution prevention options for the coastal pulp & paper sector). The 2008 report will indicate compliance with the standards for the coastal pulp and paper boiler and incineration sectors.

Jurisdictions will submit sectoral data for inclusion in the progress reports in a timely manner. To report on achievement of the CWS, a data report along with an assessment of progress will be compiled into a single report for Ministers and a public version will be posted on the CCME web site for public access.

Reports will be limited to information on those facilities which are subject to achievement and/or compliance with the Canada-wide Standards as endorsed by the Ministers of the Environment May 1, 2001 and as implemented variously by the responsible jurisdictions or industries. This information is intended to show compliance rates and performance characteristics in a manner which documents sectoral performance as well as jurisdictional performance. It is not intended to provide a facility-by-facility record of performance.

Means of determining compliance/achievement of the CWS

The Canada-wide Standards for dioxins and furans lend themselves to achievement through voluntary action, or through compliance with regulated or legally enforceable limits. As such, it is necessary to provide some means to ensure that a level playing field exists so that the numeric value provided in the CWS is applied equally or similarly in each jurisdiction. One means to do this is to require identical compliance procedures, but this may require that some jurisdictions apply compliance procedures for dioxins and furans CWSs that are different than those used for locally determined or regulated parameters such as SO_2, PM, ammonia, etc. An example is where the dioxins and furans CWS is expressed as the average of 3 stack tests, whereas a jurisdiction may normally utilize the median value of 3 tests to determine compliance.

In an effort to streamline implementation, each jurisdiction will determine the exact means of ensuring compliance/achievement in a manner consistent with the typical or desired programs for the affected facility/sector. It is anticipated that minor variations in jurisdictional requirements will result in minimal variation across the country which is insignificant with respect to the overall reduction activities which range from 50-99% for various facilities.

Common measurement parameters for reporting purposes

Each facility report will include specific measures corrected so as to be compatible and consistent for the purposes of public reporting. Dioxin and furan emissions must be corrected for the O_2 content of gases, to ensure compliance with the standards.

Each jurisdiction will determine the sector within which each subject facility will be reported. For example, a jurisdiction may determine that a small mixed waste incinerator (for example, burning both medical and municipal waste) may be subject to either standard, based upon the preponderance of waste (>50% as one type) or based upon the provincial designation of facility type. Sectoral assignments will be updated to reflect the most recent characteristics of the facility under consideration prior to reporting.

While little confusion is likely to exist over the implementation of dioxins and furans CWSs for “greenfield” facilities, it is possible that significantly expanded or modified facilities can/should be considered as new for the purposes of achievement/compliance with the dioxins and furans CWS. It will be the responsibility of the jurisdictions to determine at which point a facility no longer qualifies as an “existing” facility and must conform to the standard for “new or expanded” facilities as a result of significant modifications/alterations to the facility operations or physical plant.

Jurisdictions must report measurements that are below the detection limit in a consistent manner. These measurements should be reported as the limit of detection.

Large facilities will generally be required to perform stack tests at an annual frequency in order to demonstrate compliance. However, jurisdictions may vary the stack testing requirements for these facilities in cases where performance has been consistently demonstrated to be below the Level of Quantification (LoQ) as defined by Environment Canada. Where five years' data has been accumulated with all results reported below the LoQ, the stack testing frequency may be revised to a biennial schedule so long as all subsequent test results remain below the LoQ. For the purpose of reporting emissions, the most recent stack test results available should be used. Jurisdictions have the responsibility of deciding whether to implement this variance for all, some or none of the source types subject to these standards.

Data management and public reporting

Reports on achieving the CWSs will include a data report and a report on achievement of the standards. Sectoral and jurisdictional specific data will be supplied in a spreadsheet format to facilitate reporting. A consolidated report will be made available to all jurisdictions and to the Ministers, along with the draft public report, prior to formal release of the public report. The public report will be released upon approval by the Council of Ministers.

Jurisdictions will provide a report in spreadsheet format so that the data report and report on achievement can be prepared along with the public report for review and approval. Reports will be prepared and distributed to all jurisdictions prior to review by Ministers. Along with the report on achievement, a draft public report will be provided for review and consideration prior to the Ministers' meeting at which public release is anticipated. That public report will be posted to the CCME web site upon approval by the Ministers. Jurisdictions are encouraged to provide reference to the CCME web site and/or pointers in their own web sites in order to ensure a single location for dioxins and furans CWSs reporting should errors/miscalculations have to be corrected at some time.

In addition to the consolidated public reporting on dioxins and furans CWSs, jurisdictions must provide a contact for facility-specific information in the advent that the public wishes to access compliance or achievement information. Such data will be supplied in a manner consistent with the normal data-reporting/compliance reporting procedures of the jurisdiction in question - the consolidated spreadsheet will not be made publicly available in that it may include proprietary (business) information.

Canada-wide Standards for Dioxins and Furans Emissions from Waste Incinerators and Coastal Pulp and Paper Boilers

Signed by:

British Columbia	Honourable Ian Waddell
Alberta	Honourable Lorne Taylor
Saskatchewan	Honourable Buckley Belanger
Manitoba	Honourable Oscar Lathlin
Ontario	Honourable Elizabeth Witmer
Environment Canada	Honourable David Anderson
New Brunswick	Honourable Kim Jardine
Nova Scotia	Honourable David Morse
Prince Edward Island	Honourable Chester Gillan
Newfoundland and Labrador	Honourable Ralph Wiseman
	Honourable Tom Lush
Yukon	Honourable Dale Eftoda
Northwest Territories	Honourable Joseph Handley
Nunavut	Honourable Olayuk Akesuk

Note: Québec has not endorsed the Canada-wide Accord on Environmental Harmonization or the Canada-wide Environmental Standards Sub-agreement.

Appendix B
Canada Wide Standards for Mercury Emissions

Canadian Council of Ministers of the Environment

CANADA-WIDE STANDARDS

for

MERCURY EMISSIONS

CANADA-WIDE STANDARDS
for
MERCURY EMISSIONS

PREAMBLE

The Canadian Council of Ministers of the Environment determined that mercury levels in fish and wildlife across Canada warrant additional efforts to reduce atmospheric emissions derived from both deliberate use of mercury and from incidental releases of mercury.

Restrictions on the human consumption of fish in order to safeguard the health of both high fish consumers (sustenance and commercial fishers) and sensitive populations (infants, children and women of childbearing age) are widespread. Some of these restrictions are derived from lakes naturally high in mercury, others in lakes and rivers contaminated by historical point source discharges and still others in waters remote from identifiable sources. Traditional lifestyles may be profoundly influenced by mercury contamination.

Mercury levels in fish pose an additional, largely unquantified risk to fish-eating wildlife. Isolated examples of toxicity to loons and otters suggest the potential for large scale and/or widespread impacts. Just as mercury levels in fish affect their consumption by humans, some levels in fish may affect wildlife which consume them. In both instances, the mercury causing the impacts is derived from both natural and anthropogenic sources.

The combined impacts of mercury contamination in Canada are difficult to quantify. The exact proportion of the impact which can be ascribed to natural mercury and to past and present anthropogenic releases cannot presently be quantified. Because it is a natural and persistent bioaccumulative element which can be transported many miles in the atmosphere, mercury can have impacts many years and many miles removed from its original source. A common thread through all mercury impacts is that deposition to waterbodies from anthropogenic emissions poses a threat to human and ecosystem health, and that reduced deposition will contribute, in time, to reduced impacts.

Under a variety of regional, national, binational and international programs, treaties and agreements, mercury has been consistently targeted for emission reductions. Such a policy position is consistent with the CCME Policy for the Management of Toxic Substances which identifies that mercury shall be managed through its lifecycle to minimize releases. This is consistent with the precautionary approach endorsed in the Harmonization Accord and Canada Wide Standards Sub-agreement. Ministers of the Environment have thus agreed to undertake and promote cost-effective actions to achieve further precautionary reductions in anthropogenic emissions (releases to the air) of mercury.

The Canada-wide Standards development process reviewed the nature of the mercury issue in Canada, and concluded that two distinctive source categories were amenable to further actions, namely life-cycle management of products containing mercury to minimize releases, and reduction or minimization actions for major point source emissions of incidental mercury.

Based upon available inventory information, it is estimated that of the year 2000 national mercury emissions (12 T/yr) three sectors will contribute the bulk of these emissions, namely the base metal smelting sector (2.57 T/yr), waste incineration sector (1.2 T/yr) and coal-fired electricity generation sector (1.1 T/yr). Standards have been developed for two of these three sectors that reflect room for improvement that is significant and cost-effective. Standards have been provided also that will be used to guide the development of new facilities should they be constructed. Efforts to develop a standard for the electricity generation sector have been complicated and progress has been delayed such that a workplan to develop standards for this sector will not be completed until early in 2000. Life-cycle standards for select mercury-containing products will also be completed early in 2000.

PART 1:

Base metal smelting

Rationale for standard

The base metal smelting sector has historically been responsible for much of the mercury emitted in Canada. However the voluntary application of a number of process changes and stack treatments/scrubbers have combined to reduce mercury emissions from this sector by more than 90% since 1988. Due to reductions from this sector, Canada has complied with its obligations under the United Nations Economic Commission for Europe Heavy Metals Protocol. Despite this substantial progress additional reductions are possible. As of 2000, the mercury emissions from base metal smelting remain the single largest emission sector in Canada at 2.8 T/yr. Under the federal Strategic Options Process (SOP), industry and government recommended development by CCME of "environmental source performance guidelines" that reflect application of best available techniques. By following this approach, Canada's domestic program will be consistent with international objectives for this industry.

Nature and application:

Based upon the performance of various technologies and practices as demonstrated at existing facilities in Canada, and in consideration of the recommendations made in the federal SOP for this sector, a two-part standard is recommended. This standard reflects the application of "best available techniques" on a facility-specific basis, and a uniform reporting mechanism based upon environmental source performance (atmospheric emission) guidelines. Standards are suggested for both existing facilities, to reflect actions taken to reduce emissions of mercury, and for new facilities, to ensure that smelters utilize the best available techniques to avoid or reduce metals emissions generally and mercury emissions specifically.

Numeric Targets:

For existing facilities: application by all primary zinc, lead and copper smelters of best available pollution prevention and control techniques economically achievable to achieve an environmental source performance (atmospheric emission) guideline of 2 g Hg/tonne total production of finished metals.

For new and expanding facilities: application of best available pollution prevention and control techniques to minimize mercury emissions throughout the life-cycle of the minerals in question to achieve an environmental source performance (atmospheric emission) guideline of 0.2 g Hg/tonne production of finished zinc, nickel and lead, and 1 g Hg/tonne of finished copper, and consideration of a mercury offset[1] program to ensure no "net" emission increases occur.

[1] A new facility will recover and retire an amount of mercury equivalent to their annual emissions.

Timeframe for achieving the targets:

Existing facilities will be expected to make a determined effort[2] to meet this standard by 2008, coincident with implementation of the federal Strategic Options Report, while any new facility will be required to design for and achieve compliance immediately upon full scale operation. Jurisdictions will evaluate changes and upgrades to existing facilities to ensure they constitute determined efforts.

Waste Incineration

Rationale for standard

Waste incineration[3] has historically been responsible for a significant portion of the mercury emitted in Canada, however reductions in emissions have been apparent. Improved exhaust gas controls to reduce emissions of acid gases and fine particulates or activated carbon injection systems have decreased emissions of both mercury and dioxins and furans from the municipal solid waste[4] sector. At the same time, action has been taken by many product manufacturers to reduce the mercury content of consumer goods which could end their life cycle in domestic solid waste (e.g., alkaline batteries) and thus have reduced the mercury available in the waste stream. Mercury from this sector is estimated to be 446 kg/year. Many medical waste incinerators[5] have closed for economic or environmental reasons, but a range of medium- to small-sized facilities remain which alone are small sources, but as a sector are considerable, emitting an estimated 250 kg/yr. Two sectors in which emission reductions are not apparent, hazardous waste[6] (550 kg/yr) and sewage sludge (285 kg/yr) incineration, can achieve reductions either through source control or gas-controls. Control of mercury emissions has been recognized in a variety of jurisdictions, including some Canadian Provinces, with emission standards being developed by the Eastern Canadian Premiers and New England Governors (ECP-NEG), or the United Nations Economic

[2] Determined efforts include the ongoing review of opportunities for reductions and implementation of in-plant changes and/or emissions control upgrades that are technically and economically feasible and which confer on-going reductions in emissions

[3] For the purpose of the Mercury CWS, an incinerator shall be considered to be a device, mechanism or structure constructed primarily to thermally treat (e.g., combust or pyrolyze) a waste for the purpose of reducing its volume, destroying a hazardous chemical present in the waste, or destroying pathogens present in the waste. This includes facilities where waste heat is recovered as a byproduct from the exhaust gases from an incinerator, but does not include industrial processes where fuel derived from waste is fired as an energy source as a matter incidental to the manufacture of the primary product.

[4] For the purpose of the Mercury CWS, municipal solid waste shall be taken to include any waste which might normally be disposed of in a non-secure landfill site if not incinerated (i.e., including non-hazardous solid wastes regardless of origin), but is not intended to include "clean" wood waste. Clean wood waste means waste from woodworking or forest product operations where the wood waste has not been treated with preservative chemicals (e.g., pentachlorophenol) or decorative coatings.

[5] For the purpose of the Mercury CWS, medical waste is any waste which includes as a component any Biomedical Waste as defined in the February 1992 CCME ***Guidelines for the Management of Biomedical Waste in Canada***, with the exception that animal wastes derived from animal health care or veterinary research and teaching establishments are excluded.

[6] hazardous waste incinerators do not include facilities that use waste derived fuel.

Commission for Europe (UNECE) providing a basis for evaluating possible Canada-wide Standards.

Actions to reduce national emissions below the anticipated 2000 rate of 1.5 T/yr require that any new facilities meet stringent limits, and that the bulk of the emissions from existing facilities be controlled through retrofits with control technology that is efficient at removing mercury, or the mercury containing waste be diverted from incinerators. All facilities, and particularly smaller ones, may find that pollution prevention, waste segregation and diversion are options for either achieving the limit, or reducing "end-of-stack" expenditures, and during implementation all facilities should be encouraged to place a priority on reduced inputs rather than controlled releases. Attainment of the numeric standards adopted by the ECP-NEG for application to large municipal, and sludge incinerators, and by the UNECE for hazardous waste incineration is suggested as cost-effective means of reducing emissions from this sector. A review of the ECP-NEG limit for medical incinerators concluded that larger medical incinerators actually combust a considerable amount of municipal waste, and as such it is recommended they comply with the same limit as the municipal sector.

Nature and application:

Emission limits are expressed as a concentration in the exhaust gas exiting the stack of the facility. New or expanding facilities will be expected to comply immediately with the standard, and it will be up to individual jurisdictions to determine what constitutes a significant expansion to trigger the standard. The limits for existing facilities are capable of being met using generally available technology (or waste diversion). Larger facilities will be subject to annual stack testing to verify compliance with the limit and smaller (medical, municipal) facilities will have the option of reporting on a successful mercury diversion plan or of conducting a one-time stack test, to illustrate progress towards the standard.

Numeric targets:

For new or expanding facilities of any size, application of best available pollution prevention and control techniques, such as a mercury waste diversion program, to achieve a maximum concentration[7] in the exhaust gases from the facility as follows:

Municipal waste incineration[8,9]	20 µg/Rm^3
Medical waste incineration	20 µg/Rm^3
Hazardous waste incineration	50 µg Rm^3
Sewage sludge incineration	70 µg/Rm^3

For existing facilities application of best available pollution prevention and control techniques, to achieve a maximum concentration[7] in the exhaust gases from the facility as follows:

Municipal waste incineration[8]

> 120 Tonnes/year [9]	20 µg/Rm^3
< 120 Tonnes/year[10]	20 µg/Rm^3

Medical waste incineration	
> 120 Tonnes/year [9]	20 µg/Rm^3
< 120 Tonnes/year[10]	40 µg/Rm^3
Hazardous waste incineration	50 µg/Rm^3
Sewage sludge incineration	70 µg/Rm^3

[7] Stack concentrations of mercury will be corrected to 11% oxygen content for reporting purposes.

[8]Conical waste combusters are under separate consideration since the proposed standard for municipal waste incinerators cannot be achieved with these burners. Newfoundland will review the use of conical waste combusters and consider a phase-out strategy that will reduce mercury emissions. Such a strategy would be developed in conjunction with the Canada-wide Standard for dioxins and furans.

[9] Larger facilities must achieve this stack concentration as confirmed by annual testing.

[10] Smaller facilities must make determined efforts[2] to achieve this stack concentration. The effectiveness of the pollution prevention measures will be established by way of a one-time stack test conducted after implementation of the plan or by the provision of an inventory documenting an audit of a waste diversion program, which is deemed an acceptable substitute.

Timeframe for achieving the targets:

Any new or expanding facility will be required to design for and achieve compliance immediately upon attaining normal full scale operation, compliance to be confirmed by annual stack testing or an equivalent emission rate as confirmed by an audit of a waste diversion program.

Existing facilities will endeavour to meet the standards on the following schedule:

Municipal waste incineration	2006
Medical waste incineration	2006
Hazardous waste incineration	2003
Sewage sludge incineration	2005

PART 2:

REPORTING ON PROGRESS:

Ministers will receive reports by jurisdictions in 2004, 2007 and 2010, and will ensure that a single public report is prepared and posted on the CCME web site for public access. The 2010 report will include an evaluation of these standards and a recommendation whether changes should be considered.

These reports will be accompanied by other information on additional outcomes, activities, research or issues which are relevant to the mercury CWSs and/or sector under consideration. Examples of such reporting includes speciation measures relevant to design of stack control measures, other environmental programs with implications for compliance with the standards,

etc..

Each jurisdiction will detail the means of ensuring compliance/achievement in a manner consistent with the typical or desired programs for the affected facility/sector, so as not to impose an unnecessary level of reporting duplication upon the jurisdictions. In those sectors where the CWS calls for determined efforts, jurisdictions will report on their evaluation of these efforts.

During the years prior to the date for achievement/compliance of a standard, jurisdictions will provide information explaining the status of their implementation of each mercury CWS so that a consolidated summary of jurisdictional progress can be prepared for the public. More details and a mock-up report are available in Annex 1.

ADMINISTRATION:

Jurisdictions will review and renew Part 2 and Annex 1 five years from coming into effect.

Any party may withdraw from these Canada-Wide Standards upon three month's notice.

These Canada-Wide Standards come into effect for each jurisdiction on the date of signature by the jurisdiction.

Annex 1
Mercury Reporting Framework

Introduction

Under the Harmonization Accord and its Canada-wide Environmental Standards Sub-Agreement, all jurisdictions are to report to the public and to Ministers on their progress towards achieving the CWSs for mercury.

This reporting framework is intended to provide a transparent and consistent mechanism for reporting by jurisdictions in a fashion which minimizes resource requirements for government and industry alike, while maximizing the availability of information on achievement of these standards.

The framework addresses:

1) frequency, timing and scope of reporting
2) guidance as to the means of determining compliance/achievement of the CWS
3) common measurement parameters for reporting purposes
4) data management and public reporting

Frequency, timing and scope of reporting

There will be reporting on a schedule which is tied into assessing the performance of the governments in meeting the benchmarks and timelines relevant to the standards. A report issued in 2004 will include compliance by one incineration sector and progress in all others towards implementation, the report in 2007 compliance by all incineration sectors and progress for base metal smelting, and the third report in 2010 an overall evaluation of compliance for all standards and any recommendations for revisions. Jurisdictions will submit spreadsheets which will contain all relevant information necessary for a single public report to be posted on the CCME web site for public access.

Reports will be limited to information on those facilities which are subject to achievement and/or compliance with the Canada-wide Standards as endorsed by the Ministers of the Environment (insert date) and as implemented variously by the responsible jurisdictions or industries. This information is intended to show compliance rates and performance characteristics in a manner which documents sectoral performance as well as jurisdictional performance. It is not intended to provide a facility-by-facility record of performance.

Means of determining compliance/achievement of the CWS

The Canada-wide Standards for mercury lend themselves to achievement through voluntary action, or through compliance with regulated or legally enforceable limits. As such, it is necessary to provide some means to ensure that a level playing field exists so that the numeric value provided in the CWS is applied equally or similarly in each jurisdictions. One means to do this is to require identical compliance procedures, but this may require that some jurisdictions apply compliance procedures for mercury CWSs that are different than those used for locally determined or regulated parameters such as SO2, PM, ammonia, etc. An example is where the mercury CWS is expressed as the average of 3 stack tests, whereas a jurisdiction may normally utilize the median value of 3 tests to determine compliance.

In an effort to streamline implementation, each jurisdiction will determine the exact means of ensuring compliance/achievement in a manner consistent with the typical or desired programs for the affected facility/sector. It is anticipated that minor variations in jurisdictional requirements will result in minimal variation across the country which is insignificant with respect to the overall reduction activities which range from 50-99% for various facilities.

Common measurement parameters for reporting purposes

Each facility report will include specific measures corrected so as to be compatible and consistent for the purposes of public reporting. Mercury emissions must be corrected for the O_2 content of gases, to ensure compliance with the standards.

Each jurisdiction will determine the sector within which each subject facility will be reported. For example, a jurisdiction may determine that a small mixed waste incinerator (for example, burning both medical and municipal waste) may be subject to either standard, based upon the preponderance of waste (>50% as one type) or based upon the provincial designation of facility type. Sectoral assignments will be updated to reflect the most recent characteristics of the facility under consideration prior to reporting.

While little confusion is likely to exist over the implementation of mercury CWSs for “greenfield” facilities, it is possible that significantly expanded or modified facilities can/should be considered as new for the purposes of achievement/compliance with the mercury CWS. It will be the responsibility of the jurisdictions to determine at which point a facility no longer qualifies as an “existing” facility and must conform to the standard for “new or expanded” facilities as a result of significant modifications/alterations to the facility operations or physical plant.

Data management and public reporting

Facility-specific information will be supplied in a spreadsheet format to facilitate reporting. A consolidated data-report and achievement/compliance report will be made available to all jurisdictions and to the Ministers, along with the draft public report, prior to formal release of the public report. The public report will be released upon approval by the Ministers of the

Environment.

Jurisdictions will provide a report in spreadsheet format prior to September 30 so that the consolidated spreadsheet can be prepared along with the public report (draft) for review and approval. A consolidated spreadsheet will be prepared and distributed to all jurisdictions within 30 days of receipt of the final jurisdictional spreadsheet. Along with the consolidated spreadsheet a draft public report will be provided for review and consideration prior to the Ministers' meeting at which public release is anticipated. That public report (draft format attached) will be posted to the CCME web site upon approval by the Ministers. Jurisdictions are encouraged to provide reference to the CCME web site and/or pointers in their own web sites in order to ensure a single location for mercury CWSs reporting should errors/miscalculations have to be corrected at some time.

In addition to the consolidated public reporting on mercury CWSs, jurisdictions must provide a contact for facility-specific information in the advent that the public wishes to access compliance or achievement information. Such data will be supplied in a manner consistent with the normal data-reporting/compliance reporting procedures of the jurisdiction in question - the consolidated spreadsheet will not be made publicly available in that it may include proprietary (business) information.

Example public report format only

CWS-Hg for Municipal Solid Waste Incinerators in Canada

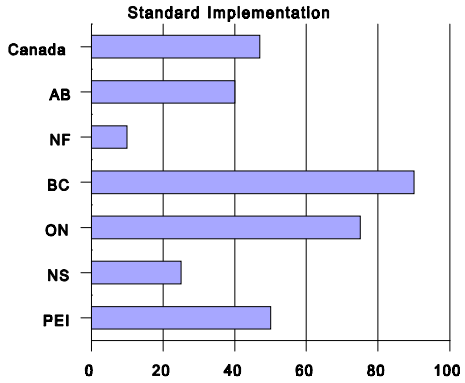
(This report covers those processing more than 120 Tonnes/yr only)

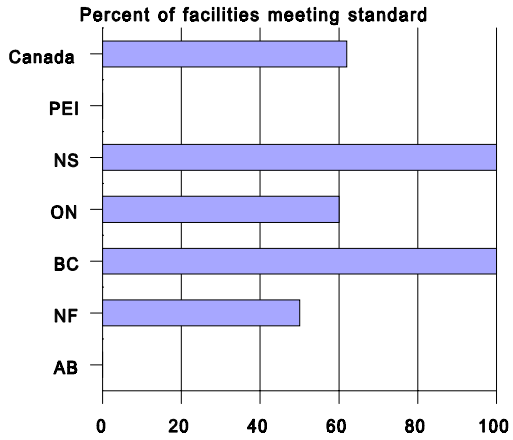
Report overview:

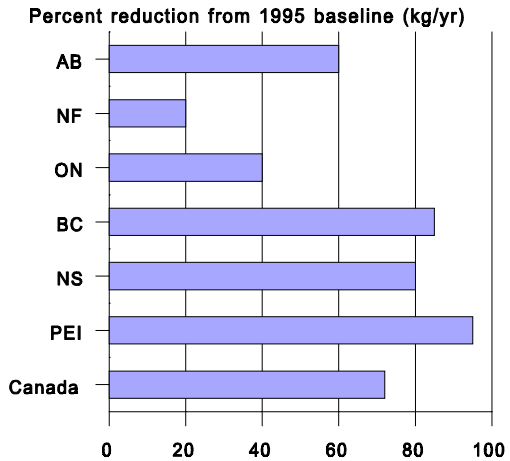
This is a consolidated report on the achievement of or compliance with Canada-Wide Standard for mercury emissions from the Municipal Solid Waste Incineration sector in Canada. Several facilities located in the Province of Quebec are not addressed in this report. This report provides an progress indicator for the jurisdictional activities to implement the standards, an indictor for facility compliance and/or achievement with the standard, a consolidated graphic showing the net reductions in emissions from this sector against two baseline years, and a national summary for the sector.

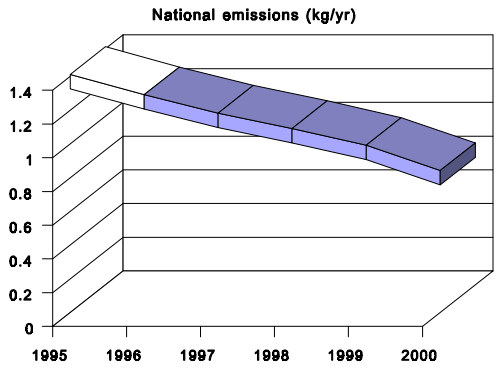
Sector overview:

The incineration of solid waste is utilized for two reasons in Canada - either to reduce volumes to minimize landfilling, or to achieve generate electricity (energy from waste). During the development of the Canada-wide Standard for this sector, a total of 13 major facilities and more than 100 minor facilities were evaluated. A baseline year of 2000 has been selected from the original total of 13 major facilities located in 7 jurisdictions all facilities remain in operation.









Canada-wide Standard for Mercury Emissions

Signed by:

British Columbia	Honourable Joan Sawicki
Alberta	Honourable Halvar Johnson
Saskatchewan	Honourable Buckley Belanger
Manitoba	Honourable Oscar Lathlin
Ontario	Honourable Dan Newman
Environment Canada	Honourable David Anderson
New Brunswick	Honourable Kim Jardine
Nova Scotia	Honourable Michael Baker
Prince Edward Island	Honourable Kevin MacAdam
Newfoundland and Labrador	Honourable Oliver Langdon
	Honourable Walter Noel
Yukon	Honourable Dale Eftoda
Northwest Territories	Honourable Joseph Handley
Nunavut	Honourable Peter Kilabuk

Note: Québec has not endorsed the Canada-wide Accord on Environmental Harmonization or the Canada-wide Environmental Standards Sub-agreement.

Appendix C
Waste Manifests

NEWMONT
The Gold Company

Shipping Order

S.O. #: 0810

Hope Bay Project ☑ Doris ☐ Windy ☐ Boston ☐ Yellowknife ☐ Cambridge Bay

Ship To: KBL ENVIRONMENTAL
Address: 341 OLD AIRPORT RD.
YELLOWKNIFE, NT
Attn/Tel #: JOHN OLDFIELD

Originator/Dept: HBML

Reason of Shipment:
☐ Repair ☐ Warranty ☐ Rental Return
☐ Damage ☐ Exchange ☐ Personal Goods
☐ Credit ☐ Overage ☐ Sample (Lab)
☑ Other

Date: MAY 21 2009
Outward Manifest or BOL #: 19970 B

P/O Reference #:

Regulated Dangerous Goods Enclosed ☑ NO ☐ Yes (Completed TDG Shipping Document Attached)

Item No.	QTY	UOM	Description of Articles or TDG Shipping Name	Weight ☑ LBS ☐ KGS
01	05		MEGA BAGS - WASTE BACKHAUL	1320
02	08		SKIDS OF ASH BARRELS (4 BARRELS EA SKID // 32 BARRELS)	5578
TOTAL:	13			6898

Forward beyond BBE via:
☐ Air ☐ Ground
Preferred Carrier:
Carrier Account #:
☐ Prepaid ☐ Collect

Fowarding Probill/Waybill:

SPECIAL INSTRUCTIONS:

Forwarding Date:

Sender: HBML
I have identified Dangerous Goods for Transport

Shipper: ~~K. Reith~~ BBE

Accepted/Forwarder:

NEWMONT
The Gold Company

Doris Strip - Waste Backhaul Tracking Form

Container	Container Type	Description	TDG Shipping Name	TDG Pin or UN #	Weight in Pounds			Destination	Reciever	Date Sent	Manifest Number
					Bag Weight	Pallet	Total Weight				
327	Mega-Bag	(Cardboard/Plastic)			170	32	202	YZF	John Oldfield Co.	May 21 2009	19970 B
330	Mega-Bag	(Wood/Plastic)			200	78	278	YZF	John Oldfield Co.	May 21 2009	19970 B
331	Mega-Bag	(Paper/Plastic)			118	60	178	YZF	John Oldfield Co.	May 21 2009	19970 B
336	Mega-Bag	(Plastic/Paper)			180	72	252	YZF	John Oldfield Co.	May 21 2009	19970 B
338	Mega-Bag	(Cardboard/Wood)			324	86	410	YZF	John Oldfield Co.	May 21 2009	19970 B
369	x4 Barrel	(Ashes/Non-Burnables)			377	80	457	YZF	John Oldfield Co.	May 21 2009	19970 B
370	x4 Barrel	(Ashes/Non-Burnables)			726	80	806	YZF	John Oldfield Co.	May 21 2009	19970 B
371	x4 Barrel	(Ashes/Non-Burnables)			603	80	683	YZF	John Oldfield Co.	May 21 2009	19970 B
375	x4 Barrel	(Ashes/Non-Burnables)			700	80	780	YZF	John Oldfield Co.	May 21 2009	19970 B
376	x4 Barrel	(Ashes/Non-Burnables)			360	80	440	YZF	John Oldfield Co.	May 21 2009	19970 B
377	x4 Barrel	(Ashes/Non-Burnables)			746	80	826	YZF	John Oldfield Co.	May 21 2009	19970 B
390	x4 Barrel	(Ashes/Non-Burnables)			728	80	808	YZF	John Oldfield Co.	May 21 2009	19970 B
392	x4 Barrel	(Ashes/Non-Burnables)			698	80	778	YZF	John Oldfield Co.	May 21 2009	19970 B
				Totals	5930	968	6898				

Appendix D
Model CY-100-CA-D-O Incinerator Manual

Model CY-100-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	**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.

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.

[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.

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.

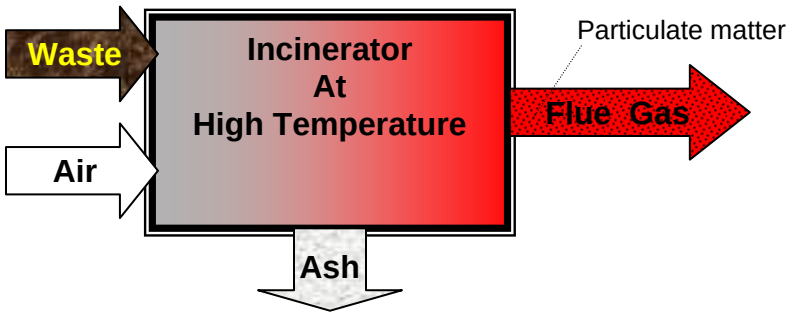


Figure 1 Schematic Diagram of Incineration Process

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.

This component can be further classified as:

---

[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.

[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.

(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.

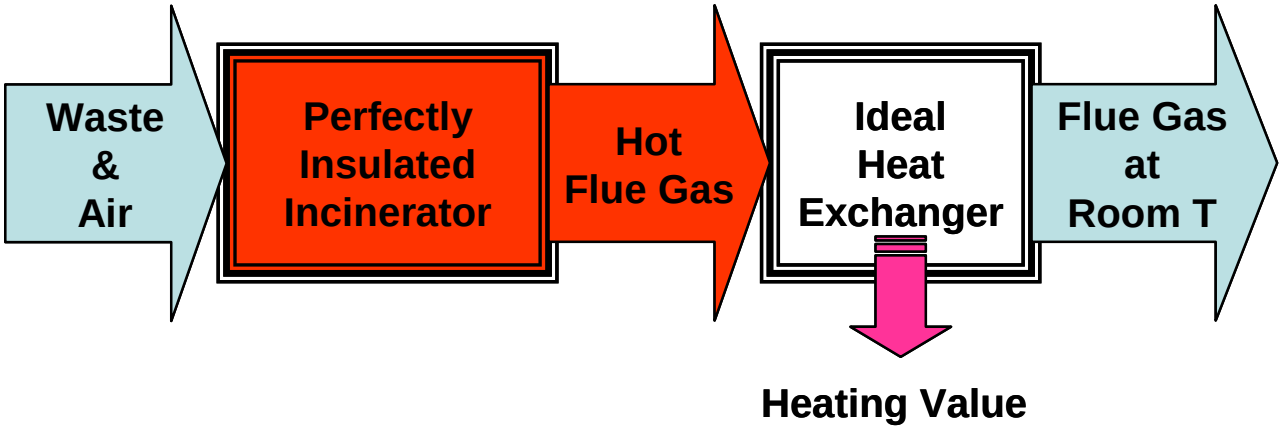


Figure 2 The Concept of Heating Value

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).

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

[5] The terms "ash" and "inorganic" are also used. Note that the latter is inaccurate as explained previously.

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".

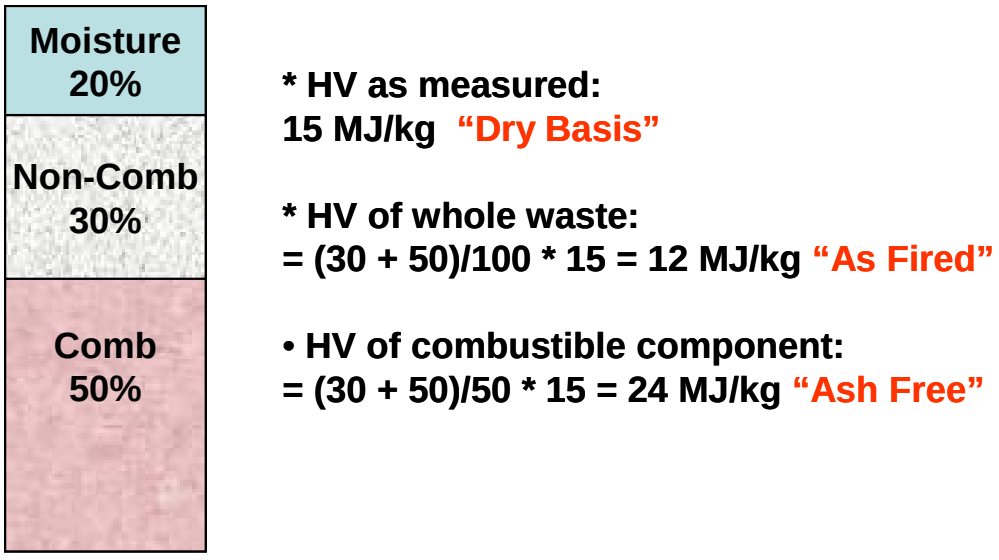


Figure 3 Different Bases for Expressing Heating Value (HV)

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.

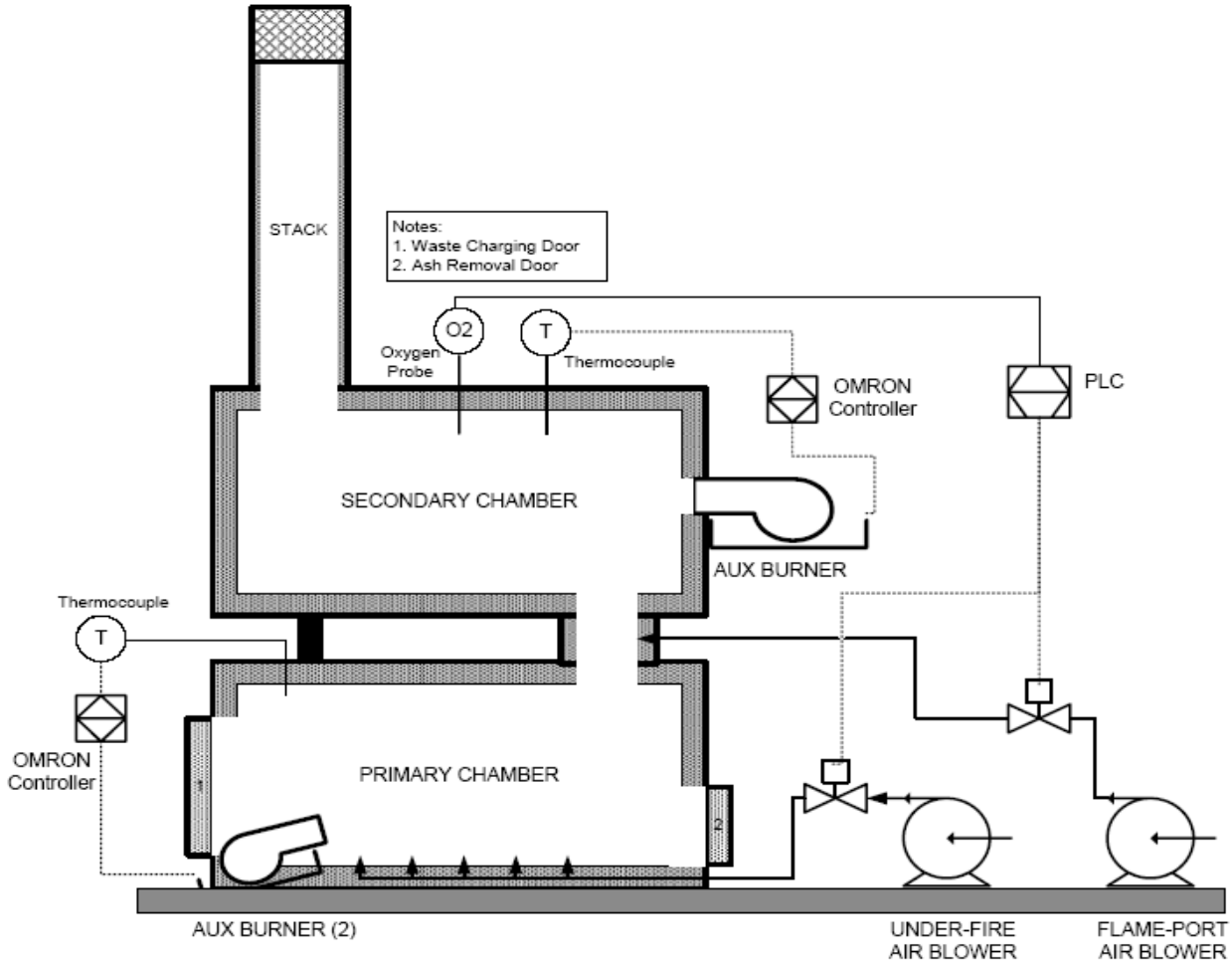


Figure 4 Schematic of the Incineration System

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.

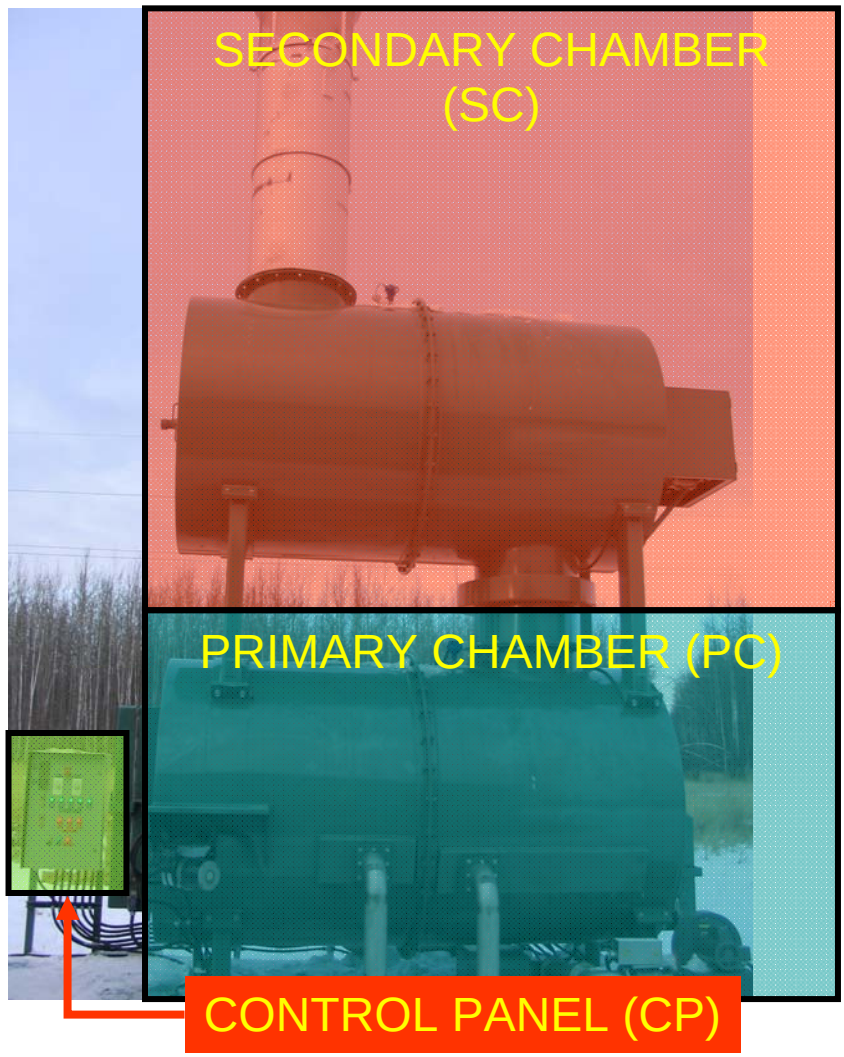


Figure 5 Overall View showing the Sections

3.4 Primary Chamber Section

The components are listed in Table 5, and the photographs are shown in Figure 6 to Figure 8.

Table 5 Components in the Primary Chamber Section

Code	Component	Description	Function
PC1	Primary Chamber	In-house made. Inside Vol: 2.8 m^3 Refractory: 10 cm; Insulation 7.5 cm	Pyrolysis and gasification Combustion of fixed carbon
PC2	Charge Door	In-house made. Door opening: 89 cm x 69 cm	Load waste to primary chamber
PC3	Ash Door	In-house made. Door opening: 48 cm x 38 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		
PC5a	Auxiliary Burner	Becket WIC-201; 700,000 Btu/h; 5 USG/h	Start-up and maintains a minimum temperature
PC5b	Same as PC5a		
PC6	Under-fire Air Blower	4C 108 Dayton; 1 HP; 3600 rpm	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 8.

Table 6 Components in the Secondary Chamber Section

Code	Component	Description	Function
SC1	Secondary Chamber	In-house made. Inside Vol: 2.8 $m^{3,}$ Refractory: 10 cm; Insulation 7.5 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	4C 108 Dayton; 1 HP; 3600 rpm	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	DL-300 Oxytrol	Measure oxygen concentration in secondary chamber
SC8	Auxiliary Burner	Becket WIC-301; 1.6 million Btu/h; 12 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

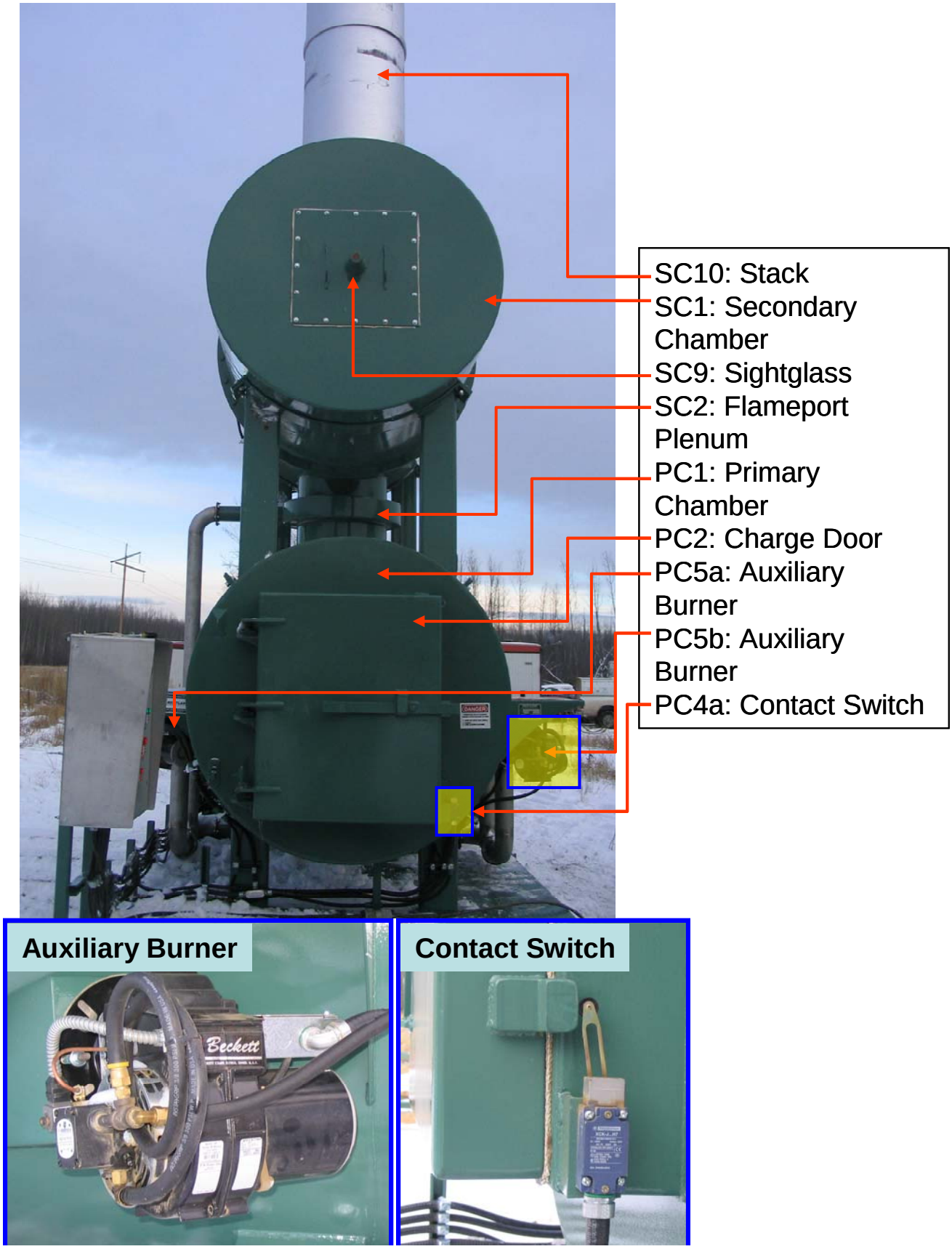


Figure 6 Components in the Primary and Secondary Chamber Sections (1)

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

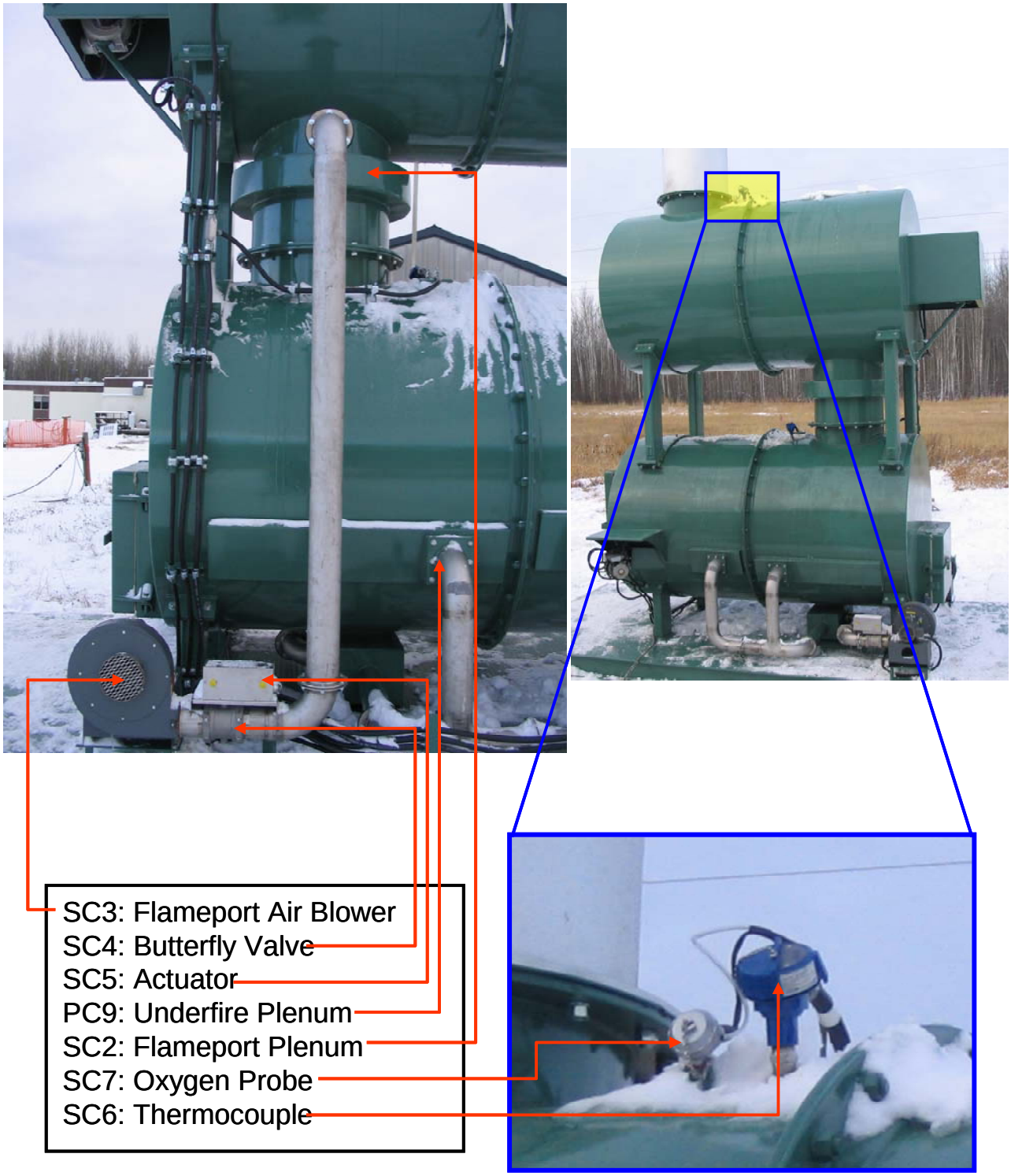


Figure 8 Components in the Primary and Secondary Chamber Sections (3)

3.6 Control Panel Section

The components are listed in Table 7. Figure 9 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 10 to Figure 12

Table 7 Components in the Control Panel Section

Code	Label	Function
Sub-Section A: Indicating Lights (ON_OFF). Figure 10		
CP1	Burner Blower #1, #2 and #3	#1 and #2: Motors for burners in primary chamber: PC5a and PC5b #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 Primary Chamber Secondary Chamber	Flames in burners indicated in the labels
Sub-Sections B and C: Main Controller and Controllers for Burners and Blowers. Figure 11		
CP3	E-STOP	Emergency stop: ▪ Push to activate: disconnects main power ▪ Twist right to connect main power
CP4	Blower Timer Burner Timer	Turn to connect power to blowers and burners for the specified time periods
CP5	Blowers Start and Stop Burners Start and Stop	Turn ON and OFF all blowers or burners while time has not expired in Timers PC4 (Note: These buttons are inactive when the timers are OFF, that is, at zero time)
Sub-Section D: Omron Temperature Controllers and Indicators. Figure 12		
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)
Sub-Section E: PLC Indicating Lights and Control Button. Figure 12		
CP7	Red Indicating Light (Marked 3 in photo)	▪ FLASHING: PLC is NOT ready since temperature is too low for oxygen probe ▪ ON: PLC is ready
CP8	Green Indicating Light (Marked 2)	▪ ON: Combustion from previous batch is complete: READY to load a new batch ▪ OFF: Combustion is taking place. Do NOT load. Wait.
CP9	Green Button (Marked 1)	PRESS *immediately* after a loading: Activates PLC control

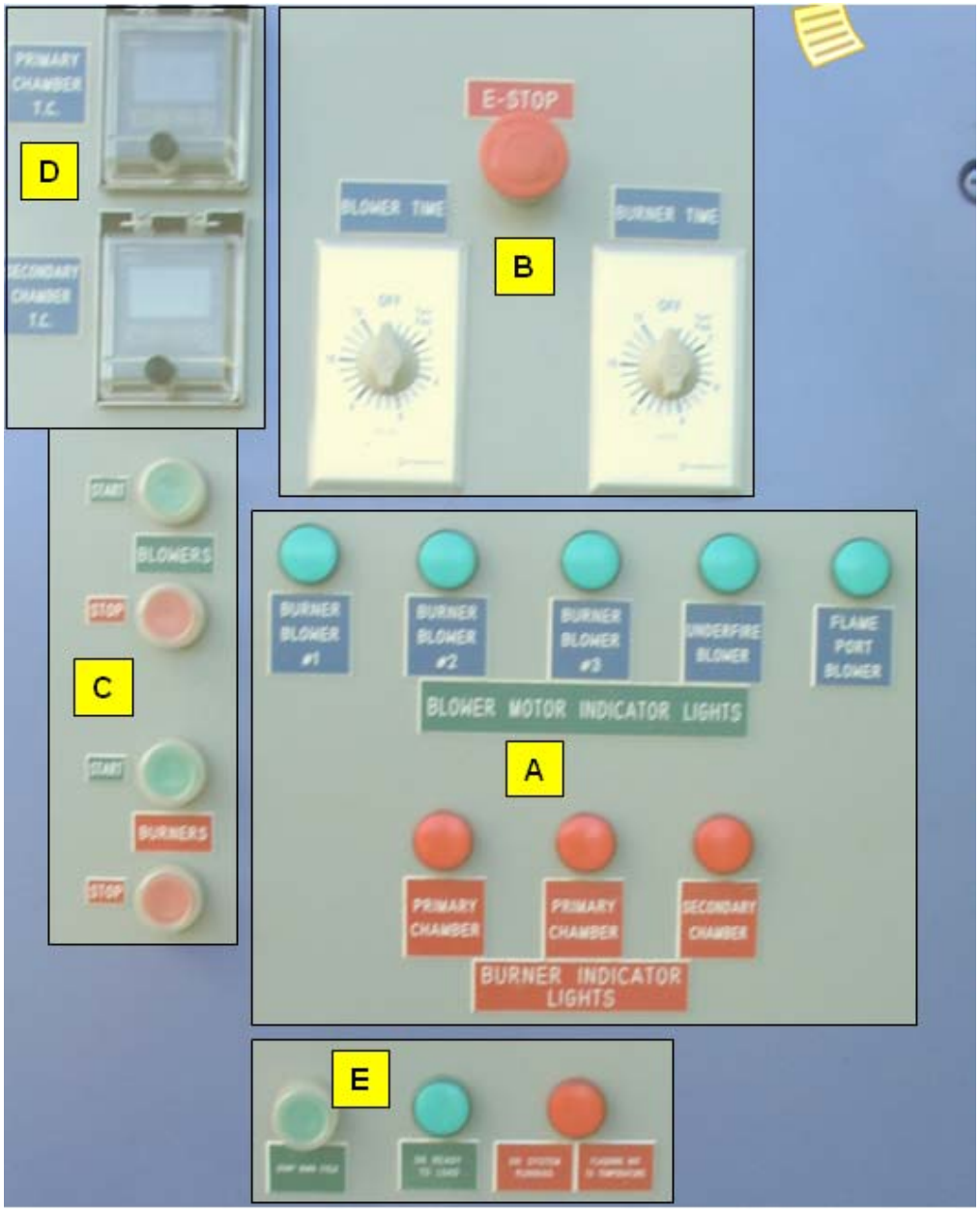


Figure 9 Overview of Control Panel, showing the Different Sections

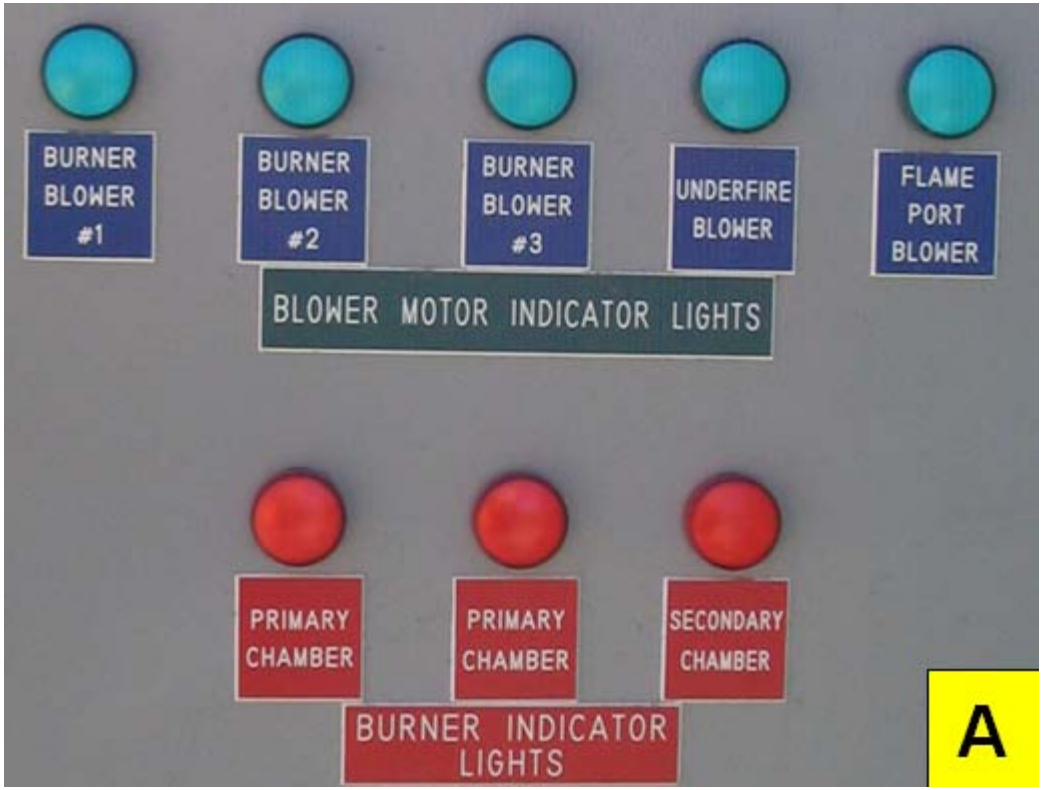


Figure 10 Sub-Section A: Indicating Lights
[CP1 and CP2 in Table 7]

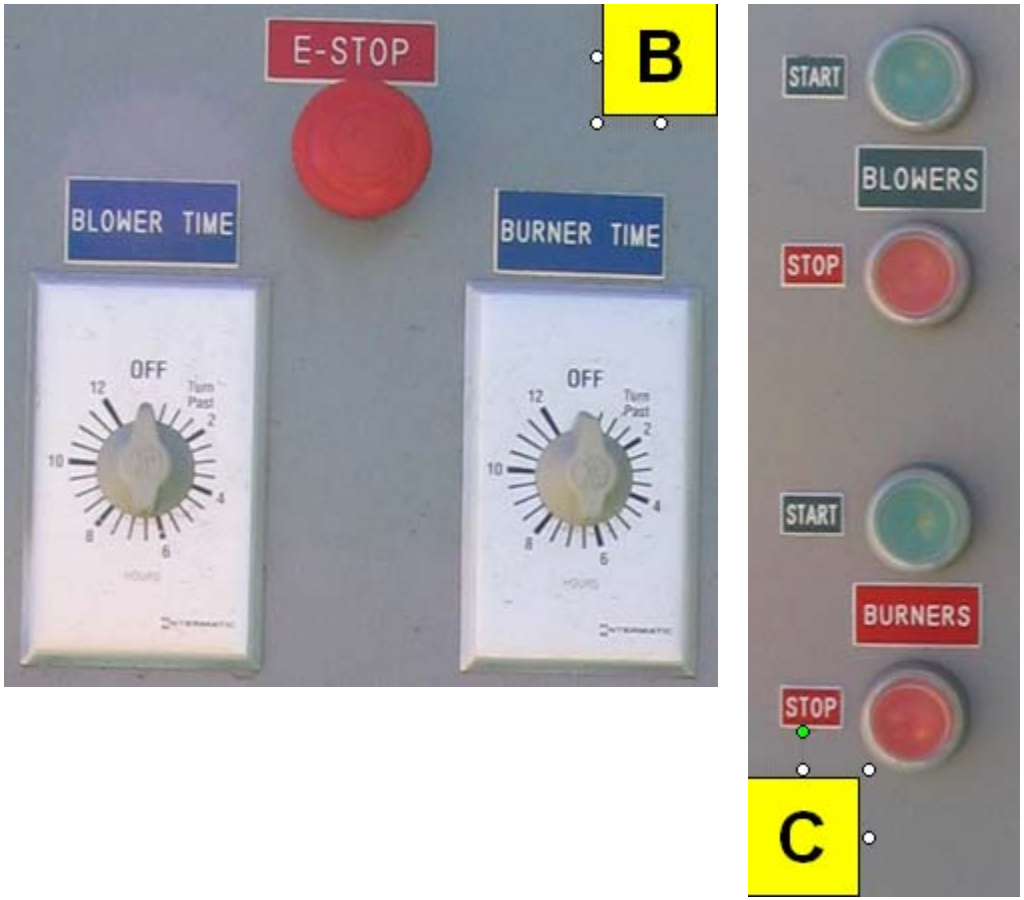


Figure 11 Sub-Sections B and C: Controllers for Burners and Blowers
[CP3, CP4 and CP5 in Table 7]

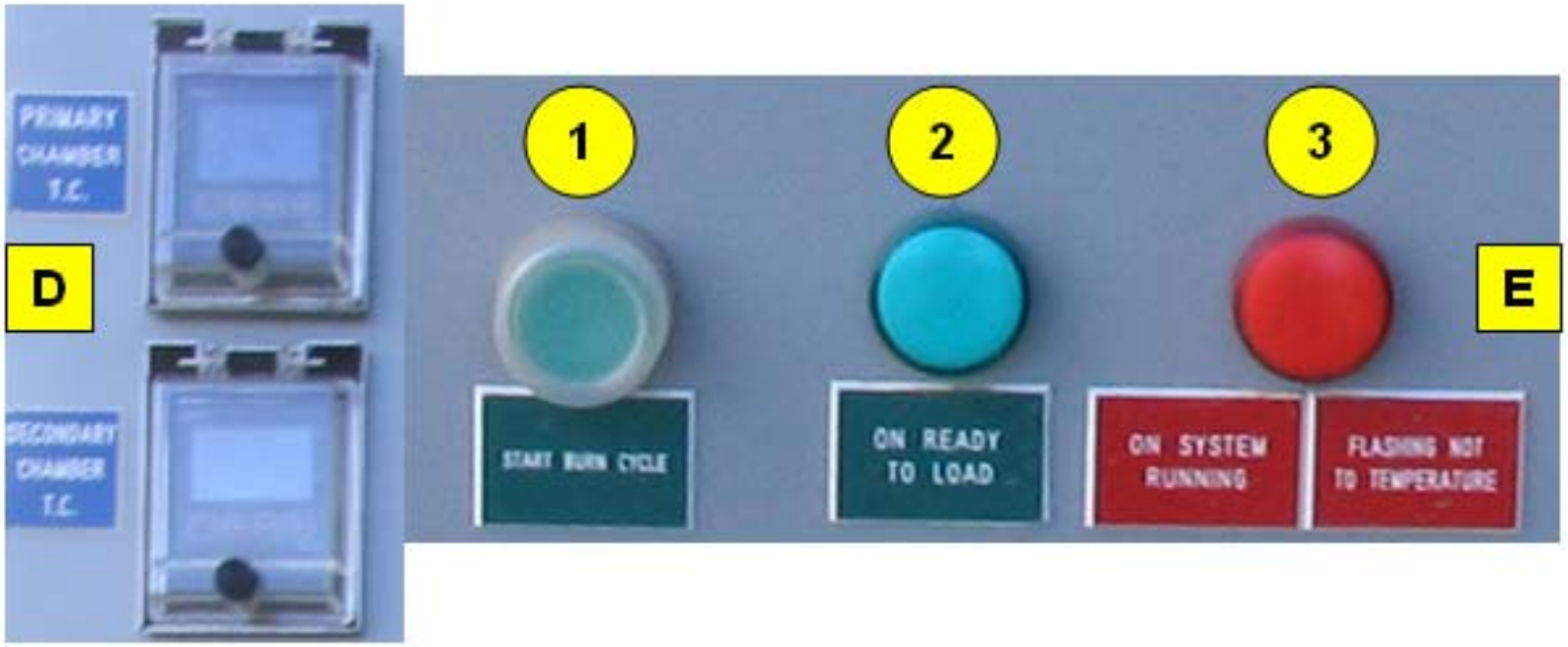


Figure 12 Sub-Section D: Temperature Controllers; E: PLC Indicating Lights and Control Button
[CP6 to CP9 in Table 7]

4 OPERATION AND MAINTENANCE

The operation of the incinerator can be described by distinct sequential steps as shown in Figure 13. In addition there are additional necessary steps which involve safety, routine inspection and waste batch preparation, which will be first described.

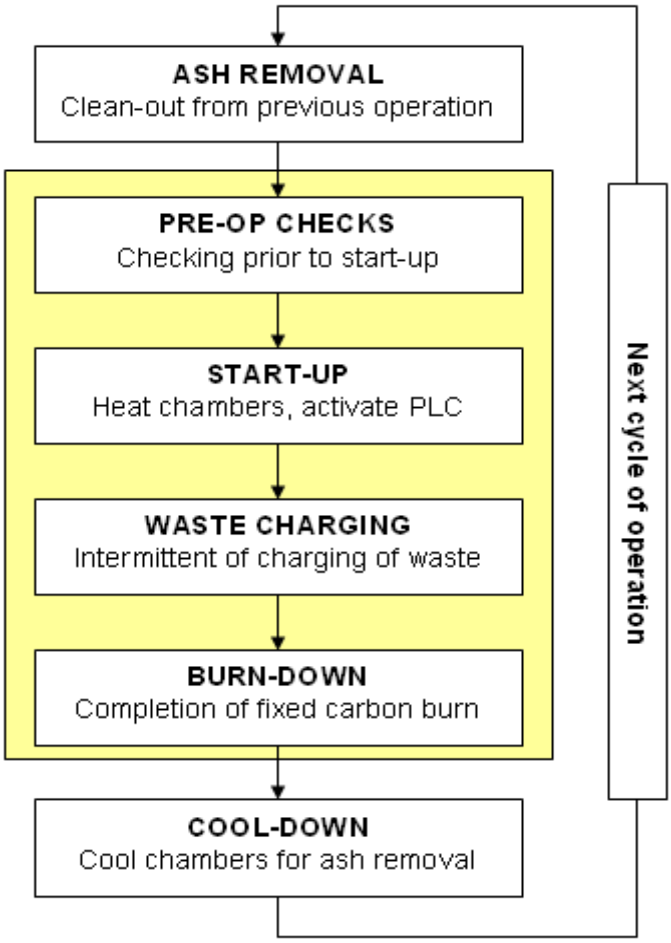


Figure 13 Steps in the Operation of the Incinerator

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 17 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 14

Note: Temperatures in Steps 7 and 8 may be regulated: If so, SET TO THE REGULATED VALUES

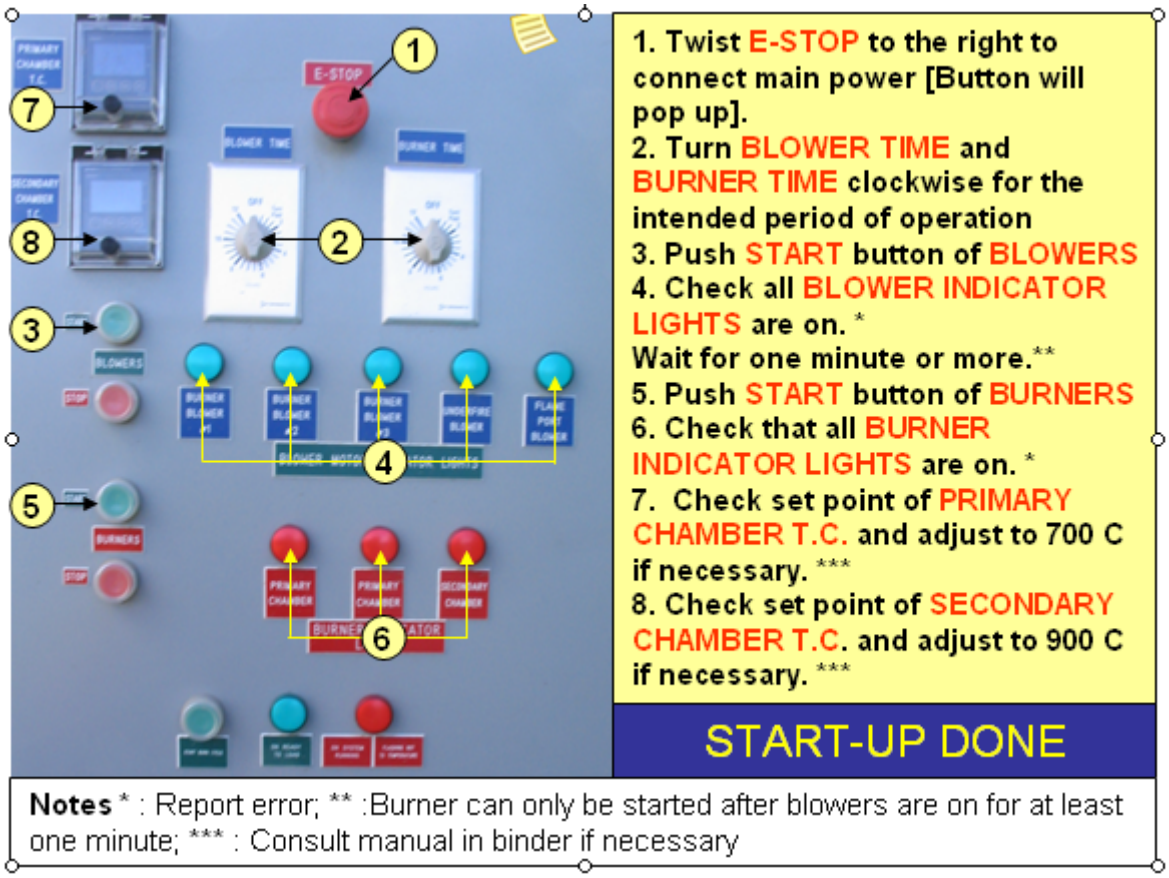


Figure 14 Procedure for Start-Up

4.7 Waste charging: see Figure 15

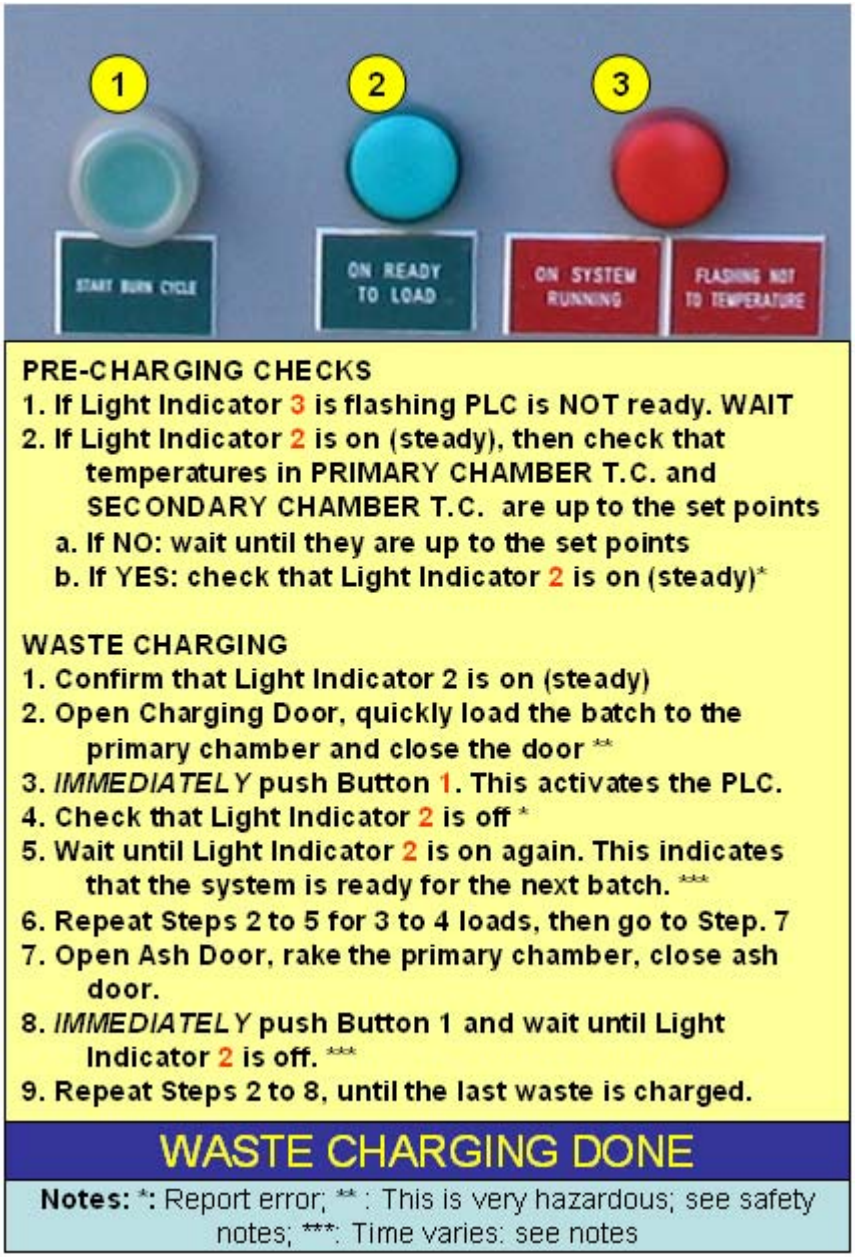


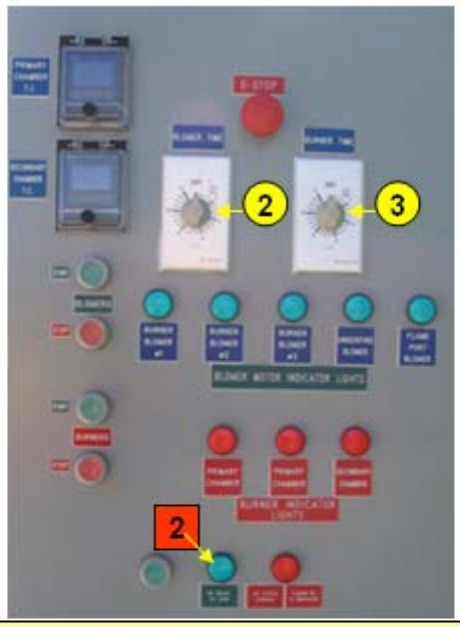
Figure 15 Procedure for Waste Charging

Additional Notes to Figure 15:

** : 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 16



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 16 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 12 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 solve them yourself. Thanks.

Table 9 Trouble Shooting Guidelines

Observation	Possible Causes	Corrective Measures
Auxiliary burner PC5a, PC5b 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 PC5a and PC5b 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 17 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.

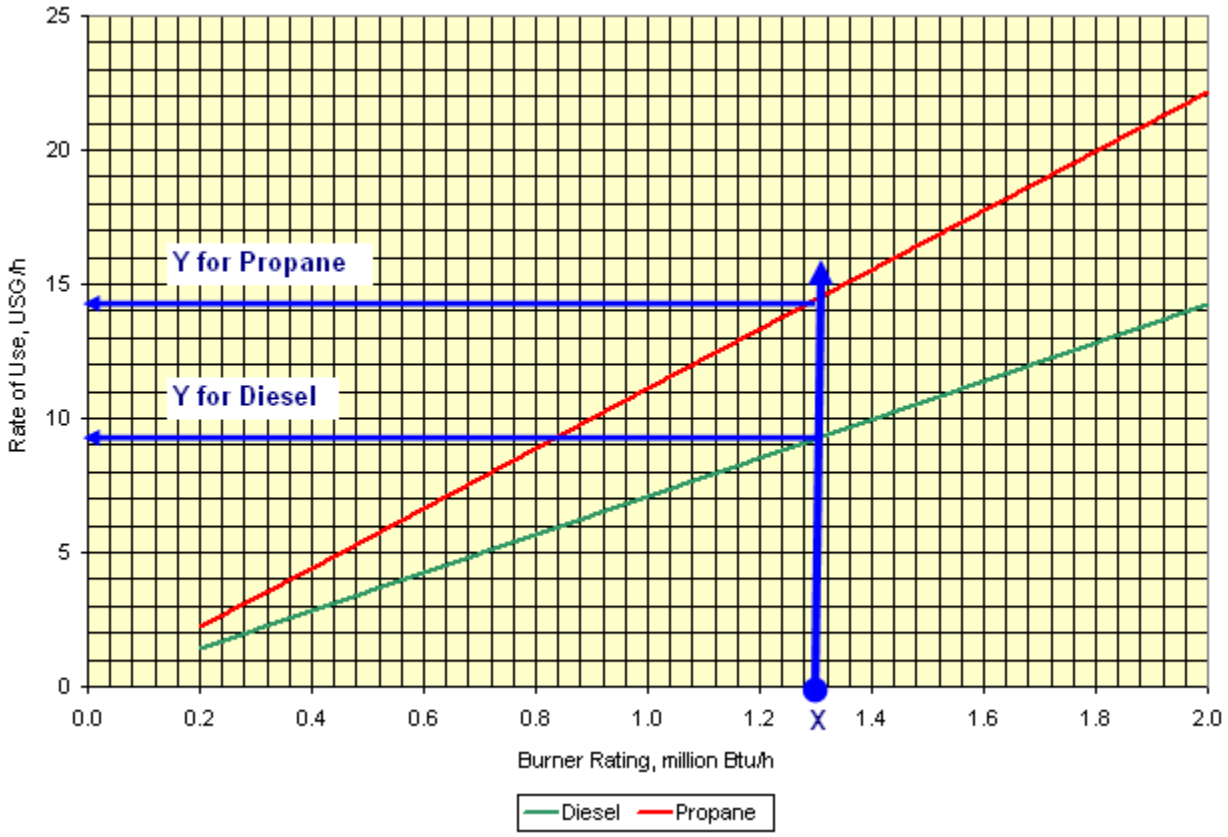


Figure 17 Consumption Rates of Propane and Diesel

5 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: May 25, 2008

MODEL NUMBER: CY 100- CA- D-O

SERIAL NUMBER: 2K7-760

PURCHASED BY: Miramar Hope Bay Project/SNC Lavalin

SELLING BRANCH: Edmonton, Alberta

6 APPENDIX A: INFORMATION SHEETS AND MANUALS

1. Suggested Spare Parts List
2. Burner: WIC 201
3. Burner: WIC 301
4. Blower: Dayton 4C 108
5. Temperature Controller: Omron E5CN
6. Valve Actuator: Neptronic BBMF 2000A
7. Oxygen Probe and Transmitter
8. Incinerator Paint MSDS
9. Wiring Diagram

WESTLAND
ENVIRONMENTAL SERVICES INC.
www.westlandenvironmental.com

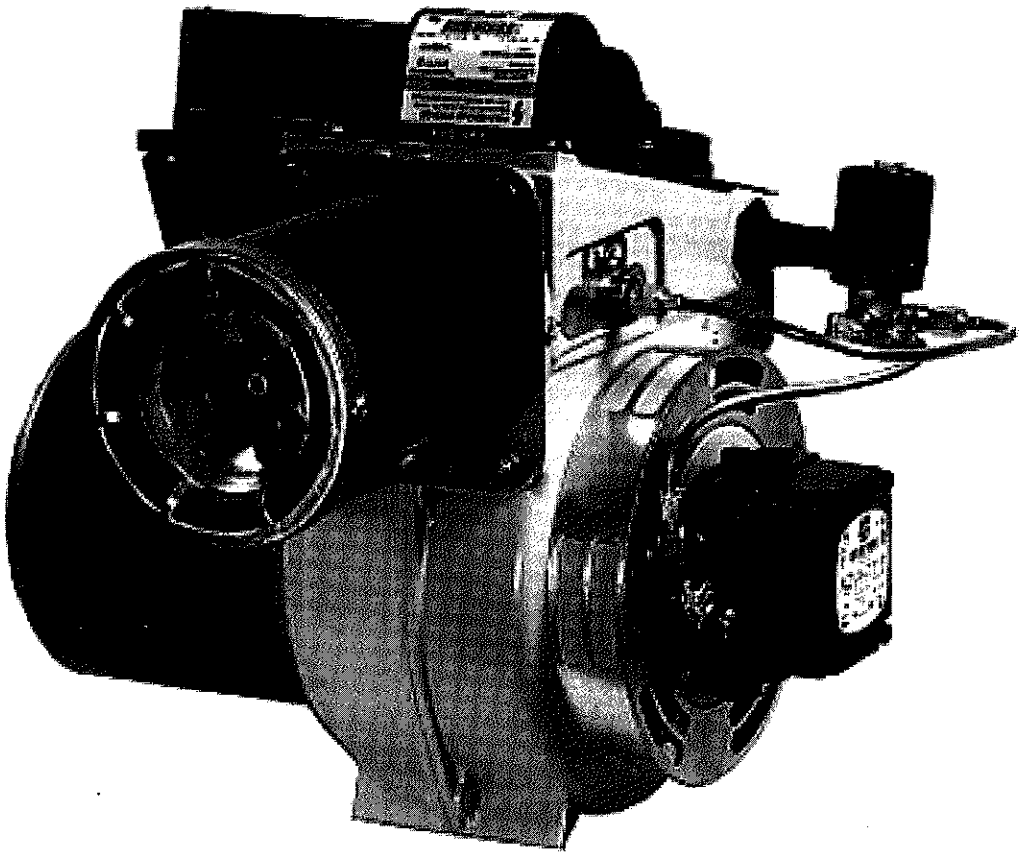
CY 100 CA D O Suggested Spare Parts List**

Quantity	Unit	Description	Part #
2	each	Beckett WIC 201 burner	7007006
1	each	Beckett WIC 301 burner	7000913
1	each	Blower-Dayton 4C108	7000051
1	each	Proximity Switch	7000169
1	each	Oxygen Probe Marathon Oxyfire	
1	each	Thermocouple, ceramic tube	7640022
100	foot	Gasket, Ceramic Fibre 1/4" x 2": $2.38/ft.	7000062
2	each	Gasket Cement, HT Silicone Tube @ $24/tube	7000064
1	each	Refractory Cement Bag	7000120

** Please note that the Suggested Spare Parts List for start-up and operations are the same.

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)		(inch-es)	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.

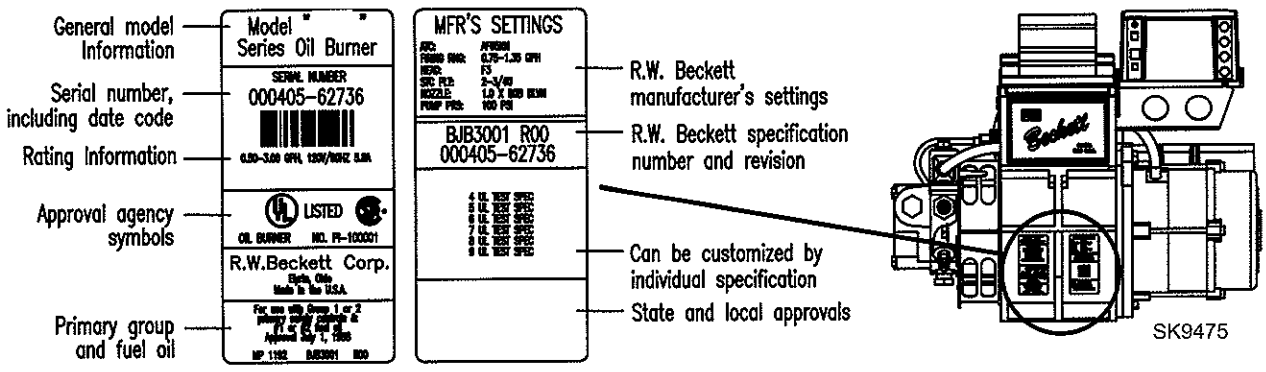
• Attach air tube (if not already installed)

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

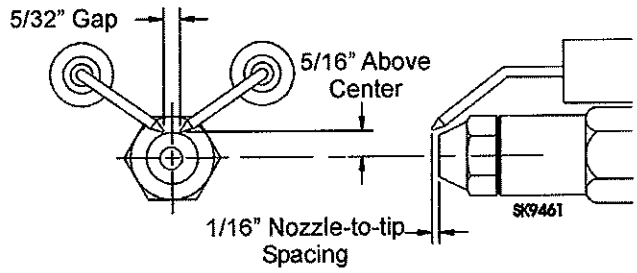
Recommended nozzle spray angles	
"F" head	70°, 80° or 90° nozzle

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.

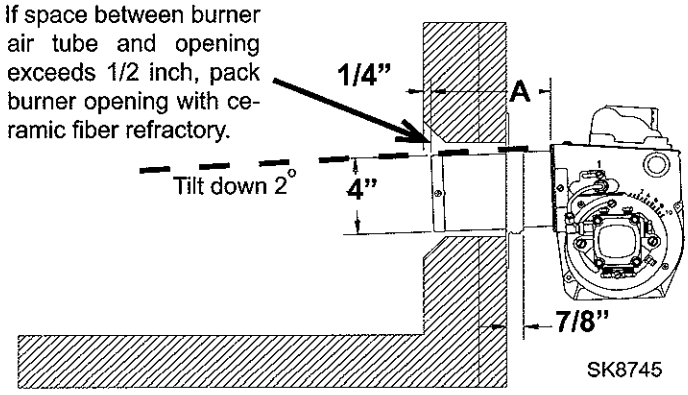
• Mounting options

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

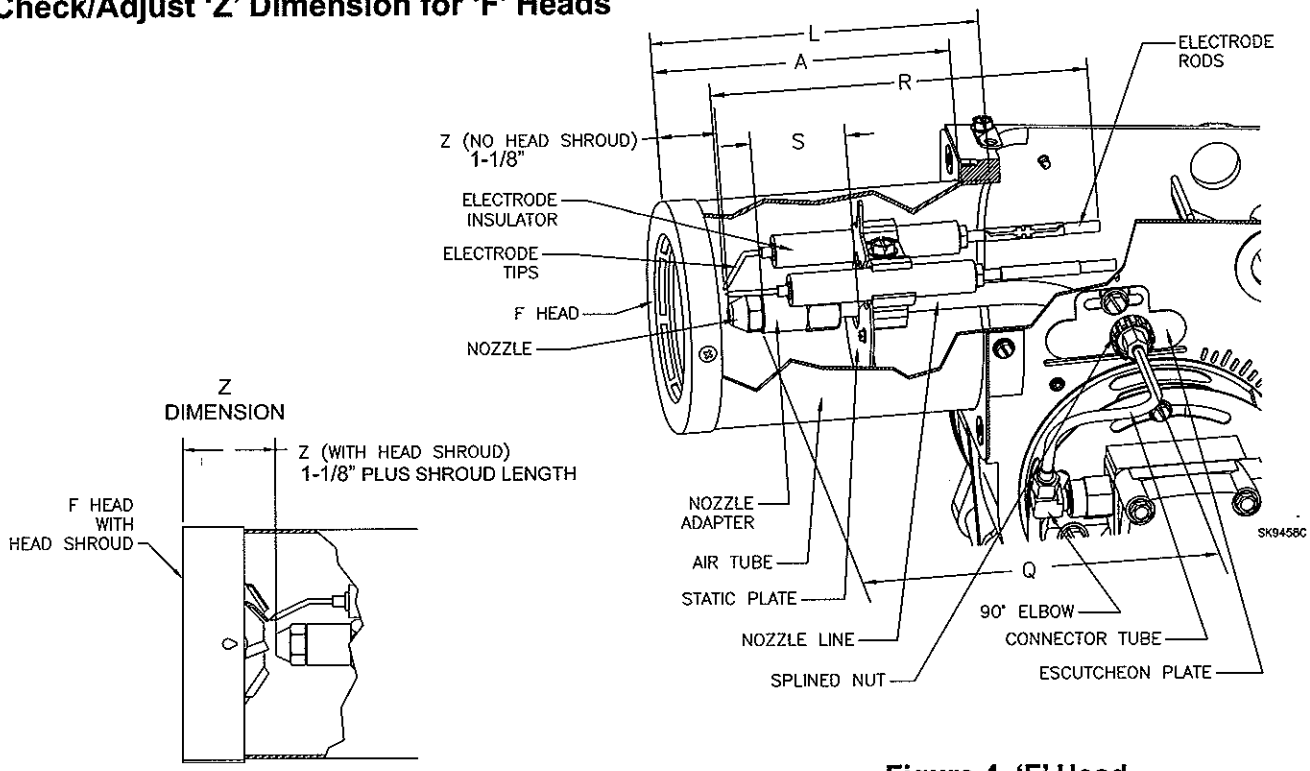


Figure 4. 'F' Head

• 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.

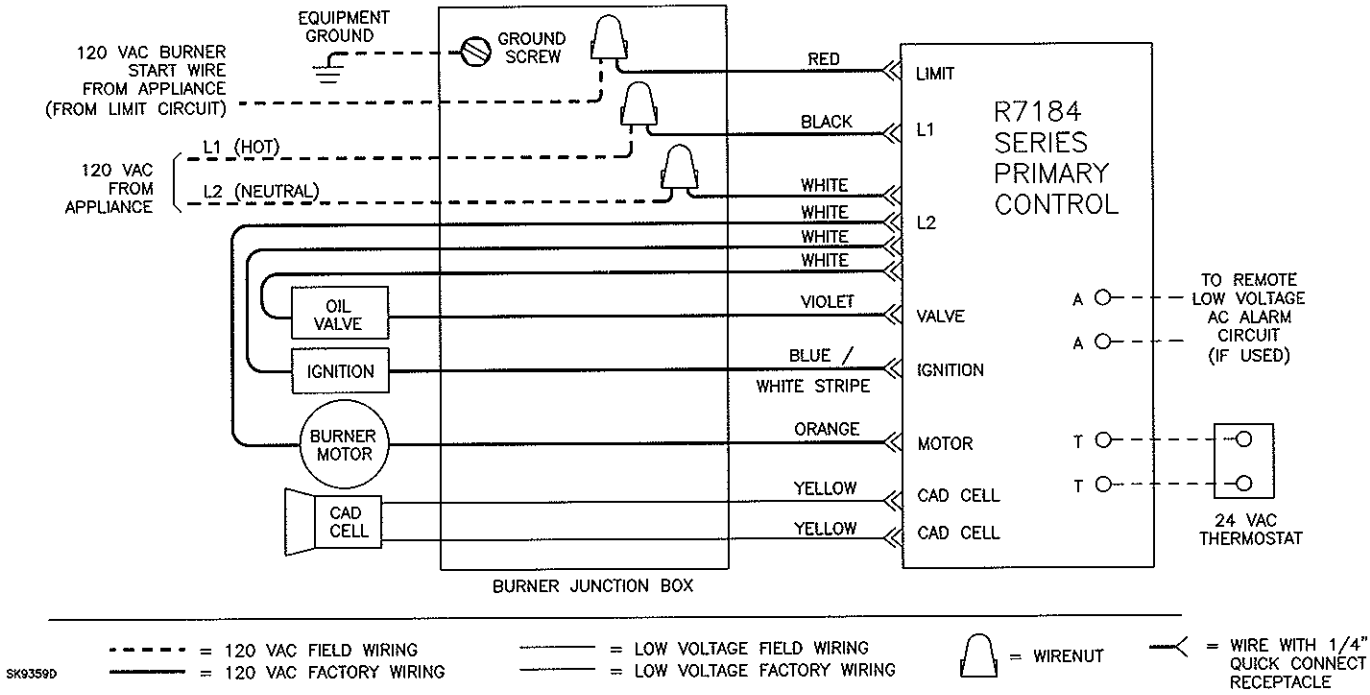
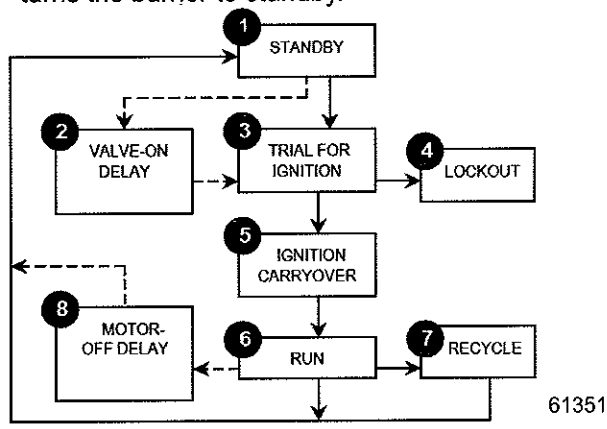


Figure 5. – Typical Burner Wiring

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.

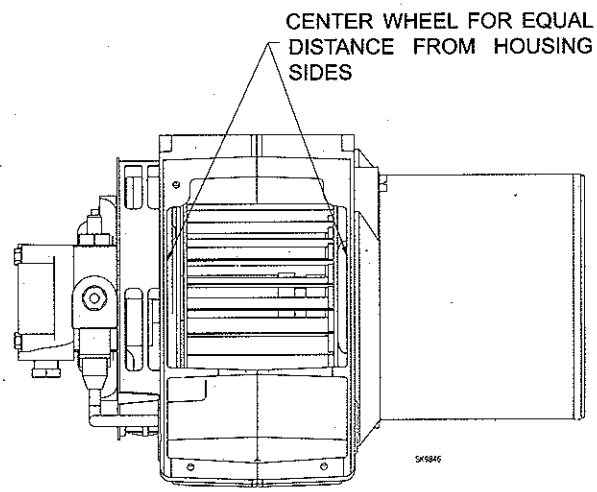
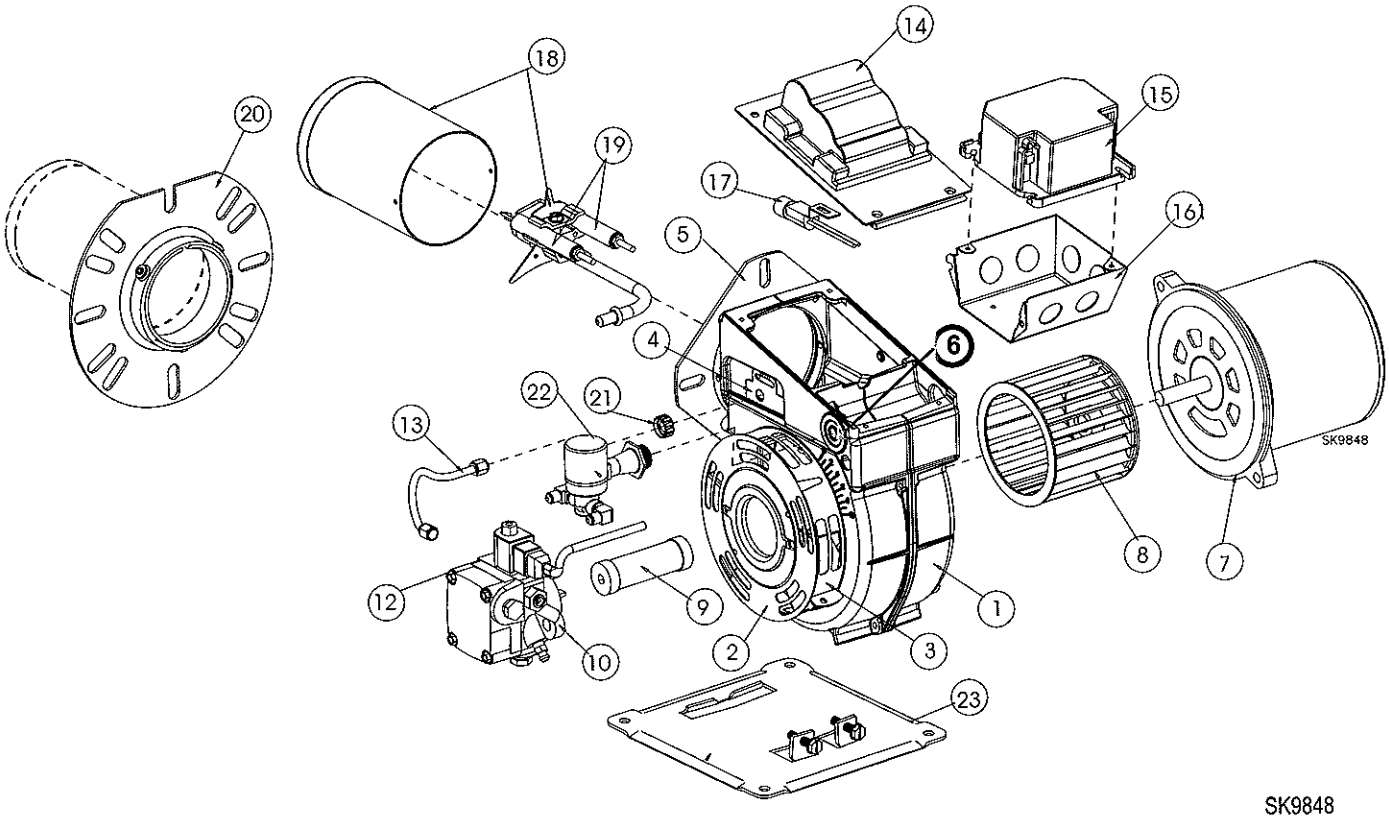


Figure 6. Blower Wheel Assembly

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
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Form Number 6104BSF/SM R03
Printed in U.S.A.

12/06

WIC 301 BURNER

Beckett
COMMERCIAL

CF1400
CF2300

OIL BURNER MANUAL

Operation: Low/High
Rate: CF1400: 4.0 to 13.6 GPH
CF2300: 7.0 to 19.9 GPH

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.

Before you begin . . .

The following resources will give you additional information for your installation. We suggest that you consult these resources whenever possible. Pay particular attention to the appliance manufacturer's instructions.

Appliance manufacturer's instructions *-Always follow the appliance manufacturer's instructions for burner installation, equipment and set-up.*

1–800–OIL–BURN *- Beckett's technical services hot-line.*
www.beckettcorp.com *- Beckett's website.*

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.

Table of Contents

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.**

NOTICE

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

Note: 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.

Agency approvals

c UL US

- UL listed to comply with ANSI/UL296 and certified to CSA B140.0.
- Accepted by N.Y.C. M.E.A.
- Other approvals may be available and must be specified at time of order.

Specifications

Fuels	#1 or #2 Fuel Oil
Firing Range	BCF1400 - 4.0 to 13.6 gph BCF2300 - 7.0 to 19.9 gph
Motor	**CF1400:** 1/2 HP 3450 rpm 120/60 Hz Standard 6.5 amps @ 120 VAC **CF2300:** 3/4 HP 3450 rpm 120/60 Hz Standard 12.5 amps @ 120 VAC **Optional Voltages** (CF1400 & CF2300): 240 VAC/1-PH, 208, 240, 480 VAC/3-PH, 50 Hz
Ignition Trans.	Continuous Duty, 120V/12,000V
Housing	Cast aluminum
Fuel Unit	100 to 300 psig
Oil Nozzle	45º to 70º Solid
Dimensions	Refer to Figure 7.

Owner's Responsibility:

WARNING

Follow These Instructions Exactly

Failure to follow these instructions, misuse, or incorrect adjustment of the burner could lead to equipment malfunction and result in asphyxiation, explosion or fire.

Contact a professional, qualified service agency for the installation, adjustment and service of your oil burning system. Thereafter, have your equipment adjusted and inspected at least annually to ensure reliable operation. 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 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.

Professional Installer/Service Agency Responsibility:

WARNING

Follow These Instructions Exactly

Failure to follow these instructions could lead to equipment malfunction and result in asphyxiation, explosion or fire.

- Please read all instructions before proceeding. Follow all instructions completely.
- This equipment must be installed, adjusted and started by a qualified service agency that is licensed and experienced with all applicable codes and ordinances and responsible for the installation and commission of the equipment.
- The installation must comply with all local codes and ordinances having jurisdiction and the latest editions of the NFPA 31 and CSA-B139 & B140 in Canada.

NOTICE

50 Hz Motors - The burner ratings, air settings and nozzle ratings are based on standard 60 Hz motors (at 3450 rpm). Derate all ratings 20% when using 50 hz motors. Consult factory for specific application data.

NOTICE

High altitude installation - Accepted industry practice requires no derate of burner capacity up to 2000 feet above sea level. For altitudes higher than 2000 feet, derate burner capacity 2% for each 1000 feet above sea level.

Pre-installation checklist

❑ 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.

The burner requires combustion air and ventilation air for reliable operation. Assure that the building and/or combustion air openings comply with National Fire Protection Standard for Oil-Burning Equipment, NFPA 31. For appliance/burner units in confined spaces, the room must have an air opening near the top of the room plus one near the floor, each with a free area at least one square inch per 1,000 Btu/hr input of all fuel burning equipment in the room. For other conditions, refer to NFPA 31 (CSA B1139-M91 in Canada).
If there is a risk of the space being under negative pressure or of exhaust fans or other devices depleting available air for combustion and ventilation, the appliance/burner should be installed in an isolated room provided with outside combustion air.

❑ Clearances

With the burner installed in the appliance, there must be adequate space in front of and on the sides of the burner to allow access and operation. Verify that the clearance dimensions comply with all local codes and with the appliance manufacturer's recommendations.

❑ Fuel supply

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***.
- Do not install valves in return line.
- Insure that a pressure limiting device is installed in accordance with the latest edition of NFPA 31.
- Gravity Feed Systems: Always install an anti-siphon valve in the oil supply line or a solenoid valve (RWB Part # 21789) in the pump/nozzle discharge tubing to provide backup oil flow cut-off protection.

- The fuel supply piping and tank must provide #1 or #2 fuel oil at pressure or vacuum conditions suitable for the fuel unit (oil pump) on the burner. Refer to fuel unit literature in the literature envelope in the burner carton to verify allowable suction pressure.

If fuel supply is level with or higher than fuel unit —

- When the fuel unit is not required to lift the oil, the installation is usually suitable for either a one-pipe or two-pipe oil system. The oil pressure at the inlet of the fuel unit must not exceed 3 psig.
- The fuel unit is shipped with the by-pass plug installed. Leave the by-pass plug installed for all low/high firing burners, regardless whether one-pipe (with by-pass loop) or two-pipe. See ***Figure 9*** for installation of the by-pass loop required for one-pipe fuel supply installations. See ***Figure 10*** for connections to the fuel unit for two-pipe fuel supply installations.

When fuel supply is below the burner fuel unit —

- Use a two-pipe oil system when the fuel unit must lift the oil more than 8 feet. The return line provided by the two-pipe system is needed to minimize the effects of air-related problems during operation.

❑ Nozzle pressure

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.
- This burner utilizes pressures higher than 100 psig, so the actual nozzle flow rate will be greater than the gph stamped on the nozzle body. (Example: A 8.00 gph nozzle at 150 psig = 9.80 gph and at 300 psig = 13.86 gph)

For typical nozzle flow rates at various pressures see accompanying chart.

- The fuel unit nozzle port pressure is factory set at 300 psig. Some original equipment manufacturer burner applications may call for a lower pressure to obtain a required firing rate. Do not change this pressure unless directed to do so by the appliance manufacturer.

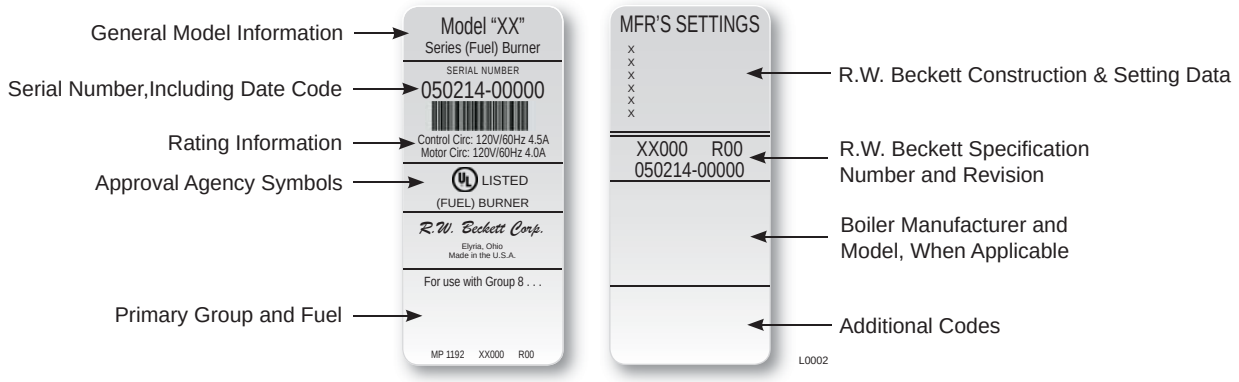
❑ Electrical supply

Verify that the power connections available are correct for the burner. Refer to ***Figure 1***. All power must be supplied through fused disconnect switches.

❑ Vent system

The flue gas venting system must be in good condition and must comply with all applicable codes.

Figure 1 – Typical Nameplate



❑ Verify burner components —

- Burner nameplate ***(figure 1)***, Model CF1400 or CF2300A
- Air tube assembly
- Mounting flange kit
- Pedestal mounting assembly kit (recommended)
- Oil nozzle, per ***Table 1*** — Use only 45° to 70° solid pattern nozzles unless otherwise shown by appliance manufacturer or on the burner nameplate rating label.

Find the required firing rate in the 300 psig column (high fire rate).
Select the corresponding nozzle from column 1 (***Rated gph @ 100 psig***).

(Example: a 500 gph nozzle @ 300 psi = 8.66 gph)

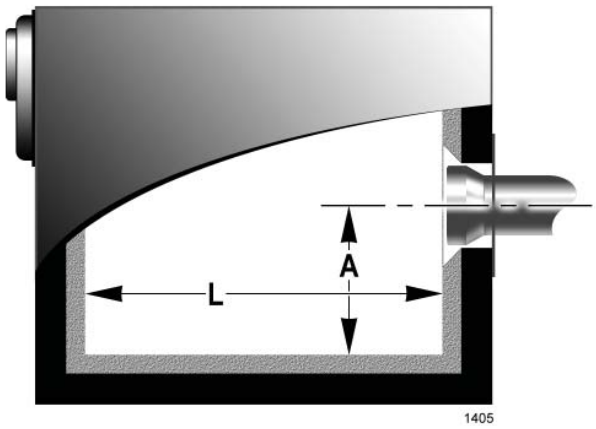
Table 1 - Nozzle capacities

Rated gph @ 100 psig	Pressure - Pounds per square inch							
	125	140	150	175	200	250	275	300
3.00	3.35	-	3.67	3.97	4.24	4.74	4.97	5.20
3.50	3.91	-	4.29	4.63	4.95	5.53	5.80	6.06
4.00	4.47	-	4.90	5.29	5.66	6.32	6.63	6.93
4.50	5.04	5.32	5.51	5.95	6.36	7.11	7.46	7.79
5.00	5.59	5.92	6.12	6.61	7.07	7.91	8.29	8.66
5.50	6.15	6.51	6.74	7.27	7.78	8.70	9.12	9.53
6.00	6.71	7.10	7.35	7.94	8.49	9.49	9.95	10.39
6.50	7.26	7.69	7.96	8.60	9.19	10.28	10.78	11.26
7.00	7.82	8.28	8.57	9.25	9.90	11.07	11.61	12.12
7.50	8.38	8.87	9.19	9.91	10.61	11.86	12.44	12.99
8.00	8.94	9.47	9.80	10.58	11.31	12.65	13.27	13.86
8.50	9.50	10.06	10.41	11.27	12.02	13.44	14.10	14.72
9.00	10.06	10.65	11.02	11.91	12.73	14.23	14.93	15.59
9.50	10.60	11.24	11.64	12.60	13.44	15.02	15.75	16.45
10.00	11.18	11.83	12.25	13.23	14.14	15.81	16.58	17.32
10.50	11.74	12.42	12.86	13.89	14.85	16.60	17.41	18.19
11.00	12.30	13.02	13.47	14.55	15.56	17.39	18.24	19.05
12.00	13.42	14.20	14.70	15.88	16.97	18.97	19.90	20.79

❑ Verify firing rate

Refer to appliance manufacturer's instructions (if available) for firing rate and nozzle selection. Otherwise, the maximum recommended firing rate for the burner depends on the length of the firing chamber and the distance from the burner center to the chamber floor. Verify that the chamber dimensions are at least as large as the minimum values given in ***Figure 2***. If the appliance dimensions are smaller than recommended, reduce the firing rate accordingly.

Figure 2 – Chamber Dimensions



Model	Firing Rate (gph)	Minimum Dimensions			
		Refractory Lined		Wet-based Boilers	
		A	L	A	L
CF1400	0 to 5	7.0"	25.0"	7.0"	25.0"
	5 to 10	8.0"	35.0"	8.0"	40.0"
CF2300	5 to 10	8.0"	35.0"	8.0"	40.0"
	10 to 15	9.0"	40.0"	9.0"	50.0"
	15 to 20	11.0"	55.0"	11.0"	60.0"

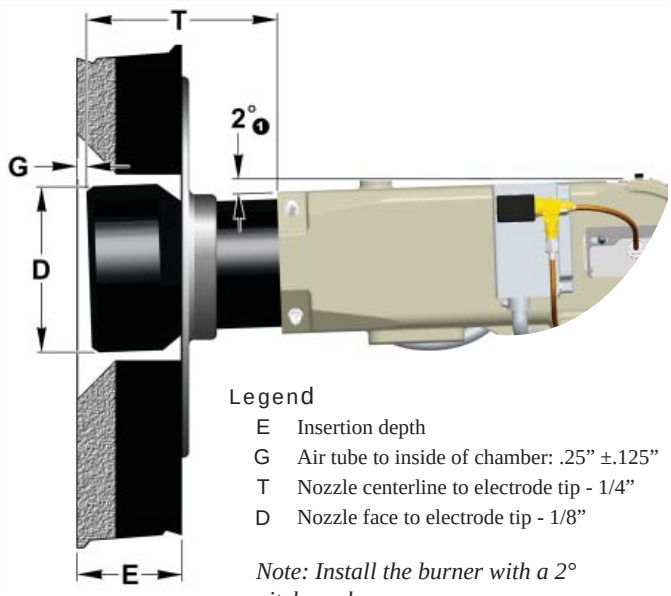
❑ Verify air tube

The information in this section may be disregarded if the air tube is supplied by the appliance manufacturer.

- On the **CF1400**, there are two tube arrangements available –
  Tube A — 4.0 to 11.0 GPH per Table 2
  Tube B — 7.0 to 13.6 GPH per Table 2
- The **CF1400** maximum firing capacity depends on the firebox pressure. Use ***Table 2*** to verify the correct air tube type for the firing rate required. Use Tube B only when Tube A cannot provide the firing rate required.

- On the **CF2300**, there are two tube arrangements available –
  Tube A — 7.0 to 19.9 GPH per Table 2
  Tube B — 10.0 to 19.9 GPH per Table 2
- The **CF2300** maximum firing capacity depends on the firebox pressure. Use ***Table 2*** to verify the correct air tube type for the firing rate required. Use Tube B only when Tube A cannot provide the firing rate required.
- See ***Figure 3*** to verify the correct air tube length and air tube combination code.

Figure 3 – Air tube mounting dimensions



Legend

- E Insertion depth
- G Air tube to inside of chamber: .25” ±.125”
- T Nozzle centerline to electrode tip - 1/4”
- D Nozzle face to electrode tip - 1/8”

Note: Install the burner with a 2° pitch as shown.

Air Tube Combination Codes					
Model	Tube	Dimension T	Dimension D	Code	Dimension E
CF1400	A	6.75”	5.5”	CF 66 KD	-
		10.25”	5.5”	CF 102 KD	-
		13.75”	5.5”	CF 136 KD	-
		17.75”	5.5”	CF 176 KD	-
	B	6.75”	5.75”	CF 66 KE	-
		10.25”	5.75”	CF 102 KE	-
		13.75”	5.75”	CF 136 KE	-
		17.75”	5.75”	CF 176 KE	-
CF2300	A	6.75”	6.5”	CF 66 KG	2.94”
		10.25”	6.5”	CF 102 KG	2.94”
		13.75”	6.5”	CF 136 KG	2.94”
		17.75”	6.5”	CF 176 KG	2.94”
	B	6.75”	8.125”	CF 66 KS	3.69”
		8.375”	8.125”	CF 86 KS	3.69”
		11.0”	8.125”	CF 110 KS	3.69”
		14.5”	8.125”	CF 144 KS	3.69”
		18.5”	8.125”	CF 184 KS	3.69”

Table 2 - Air tube capacity Versus firebox pressure

Air Tube Capacity vs Firebox Pressure				
Model	Tube	Firebox Pressure (In W.C.)	No Reserve Air	10% Turndown* (GPH)
CF1400	A	0.0	11.0	10.0
		0.2	10.5	9.45
		0.4	10.1	9.10
		0.6	9.6	8.64
		0.8	9.2	8.30
		1.0	8.7	7.83
	B	0.0	13.6	12.20
		0.2	13.1	11.70
		0.4	12.5	11.20
		0.6	12.0	10.80
		0.8	11.4	10.30
		1.0	10.9	9.80
CF2300	A	0.0	19.9	19.90
		0.2	19.2	19.10
		0.4	18.5	18.30
		0.6	17.9	17.60
		0.8	17.2	16.80
		1.0	16.5	16.00
	B	0.0	19.9	19.90
		0.2	19.7	19.60
		0.4	19.5	19.30
		0.6	19.4	19.10
		0.8	19.2	18.80
		1.0	19.0	18.50

Note: 10% turndown indicates sufficient reserve air to reduce the CO_2 in the flue to 90% of its value. The above ratings may vary 5% due to variations in actual job conditions.

***CF2300** can fire higher but is limited by UL requirements

❑ Stray light

CAUTION

Protect Against Stray Light Lockout

Failure to follow these instructions could cause loss of burner operation resulting in no heat, an unplanned process interruption, work stoppage and the potential for frozen plumbing or other cold weather property damage.

- The control must detect a dark, no-flame condition in order to start the burner or it will hold in the stray light lockout mode.
- Shield the burner view window from direct exposure to intense light.

❑ Dust and Moisture

WARNING

Protect Against Dust and Moisture

Wet, dusty environments could lead to blocked air passages, corrosion damage to components, impaired combustion performance and result in asphyxiation, explosion or fire.

- This burner is designed for clean, dry installations.
- Electrical controls are not protected against rain or sprayed water.
- Keep the installation clear of dust, dirt, corrosive vapors, and moisture.
- Protective covers and more frequent maintenance may be required.

Mount the burner

❑ Mount flange(s) on air tube

CAUTION

Protect the Air Tube From Overheating

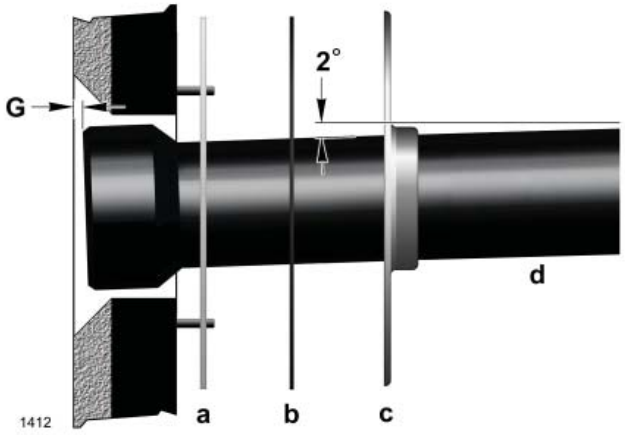
Overheating could cause damage to the air tube and other combustion components leading to equipment malfunction and impaired combustion performance.

- The end of the air tube must not extend into the combustion chamber unprotected unless it has been factory-tested and specified by the appliance manufacturer.
- Position the end of the air tube 1/4” back from flush with the refractory inside entry wall to prevent damage from overheating.

This section does not apply to burners with welded flanges.

- Do not install air tube on burner.
- For non-pressure firing flange, refer to ***Figure 4***: Install gasket (item **a**) and flange (item **c**). Ignore the next paragraph.
- For pressure-firing flange, refer to ***Figure 4***: Slide gasket (item **a**) onto the air tube, making sure the top of the air tube is up. Predrill holes in the pressure firing plate (item **b**) to match the appliance studs. Slide the pressure firing plate (item **b**) and flange (item **d**) onto the air tube as shown. Wrap ceramic fiber rope (not shown) around the air tube and press tightly into the inside diameter of the flange (item **c**).
- Slide the air tube (item **d**) into position in the appliance front. Tighten the flange-mounting-stud nuts. Set the insertion of the air tube so dimension **G** is **1/4”** nominal.
- Pitch the air tube at 2° from horizontal as shown and secure the flange to the air tube.

Figure 4 – Mount flange(s) on air tube



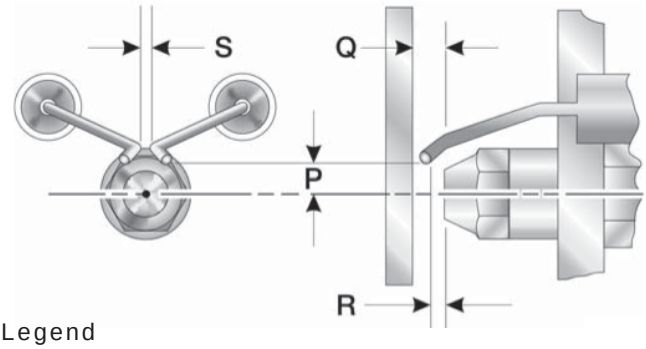
❑ Mount air tube to burner

- Remove the rear access door from the back of the burner for improved access to the interior.
- Attach the air tube to the burner with the bolts and acorn nuts provided. The acorn nuts must go on the outside of the burner, with the bolts inserted from the inside.

❑ Install nozzle

See ***Figure 5***. Install the oil nozzle in the nozzle adapter. Use a **3/4"** open-end wrench to steady the nozzle adapter and a **5/8"** open-end wrench to turn the nozzle. Tighten securely but do not overtighten.
Check, and adjust if necessary, the critical dimensions **P**, **Q**, **R** and **S** shown in the drawing. Verify that the oil tube assembly and electrodes are in good condition, with no cracks or damage.

Figure 5 – Nozzle and nozzle line assembly



Legend

S	Electrode spacing - 3/32"
Q	Nozzle to head - 1/4"
P	Nozzle centerline to electrode tip - 1/4"
R	Nozzle face to electrode tip - 1/8"

❑ Check electrode settings

WARNING **Maintain Electrode Specifications**

Failure to properly maintain these specifications could cause ignition malfunction, puff-back of hot gases, heavy smoke, asphyxiation, explosion and fire hazards.

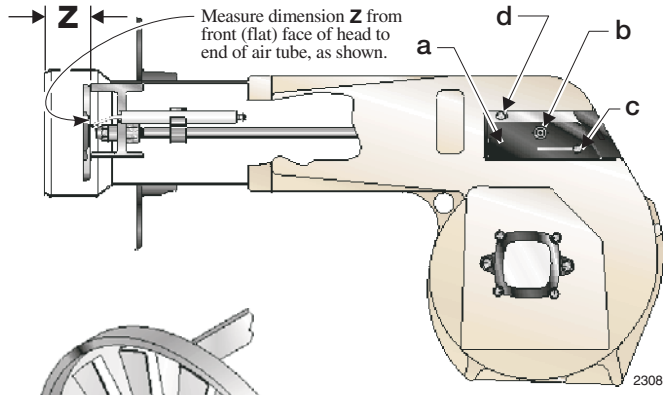
- Adjust the electrode gap and position in relation to the nozzle to the specifications shown in ***Figure 5***.

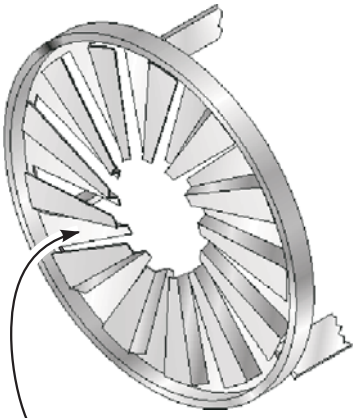
Check, and adjust if necessary, the critical dimensions shown in ***Figure 5***. Verify that the oil tube assembly and electrodes are in good condition, with no cracks or damage.

❑ Install nozzle line assembly

- Insert the nozzle line assembly into the burner air tube as in ***Figure 6.***
- See ***Figures 6 and 7***. Assemble the adjusting plate assembly per the instructions in the assembly packet.
- Slide the secondary adjusting plate (item **f**) completely to the left on the indicator adjusting plate (item **e**). Finger-tighten acorn nut (item **c**) to secure the two plates together. Slide both plates completely to the left on the primary adjusting plate (item **g**) and finger-tighten acorn nut (item **d**).
- Slide the completed adjusting plate assembly over the nozzle line end. Move the plate assembly and the nozzle line so the plate assembly fits into position as shown in ***Figure 6***.
- Install the spline nut (***Figure 6***, item **b**) on the end of the nozzle line, leaving the nut loosely placed so the plates can be moved.
- Connect the high-voltage leads from the ignition transformer to the electrodes.

Figure 6 – Nozzle line assembly in burner





Z = 1-3/4" ± 1/16"

Legend (Figure 6)

a	Adjusting plate assembly
b	Spline nut for securing nozzle line
c	Bottom acorn nut
d	Top acorn nut (for setting dim. Z only)

❑ Set dimension Z

- Replace the rear access door on the burner, making sure that the adjusting plate assembly is now securely in the groove.
- Loosen acorn nut (item **d**) in ***Figure 5***. Slide the nozzle line and plate assembly until dimension Z in ***Figure 5*** is **1-3/4 ±1/16”** (CF1400 and CF2300). When dimension Z (from end of air tube to flat area of front face of head) is correctly set, tighten acorn nut (item **d**). Verify that the adjusting plate assembly is properly seated in the groove.
- Attach the oil line from the oil valve to the nozzle line end. Tighten securely.
- Before proceeding, check dimension Z once again. Loosen acorn nut (item **d**) if necessary to reposition the nozzle line. Once dimension Z is set, **do not loosen acorn nut** (item **d**) again.

❑ Insert burner

- Position the burner in the front of the appliance and loosely tighten the nuts on the mounting studs. The burner should be pitched downward 2° as shown in ***Figures 4 and 8***.
- See ***Figure 8***. Install the pedestal support kit (recommended) by attaching the **3/4”** npt flange (item **a**) to the bottom of the burner using the (4) #10 screws provided. Cut and thread (one end only) a **3/4”** pipe nipple (item **b**) **with length 11 inches less than dimension D** in ***Figure 8***. Thread the pipe into the flange. Then slip the pipe end into the floor flange (item **c**).
- Secure the burner to the appliance by tightening the nuts on the burner flange mounting studs. Then secure the pedestal support floor flange set screw to the pipe.

Figure 7 – Adjusting plate assy.

Legend

a	Adjusting plate assembly
b	Spline nut for securing nozzle line
c	Bottom acorn nut
d	Top acorn nut (for setting dim. Z only)
e	Indicator adjusting plate
f	Secondary adjusting plate
g	Primary adjusting plate

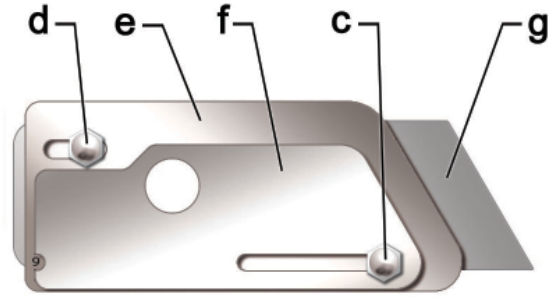
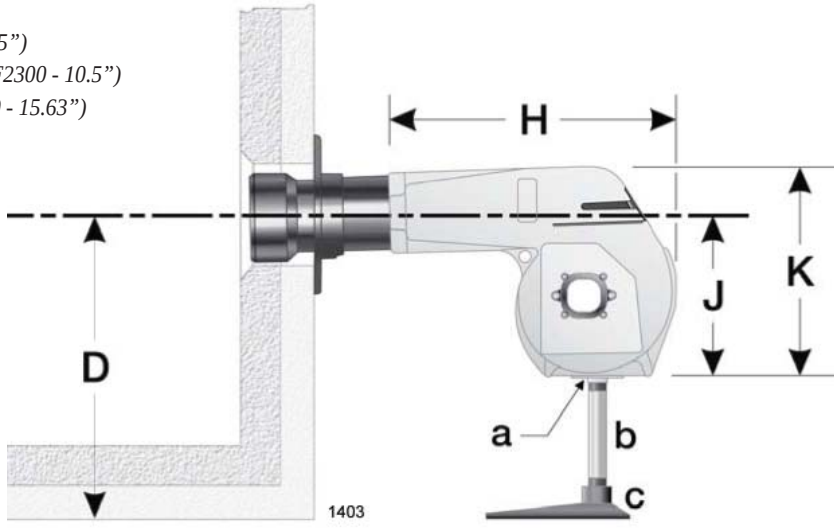


Figure 8 – Burner installed in appliance front

Legend

H	Housing total length *(CF1400 - 18”, CF2300 - 18.5”)*
J	Center to bottom of housing *(CF1400 - 10.88”, CF2300 - 10.5”)*
K	Overall housing height *(CF1400 - 13.63”, CF2300 - 15.63”)*



❑ Fuel unit by-pass plug

WARNING

Install Oil Supply To Specifications

Failure to properly install the oil supply system could cause oil leakage, equipment malfunction, puff-back of hot gases, heavy smoke, asphyxiation, explosion and fire

- Carefully install the oil supply lines, fittings and components using the guidelines provided in this section.
- The oil supply must comply with the latest edition of NFPA 31 (Canada CSA B139) and all applicable codes.
- Do NOT install valves in the return line.
- If the oil supply inlet pressure to the pump exceeds 3 psig or for gravity feed systems, install an oil safety or pressure reducing valve (Webster OSV, Suntec PRV or equivalent).

The burner is shipped with a by-pass plug installed in the fuel unit. For low/high operation, the by-pass plug must be left in the fuel unit, regardless of the fuel system used (one-pipe with by-pass loop or two-pipe). Do not remove the by-pass plug.

❑ One-pipe oil system by-pass loop

WARNING

Factory-Installed Pump Bypass Plug

Failure to follow these guidelines will cause the fuel pump seals to rupture and result in oil leakage, burner malfunction and potential fire and injury hazards.

- Models CF1400 and CF2300 are shipped with the pump bypass plug installed.
- Do not remove the bypass plug from the pump. It is required for step-firing (Lo/Hi) operation.
- Do not operate the burner unless a return line or bypass loop is installed or the pump seal will rupture.
- Carefully comply with the following instructions provided in this section of the manual.

Refer to ***Figure 9*** (item **m**). Note the addition of a field-installed by-pass loop (use 3/8" copper tubing) from the fuel unit Return port to the Inlet port. This line is required for low/high operation. It simulates the flow of a two-pipe system at the fuel unit.

❑ Oil supply/return lines

- Install the oil tank and oil lines in accordance with all applicable codes.
- Size the oil supply and return lines using the guidelines given in the fuel unit literature included in the literature envelope. Oil line flow rate will equal the burner rate for one-pipe systems. For two-pipe systems, refer to ***Table 3*** for the fuel unit gearset capacity - the rate at which fuel is recirculated when connected to a two-pipe system. Size two-pipe oil lines based on this flow rate.
- Use continuous lengths of heavy-wall copper tubing, routed under the floor where possible. Do not attach fuel lines to the appliance or to floor joists if possible. This reduces vibration and noise transmission problems.
- Install an oil filter sized to handle the fuel unit gearset flow capacity (***Table 3***) for two-pipe systems. However, size the filter for the firing rate for one-pipe systems. Locate the filter immediately adjacent to the burner fuel unit.
- Install two high-quality shutoff valves in accessible locations on the oil supply line. Locate one valve close to the tank. Locate the other valve close to the burner, upstream of the fuel filter.

❑ Burner fuel flow

One-pipe systems – See ***Figure 9*** for the fuel flow paths for high-fire and low-fire operation. The low-fire by-pass regulation is done internally for type **B** fuel units. Oil supply connects to one of the fuel unit Inlet ports.

Two-pipe systems – See ***Figure 10*** for the fuel flow paths for high-fire and low-fire operation. The low-fire by-pass regulation is done internally for type B fuel units. Oil supply connects to one of the fuel unit Inlet ports. Oil return connects to the fuel unit Return port.

Low-fire/high-fire operation – The fuel unit nozzle port pressure is factory set at 300 psig.

- At high fire, full pressure (300 psig) is applied at the oil nozzle, causing full input.
- At low fire, the by-passing is done inside the fuel unit when the by-pass valve operates.
- This by-passing of oil reduces the oil pressure at the nozzle (to between 125 psig and 175 psig), reducing the input.

Figure 9 – One-pipe oil flow with "B" pump

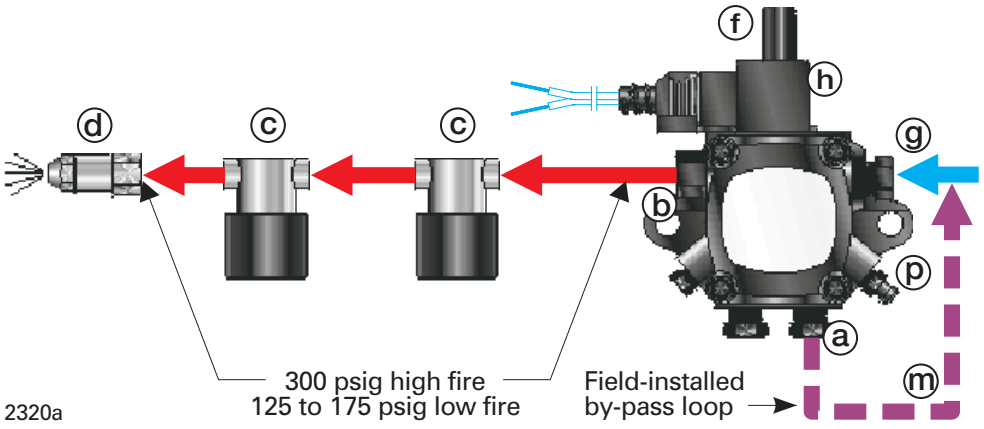
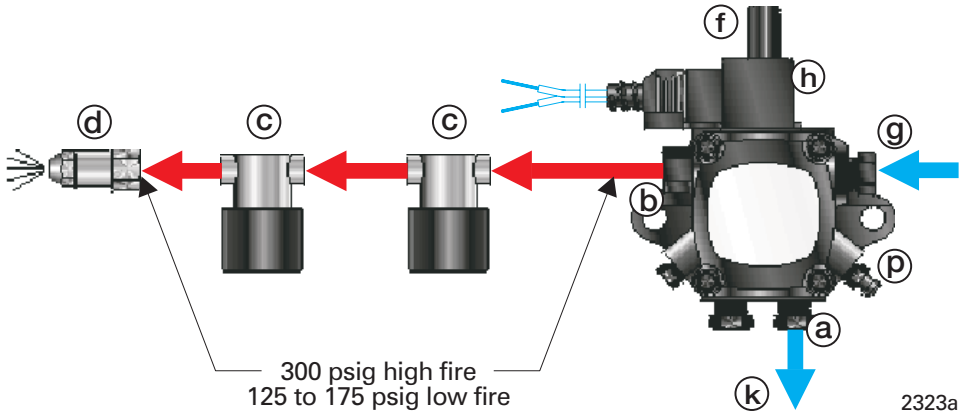


Figure 10 – Two-pipe oil flow with "B" pump



Legend (figure 9 & 10)

a	Return port
b	Nozzle port
c	Oil valves
d	Nozzle & adapter
f	By-pass pressure regulator
g	Inlet port
h	By-pass valve ("B" pump)
k	Return line to oil tank
m	One-pipe by-pass loop, 3/8"
p	Air bleed valve

Table 3 – Fuel unit gearset capacities

Model	Fuel Unit Model Number	Gearset Capacity (gph)
CF1400	B2TA-8245	21
CF2300	B2TA-8852	39

- **Nozzle pressure** – The fuel unit nozzle port pressure is factory set at 300 psig. Some original equipment manufacturer burner applications may call for a lower pressure to obtain a required firing rate. Do not change this pressure unless directed to do so by the appliance manufacturer.

Wire the burner — R7184B

WARNING **Electrical Shock Hazard**

Electrical shock can cause severe personal injury or death.

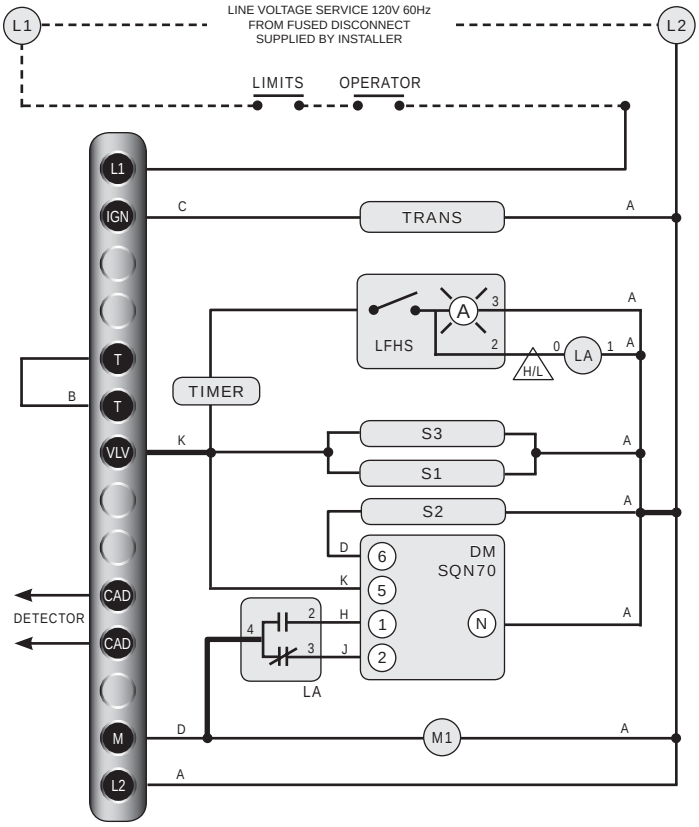
- Disconnect electrical power before installing or servicing the burner.
- Provide ground wiring to the burner, metal control enclosures and accessories. (This may also be required to aid proper control system operation)
- Perform all wiring in compliance with the National Electric Code ANSI/NFPA 70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

Install the burner and all wiring in accordance with the National Electrical Code and all applicable local codes or requirements.

Wire the burner in compliance with all instructions provided by the appliance manufacturer. Verify operation of all controls in accordance with the appliance manufacturer's guidelines.

See ***Figure 11*** for a typical wiring diagram, with R7184 oil primary, for reference purposes only.

Figure 11. - Typical wiring (R7184B)



Legend

CC	Flame sensor, cad cell typical
DM	Damper motor
FD	Fused Disconnect, by others
F-F	Cad cell flame sensor terminals
H/L	Low/high control wiring tag
LFHS	Low fire hold switch
LM	Limit controls, by others
M1	Burner motor
OP	Operating controls, by others
PR	Oil primary control, R7184 typ.
S2	High/low valve
S1, S3	On/off valve
TR	Ignition transformer
T-T	24-volt thermostat/limit terminals

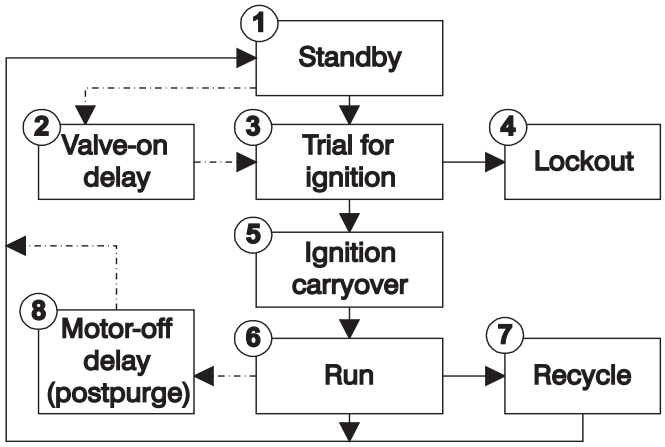
Sequence of operation — typical

Install the burner and all wiring in accordance with the National Electrical Code and all applicable local codes or requirements.

Wire the burner in compliance with all instructions provided by the appliance manufacturer. Verify operation of all controls in accordance with the appliance manufacturer's guidelines.

Sequence of operation — typical

1. **Standby** — The burner is idle, waiting for a call for heat. When a call for heat is initiated, there is a 3- to 10-second delay while the control performs a safe start check.
2. **Valve-on delay** — As applicable, the ignition and motor are turned on for a 15-second prepurge.
3. **Trial for ignition (TFI)** — The fuel valve is opened, as applicable. A flame should be established within the 15-second lockout time (30-second lockout time is available).
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. Call a qualified service technician.
5. **Ignition carryover** — Once flame is established, the ignition remains on for 10 seconds to ensure flame stability. It then turns off.
6. **Run** — The burner runs until the call for heat is satisfied. The burner is then sent to burner motor-off delay, as 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 ignition steps outlined above. If the flame is lost three times in a row, the control locks out to prevent continuous cycling with repetitious flame loss caused by poor combustion.
8. **Burner motor-off delay** — If applicable, the fuel valve is closed and the burner motor is kept on for the selected postpurge time before the control returns the burner to standby.



Resetting to OHM

- If the control locks out three times in a row without a complete heat cycle between attemps, the lockout becomes restricd. A qualified service technician should be called to inspect the burner.

Prepare the burner for start-up

WARNING **Professional Installation and Service Required**

Incorrect installation and mishandling of start-up could lead to equipment malfunction and result in asphyxiation, explosion or fire.

- This burner must be installed and prepared for start-up by a qualified service technician who is trained and experienced in commercial oil burner system installation and operation.
- Do not attempt to start the burner unless you are fully qualified.
- Do not continue with this procedure until all items in the "Prepare the burner for start-up" section have been verified.
- Carefully follow the wiring diagrams, control instruction sheets, flame safeguard sequence of operation, test procedures and all appliance manufacturer's directions that pertain to this installation.
- If any of these items are not clear or are unavailable, call Beckett at 1-800-645-2876 for assistance.

WARNING **Do Not Bypass Safety Controls**

Tampering with, or bypassing safety controls could lead to equipment malfunction and result in asphyxiation, explosion or fire.

- Safety controls are designed and installed to provide protection.
- Do not tamper with, or bypass any safety control.
- If a safety control is not functioning properly, shut off all main electrical power and fuel supply to the burner and call a qualified service agency immediately.

CAUTION **Keep Service Access Covers Securely Installed**

These covers must be securely in place to prevent electrical shock, damage from external elements, and protect against injury from moving parts.

- All covers or service access plates must be in place at all times except during maintenance and service.
- This applies to all controls, panels, enclosures, switches, and guards or any component with a cover as part of its design.

Start-up checklist – Verify the following before attempting to start burner.

- ☐ Combustion air supply and venting have been inspected and verified to be free of obstructions and installed in accordance with all applicable codes.
- ☐ Oil nozzle has been selected correctly and securely installed in the nozzle adapter.
- ☐ Fuel unit by-pass plug ***has not*** been installed for one-pipe oil system.
- ☐ By-pass plug ***has been*** installed for two-pipe oil system.
- ☐ Fuel connection to nozzle line assembly is secure.
- ☐ Dimension Z has been set per this instruction manual.
- ☐ Fuel supply line is correctly installed, the oil tank is sufficiently filled, and shut-off valves are open.
- ☐ Burner is securely mounted in appliance, with pressure firing plate and gasket installed for pressurized chamber application.
- ☐ Appliance has been filled with water (boilers) and controls have been operationally checked.
- ☐ Burner has been installed in accordance with appliance manufacturer's instructions (when available).
- ☐ Also refer to appliance manufacturer's instructions (when available) for start-up procedures.

❑ Z dimension

Should be set per these instructions (see **page 10**). The top acorn nut (***Figure 12***, item **d**) should never be loosened once the Z dimension is initially set.

❑ Adjusting plate assembly (Figure 12)

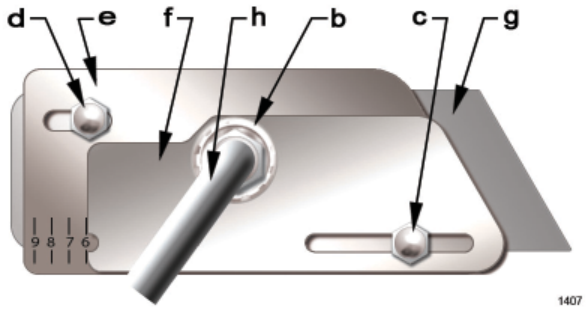
Make sure spline nut (item **b**) and bottom acorn nut (item **c**) are loose before proceeding to next section.

❑ Initial head position (Figure 12)

The indicator plate assembly (item **e**) markings correspond to head position settings.

- Slide the secondary adjusting plate (item **f**) toward the rear of the burner until the number on the indicator plate corresponds to the initial head setting given in ***Tables 4a*** and ***4b*** for the desired firing rate and burner (high-fire).
- ***Figure 12*** shows a typical example, with a head setting of 6.
- When the head position has been set, tighten the bottom acorn nut (item **c**) and the spline nut (item **b**).

Figure 12 – Adjusting plate initial setting, typical



Legend

- b Spline nut for securing nozzle line
- c Bottom acorn nut (for head adjustments)
- d Top acorn nut (for setting dim. Z only - do not loosen after setting Z)
- e Indicator adjusting plate
- f Secondary adjusting plate
- g Primary adjusting plate
- h Copper oil line from oil valve to nozzle line

Table 4a. CF1400 Initial indicator adjustment plate settings

	Tube	Head Position		Damper Position	
		Approximate Head Setting	Firing Rate (gph)	Approximate Air Damper Setting	Firing Rate (gph)
CF1400	A	0	4.00	0	--
		1	4.50	10	--
		2	5.00	20	4.00
		3	6.00	30	5.00
		4	7.00	40	7.00
		5	7.50	50	8.00
		6	8.00	60	10.00
		7	9.00	70	11.00
		8	9.50	80	--
		9	10.00	90	--
		10	11.00	100	--
		--	--	110	--
		--	--	120	--
	B	0	7.00	0	--
		1	7.50	10	--
		2	8.00	20	--
		3	9.00	30	--
		4	10.00	40	7.00
		5	10.50	50	8.00
		6	11.00	60	10.00
		7	12.00	70	11.00
		8	13.00	80	12.00
		9	13.25	90	12.50
		10	13.60	100	13.00
		--	--	110	13.25
		--	--	120	13.60

Table 4b. CF2300 Initial indicator adjustment plate settings

	Tube	Head Position		Damper Position	
		Approximate Head Setting	Firing Rate (gph)	Approximate Air Damper Setting	Firing Rate (gph)
CF2300	A	0	11.0	0	--
		1	12.0	10	7.0
		2	13.0	20	10.0
		3	14.0	30	13.0
		4	15.0	40	14.0
		5	16.0	50	15.0
		6	17.0	60	16.0
		7	18.0	70	17.0
		8	19.0	80	18.0
		9	20.0	90	19.0
		--	--	100	20.0
	B	0	12.5	0	--
		1	13.0	10	10.0
		2	14.0	20	13.0
		3	15.0	30	14.0
		4	16.0	40	15.0
		5	17.0	50	16.0
		6	18.0	60	17.0
		7	18.5	70	18.0
		8	19.0	80	18.5
		9	20.0	90	19.0
		--	--	100	20.0

❑ Initial air settings

The following steps outline the procedure for initially setting the damper. Refer to ***Figure 13*** and ***Tables 4a*** or ***4b*** for this procedure.

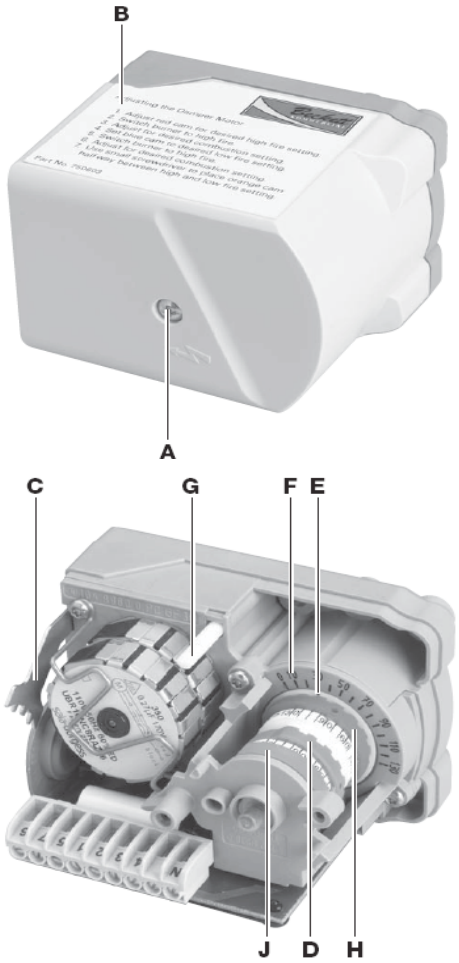
1. Remove the cover screw (**A**) then the cover (**B**) and place to one side.
2. Using the wrench (**C**) supplied with the damper motor, adjust the blue low fire cam (**D**) to the initial setting listed in ***Tables 4a*** or ***4b***.
3. Using the same wrench, adjust the red high fire cam (**H**) to the initial settings listed in ***Tables 4a*** or ***4b***.
4. Ensure the damper plate is in the correct position. The cam notch (**E**) should align with the low fire setting on the damper motor scale (**F**).
5. If the damper plate is not in the correct position, disengage the motor by pushing in on the motor pin (**G**), then rotating the damper plate until the cam notch and motor scale setting are aligned. Re-engage the pin.
6. To adjust the high fire transition, use a small straight edge screw driver, turn the white adjustment screw, located in the orange transition cam, either clockwise or counterclockwise until the cam indicator is half way between the high and low settings on the scale.
    - Rotate the air adjusting plate until the lower edge of the pointer is opposite the number from ***Tables 4a*** or ***4b*** corresponding to the desired low fire rate.
    - This initial setting should be adequate for starting the burner at low fire. Once the burner is in operation, the air setting will be adjusted for best performance as discussed later in this manual.
    - Follow the procedures described later in this manual to fine tune the air settings.

NOTICE

The damper plate is attached by screws to its shaft, and bears against a flat on the shaft for alignment. The shaft is secured to the damper motor by a sleeve coupling with two setscrews bearing against the damper shaft and two more against the motor shaft. The motor shaft has a flat matching the one on the damper shaft. The flats on the damper shaft and the motor shaft should be aligned so that the position indicator in the damper motor reads accurately. The best way to align the flats is to tighten the setscrews that bear against the flats on the shafts first, and then tighten the ones that bear against the round surface of the shafts afterward.

The test for proper alignment is to disengage the damper motor from its shaft using the disengaging pin (Item **G** in ***Figure 13B***) and rotate the damper plate to its full closed position. The position indicator should point to 0° within + 5° tolerance.

Figure 13 - Damper Motor



Legend (figure 13)

A	Cover screw	F	Damper motor scale
B	Cover	G	Disengaging pin
C	Wrench	H	High fire cam (red)
D	Low fire cam (blue)	J	Transition cam (orange)
E	Cam notch		

❑ Set appliance limit controls

- Set the appliance limit controls in accordance with the appliance manufacturer's recommendations.
- Move the low-fire hold switch (not shown) to the low fire hold position. This will hold the burner in low fire during initial start-up.

❑ Prepare the fuel unit for air venting

- To vent air from one-pipe oil systems, attach a clear hose to the vent plug on the fuel unit. Provide a container to catch the oil. Loosen the vent plug.
- Vent the air as described under 'Start the Burner'.

Start the burner

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.

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.

Do not proceed unless all prior steps in this manual have been completed.

❑ Start burner and vent air from oil line

WARNING **Hot Gas Puff-back and Heavy Smoke Hazard**

Failure to bleed the pump properly could result in unstable combustion, hot gas puff-back and heavy smoke.

- Do not allow oil to intermittently spray into a hot combustion chamber while bleeding.
- Install a gauge in the nozzle discharge port tubing or fully open the pump bleed valve to prevent oil spray from accumulating in the combustion chamber when venting air from the fuel pump.
- Ensure that all bubbles and froth are purged from the oil supply system before tightening the pump air bleed valve.

❑ Disable function

- Any time the motor is running, press and hold the reset button to disable the burner. The burner will remain off as long as the button is held and will return to standby when released.

❑ CAD cell resistance check

- While the burner is firing, and after the ignition has been turned off, press and release the reset button (hold 1/2 second or less) to check the cad cell resistance. The LED will flash 1 to 4 times, depending on the cad cell resistance (refer to the table below).

Number of LED flashes	Cad Cell Resistance (ohms)
1	Normal (0 to 400)
2	Normal (400 to 800)
3	Normal (800 to 1600)
4	Limited (1600-Lockout)*

** Lockout can occur above 4000 ohms.*

LED Indicator	Status
On	Flame sensed
Off	Flame not sensed
Flashing (1/2 sec off - 1/2 sec on)	Lockout/Restricted Lockout
Flashing (2 sec off - 2 sec on)	Recycle

❑ Operating the burner

1. Move the **low-fire hold** switch to the **low fire hold** position (to hold burner in low fire when started).
2. Verify that the air adjusting cam (***Figure 13b***, item **d**) has been set to the initial low-fire air setting as described under Initial air settings.
3. Open the oil shutoff valves in the oil supply (and return) line(s) to the burner.
4. Set the thermostat (or operating control) to call for heat.
5. Close the line switch to the burner. The burner motor should start immediately.
6. If the burner motor does not start, reset the motor overload switch (if so equipped) and press the reset switch of the burner primary control.
7. Vent the fuel unit as soon as the burner motor starts rotating. To vent —

   - Attach a clear plastic tube to the air bleed valve (***Figure 9 or 10*** **as applies, item p**).
   - Place the end of the tube in a container to catch the oil. Then loosen the fuel unit air vent valve.
   - Tighten the air vent valve after all air has been purged.
   - **IF burner stops during venting** —
     - The burner primary control will lockout if flame is not established within its time limit. This is typically 15 seconds for R7184B primary controls, but may be less for other flame supervisory controls.
     - The burner may lockout several times during the period needed to purge all the air. To extend air venting time, press the red reset button for 1/2 second during the prepurge cycle to continue purging.
   - **IF burner stops after flame established** —
     - Additional venting is probably required. Repeat the air venting procedure.
8. Once flame is steady, proceed to Set high-fire air.

❑ Set high-fire air

1. Allow the burner to run at **low fire** until the appliance has warmed sufficiently.
2. Visually check the flame. The flame should not be dark orange or smoky. If the flame appears to be smoking, increase the amount of air by readjusting the damper indicator to a higher number.
3. Once the appliance has warmed, the **high-fire** setting can be checked and adjusted.
4. Locate the approximate air adjusting plate setting for **high fire** in ***Table 4a*** **or** ***4b***.
5. Place the **low-fire hold** switch in the **high-fire position**. The damper motor will begin to rotate after four seconds.
6. Use combustion test instruments to adjust the burner.
   a. Adjust the air by moving the red cam to a lower number until a trace of smoke is achieved with CO_2 level as high as possible (lowest possible O_2). **Example**: 13.5% CO_2 (2.5% O_2) with a trace of smoke.
   b. Increase the air by increasing the red cam number to reduce CO_2 by 2 percentage points at a zero smoke level. (Increase O_2 by 3 percentage points at a zero smoke level.)
   Example: Reduce CO_2 from 13.5% to 11.5%, with zero smoke (or increase O_2 from 2.5% to 5.5%).
   c. A margin of reserve air has been added to accommodate variable conditions.
7. Check the breech draft pressure against the appliance manufacturer's recommended setting (typically + 0.1" W.C.).
8. If the breech pressure is higher or lower than recommended level, adjust the appliance breech damper to achieve the specified setting. Recheck the smoke and CO_2 levels. Adjust burner air if necessary.
9. Once all settings are complete and satisfactory, proceed to 'Set low-fire air'.

❑ Set low-fire air

1. Move the **low-fire hold** switch from the **"High Fire position"** to the **"Low Fire Hold"** position.
   a. The damper will return to the **low-fire** air setting.
2. Check the smoke and CO_2 (O_2) levels.
   a. Pull a smoke sample from the flue.
   b. The sample should be clean (zero smoke level).
   c. Check the CO_2 (O_2) level:
   CO_2 should be at 11 to 12% (O_2 at 5.9 to 4.5%).
   If the CO_2 is less than 11% (O_2 more than 5.9%), decrease the air and check the smoke level.
3. Operate the burner from **low fire** to **high fire** and back to verify operation.
4. Turn the burner off. Wait one or two minutes (for chamber to clear) and then turn on again to verify starting characteristics.
5. Perform limit circuit performance test specified by appliance manufacturer to verify operation of burner/appliance combination.

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.

Annual Service

- ❒ 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.

Monthly maintenance — by owner

- ❒ Observe combustion air openings and vent system for integrity. Openings must be clean and free of obstructions.
- ❒ Check oil lines and fittings to verify there are no leaks.
- ❒ Observe burner ignition and performance to verify smooth operation.
- ❒ Shut the system down if you observe abnormal or questionable operation. Call a qualified service agency for professional inspection and service.

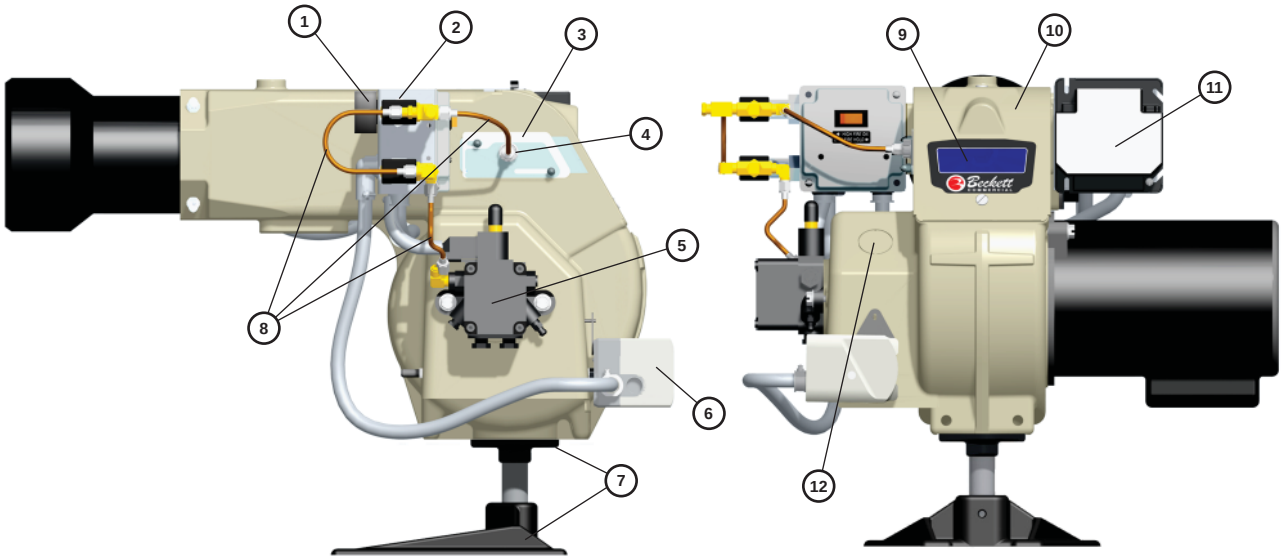
See next page for Beckett replacement parts ▶

Replacement Parts

For best performance specify genuine *Beckett* replacement parts

Item	Part Name	Description		Part No.
1	Timer	Nozzle valve delay		21295U
2	Oil Valve	Box mounted		21789U
3	Knurled Nut	All models		3666
4	Adjusting plate assembly	w/ cast aluminum door w/ stamped sheet-metal door		5994U 5201701U
5	Fuel pump	B2TA-8245 H3PAN-C150H		21313U 21309U
6	Damper motor	2-stage		750601U
7	Pedestal kit	All models		51193
8	Fuel lines	Specify length		-
9	Sight glass	All models		31346
10	Rear cover door assembly	w/ cast aluminum door* w/ stamped sheet-metal door*	CF1400 CF2300 CF1400 CF2300	5994U 51204U 5201301U 5201302U
11	Control	Specify		-
12	Coupling hole plug Coupling access door	use with threaded hole use with rectangular opening		32439U 16703GY
13	Head assembly	CF1400 CF2300		5978 51203
14	Electrode assembly	All models		51212
15	Ignition leads	8-1/4” long 11-3/4” long 15-1/4” long 19-1/4” long		5990082 5990116 5990152 5990192
16	Nozzle line assembly	Refer to ***Figure 5, Page 9***		
17	Air tube	Refer to ***Figure 4, Page 8***		
18	Transformer	12,000 volt		51214
19	Coupling	B pump H pump		21290 21308
20	Blower wheel	CF1400 - 5.59” x 3.09” CF2300 - 6.75” x 3.13”		21268U 21267U
21	Motor	120/208-230 single phase 208-230/460 three phase	CF1400 CF2300 CF1400 CF2300	21401U 21402U 21638U 21499U
	Motor relay (not shown)	120V single phase 208V single phase three phase		7273 7300 2194301
	Adjustable flange	see ***Figure 15*** on opposite page		

Figure 14 – Burner Replacement Parts



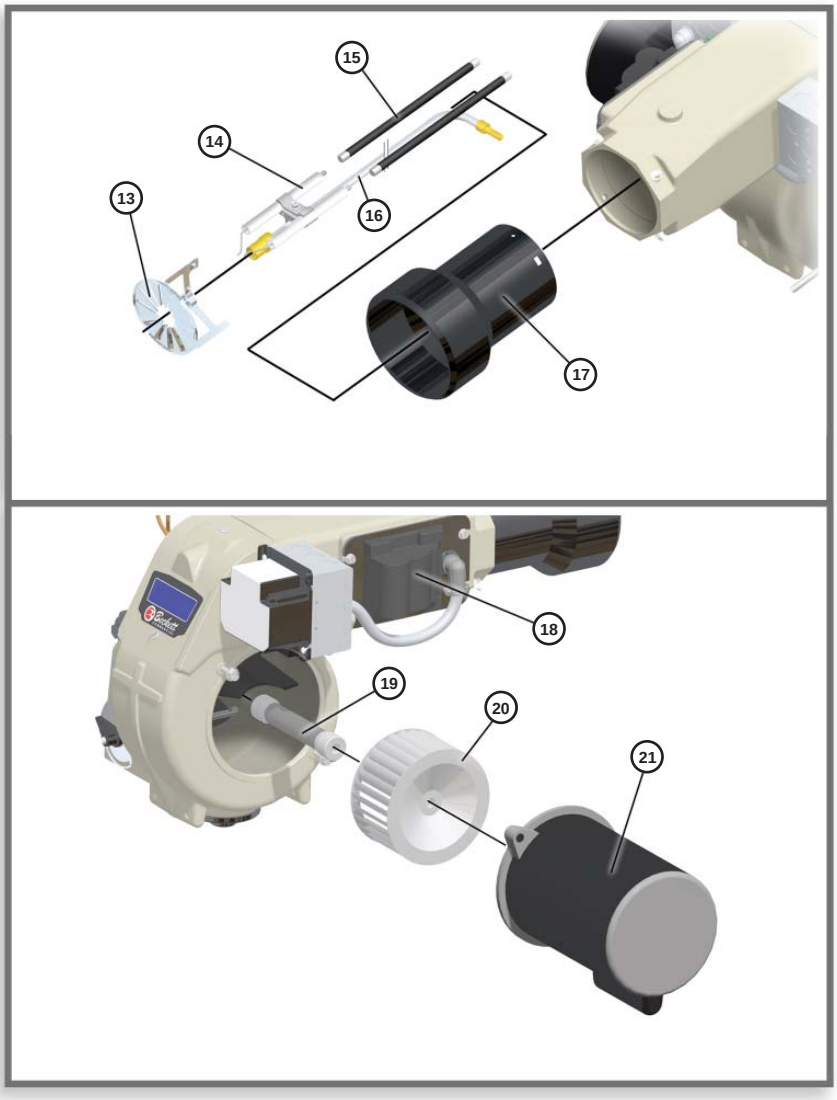
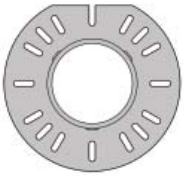
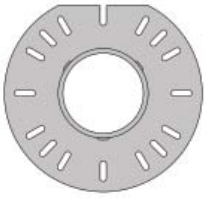


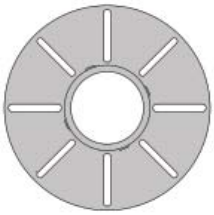
Figure 15 – Adjustable mounting plates



Flange A



Flange B



Flange C

Model	Flange **A**	Flange **B**	Flange **C**
CF1400	51312 (10.00" DIA.)	n/a	51629 (12.25" DIA.)
CF2300	51313 (12.44" DIA.)	51498 (13.92" DIA.)	51630 (16.00" DIA.)

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

INSTALLATION INFORMATION

SUNTEC industries incorporated

MODEL A SINGLE STAGE TWO-STEP
MODEL B TWO-STAGE TWO-STEP FUEL UNITS AND
MODEL B TWO-STAGE HIGH PRESSURE FUEL UNITS

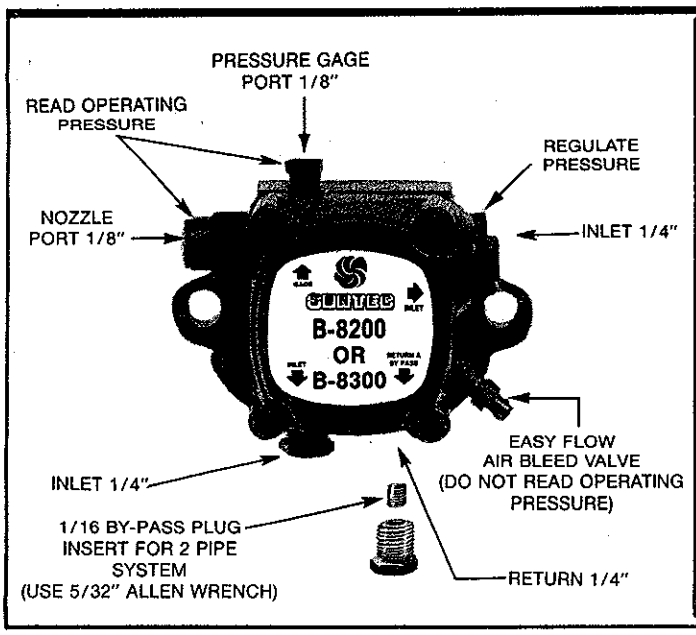


FIGURE 1

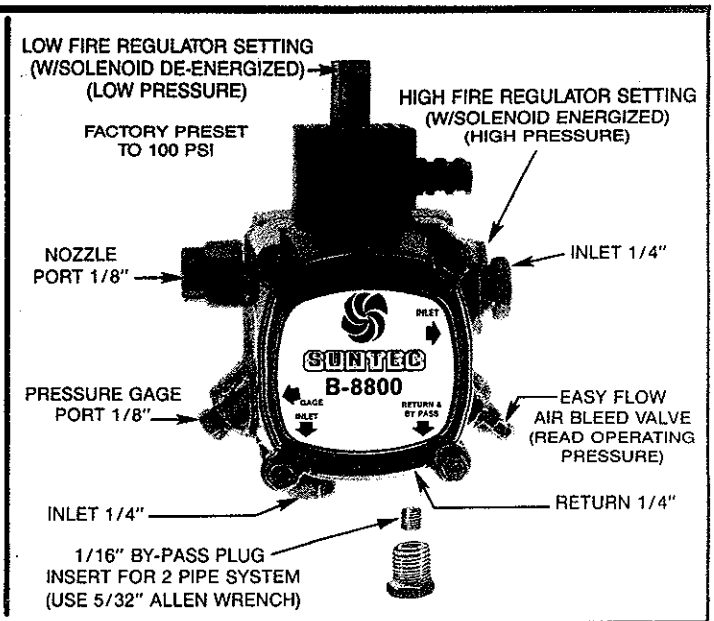


FIGURE 2

ONE-PIPE SYSTEM • FIGURE 3

DO NOT INSTALL BYPASS PLUG! Connect inlet line to pump inlet. Start burner. Arrange primary burner control for continuous operation during purging. Open easy flow bleed valve 1 turn CCW. Bleed unit until all air bubbles disappear — HURRIED BLEEDING WILL IMPAIR EFFICIENT OPERATION OF UNIT. Tighten easy flow bleed valve securely.

TWO-PIPE SYSTEM • FIGURE 4

REMOVE 1/16" BY-PASS PLUG FROM PLASTIC BAG ATTACHED TO UNIT. Remove 1/4" plug from return port. Insert by-pass plug (See Figure 1 or 2), tighten plug. Attach return and inlet lines. Start burner — Air bleeding is automatic. Opening Easy Flow Air Bleed Valve will allow a faster bleed if desired. Return line must terminate 3-4" above supply line inlet. (See Figure 4). Failure to do this may introduce air into the system and could result in loss of prime.

TWO STEP PUMPS • FIGURE 2

MODEL SHOWN IS RIGHT HAND ROTATION; ALL PORTS ARE REVERSED FOR LEFT HAND ROTATION.

SOLENOID WIRING Refer to burner manufacturer's manual for instructions.

NOTE: Wiring of the solenoid in parallel with the safety control circuit will bypass the low fire regulator.

REGULATOR SETTING Install pressure gage in gage port (remove after adjustment) with proper nozzle in nozzle line

- Low Fire — Factory preset to 100 PSI with rated nozzle.
- High Fire — With solenoid energized adjust high fire regulator to desired pressure. (Range 200 to 300 PSI)

NOTE: EXTERNAL CUTOFF VALVE (120V MAXIMUM) IS REQUIRED.

GENERAL INFORMATION • ALL SYSTEMS

IMPORTANT INFORMATION Long or oversized inlet lines may require the pump to operate dry during initial bleeding period. In such cases, the priming may be assisted by injecting fuel oil into the pump gearset. Under lift conditions, oil lines and fittings must be air tight. To assure this, "Pipe Dope" may be applied to both the used and unused inlet and both return fittings. DO NOT USE TEFLON TAPE!! DO NOT USE COMPRESSION FITTINGS!!

MOUNTING POSITION Model "A" Single Stage Fuel Unit may be mounted in any position. Model "B" Two Stage Fuel Unit may be mounted in any position except upside down (1/8" ports pointed down).

VACUUM CHECK A Vacuum Gage may be installed in either of the 1/4" inlet ports or in the 1/8" return port (on single pipe installations), whichever is most convenient. The Model "A" pump should be used where the vacuum does not exceed 6" hg. single pipe and 12" hg. two pipe. The Model "B" should be used where vacuum does not exceed 17" hg. Running vacuum is the total of all pressure drops (ΔP) from the tank to the inlet of the pump.

CAUTION

Pressurized or gravity feed installations must not exceed 10 P.S.I. on inlet line or return line at the pump. A pressure greater than 10 P.S.I. may cause damage to the shaft seal.

ONE-PIPE SYSTEM • MODEL A

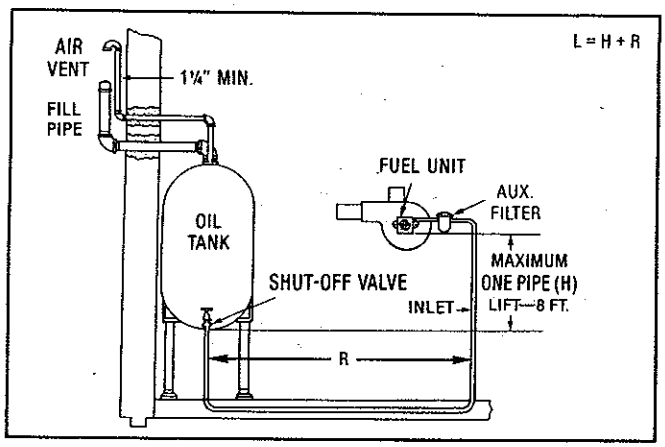


FIGURE 3

The SUNTEC MODEL "A"-70 FUEL UNIT may be installed ONE-PIPE with Gravity Feed or Lift.

The maximum allowable lift is 8 ft. — See Figure 3.

IMPORTANT: One-pipe installations must be absolutely air tight or leaks or loss of prime may result. Bleed line and fuel unit completely. **Bleed for 15 seconds after last air is seen from easy flow to be certain lines are air free.**

L = Line Length in Feet H = Head in Feet Q = Firing Rate in GPH

3/8" line $L = \frac{6 - .75H}{.0086\ Q}$ 1/2" line $L = \frac{6 - .75H}{.00218\ Q}$

If tank is above pump change - to +. Fittings, valves, and filters will reduce total length allowed.

TWO-PIPE SYSTEM • MODEL A AND B

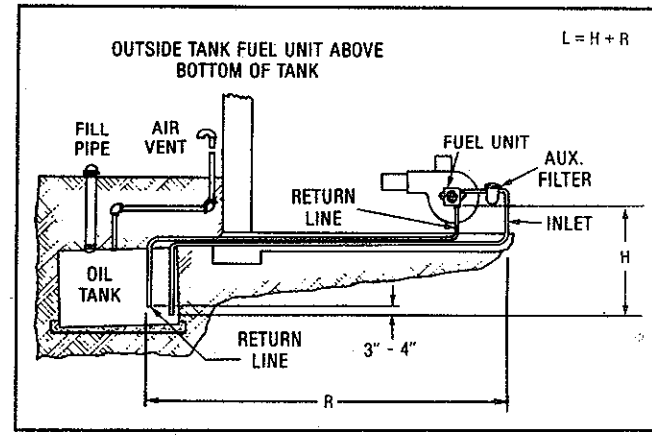


FIGURE 4

Always terminate return line as shown in Figure 4. Line lengths include both vertical and horizontal lengths.

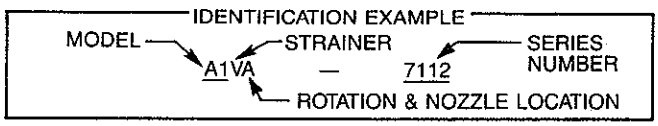
MODEL A SINGLE-STAGE TWO-STEP • TWO-PIPE MAXIMUM LINE LENGTH (H + R)

Lift "H" Figure 4	3450 RPM					
	3/8" OD Tubing		1/2" OD Tubing			5/8" OD Tubing
	10 GPH	16 GPH	10 GPH	16 GPH	23 GPH	23 GPH
0'	33'	29'	100'	100'	72'	100'
1'	31'	27'	100'	100'	66'	100'
2'	28'	25'	100'	98'	59'	100'
3'	25'	23'	100'	89'	53'	100'
4'	23'	20'	92'	80'	46'	100'
5'	21'	18'	82'	72'	40'	100'
6'	18'	16'	72'	63'	34'	100'
7'	16'	14'	62'	55'	27'	88'
8'	13'	12'	52'	46'	20'	72'
9'	11'	9'	43'	37'	14'	56'
10'	—	—	33'	29'	8'	39'

MODEL B TWO-STAGE TWO-STEP AND TWO-STAGE HIGH-PRESSURE • TWO-PIPE MAXIMUM LINE LENGTH (H + R)

Lift "H" Figure 4	3450 RPM					
	3/8" OD Tubing		1/2" OD Tubing			5/8" OD Tubing
	10 GPH	16 GPH	10 GPH	16 GPH	23 GPH	23 GPH
0'	70'	60'	100'	100'	100'	100'
2'	64'	55'	100'	100'	100'	100'
4'	58'	50'	100'	100'	100'	100'
6'	52'	44'	100'	100'	100'	100'
8'	45'	39'	100'	100'	100'	100'
10'	39'	34'	100'	100'	100'	100'
12'	33'	28'	100'	100'	94'	100'
14'	27'	23'	100'	91'	76'	100'
16'	21'	18'	81'	70'	59'	100'
18'	—	—	57'	49'	41'	100'

PUMP USAGE IDENTIFICATION



STRAINER TYPE	UL Strainer Rating (GPH)* #2 Fuel Oil
V	3
Y	7
T	23
G	34

*Max. firing rate not to exceed max. nozzle capacity or strainer rating whichever is LESS. A greater firing rate requires a suitable external strainer.

ALL INSTALLATIONS SHOULD BE MADE WTH LOCAL AND NATIONAL CODES.

SUNTEC industries incorporated

GLASGOW, KY 42142-5000

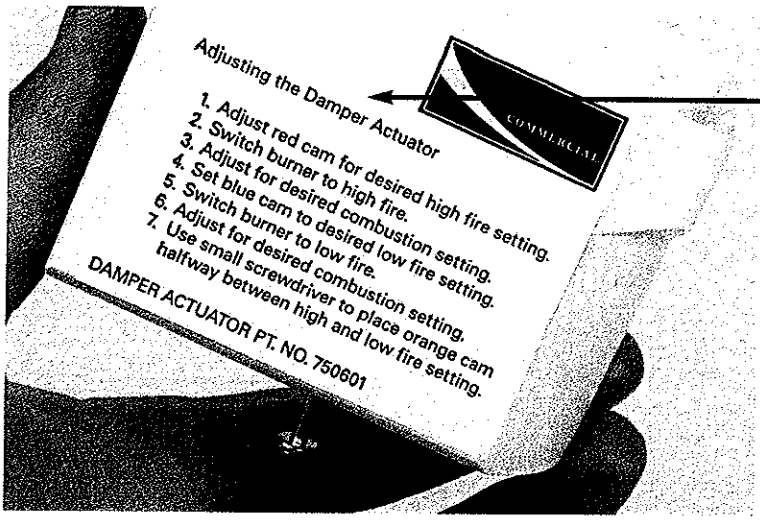
... working harder to serve you even better.

Form No. 2130
December 1995

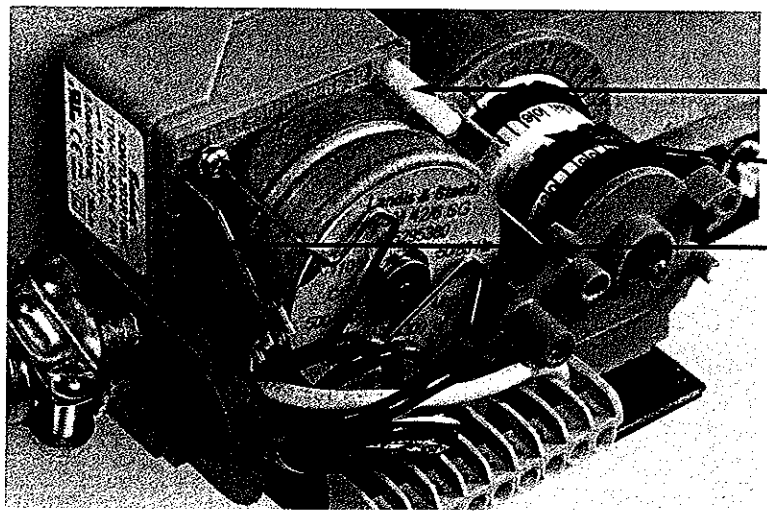
Beckett

Damper Actuator

For Commercial Two-Stage Burners
Adjustment Instructions



Adjustment Instructions Printed on Cover



Disengaging Pin in the Engaged (out) Position

Cam Stack

Adjustment Wrench

The **Disengaging Pin** allows the Damper and Cam Stack to be rotated by hand.

The **Disengaging Pin** *must be in the engaged position (out) when the burner is operating.*

Damper Position Indicator (Notch in White Ring)

Damper Position Scale

Red High Fire Cam with White Adjustment Scale

Blue Low Fire Cam with White Adjustment Scale

Transition Cam shares Adjustment Scale

Beckett

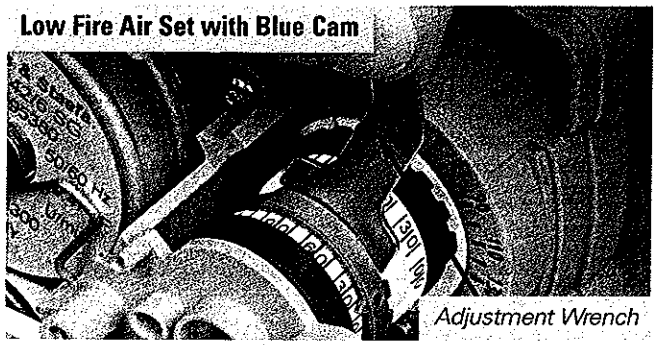
Damper Actuator

For Commercial Two-Stage Burners

Adjustment Instructions

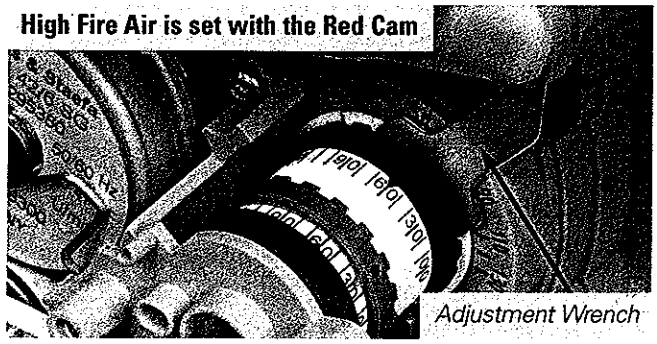
Setting the High Fire Air and Low Fire Air

Low Fire Air Set with Blue Cam



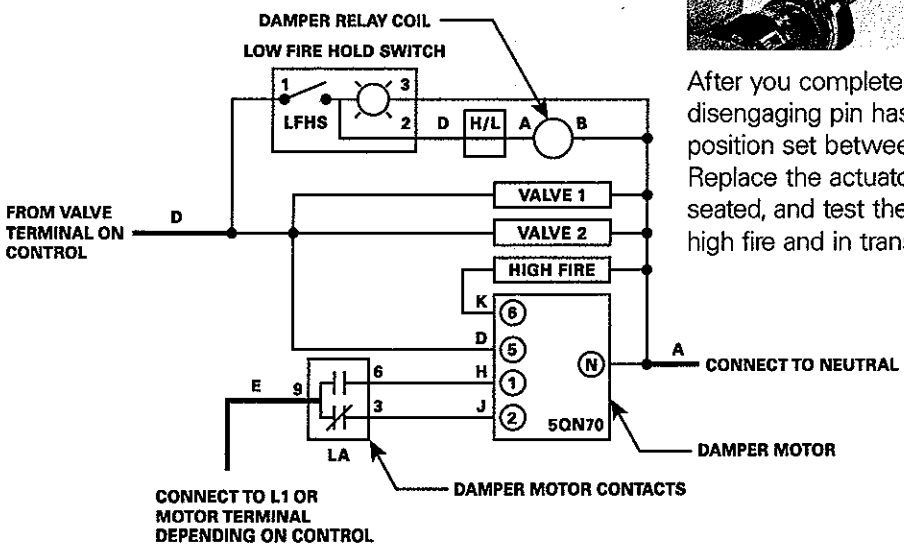
Adjustment Wrench

High Fire Air is set with the Red Cam



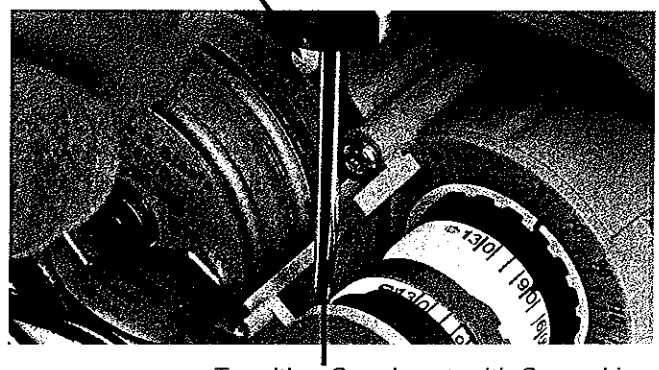
Adjustment Wrench

An old air setting specification of 7 is equal to 70° on the damper position scale of this new damper actuator.
If adjusting the air settings while the burner is operating, it is necessary to cycle the burner from High to Low Fire or Low to High by using the lighted low fire hold switch.



Setting the Transition

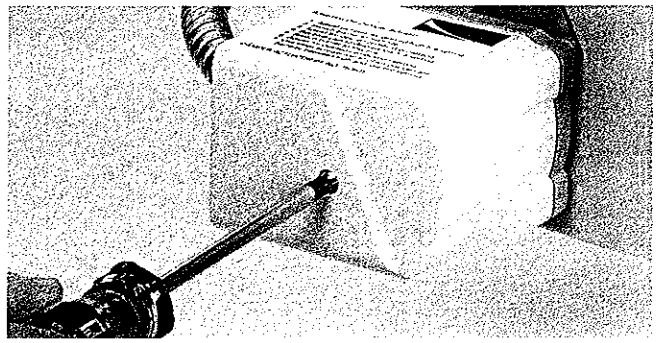
Cam is disengaged



Transition Cam is set with Screwdriver

The **ORANGE CAM** sets the transition point between Low Fire Oil and High Fire Oil.

It should be set halfway between the settings of the RED Cam and the BLUE Cam.

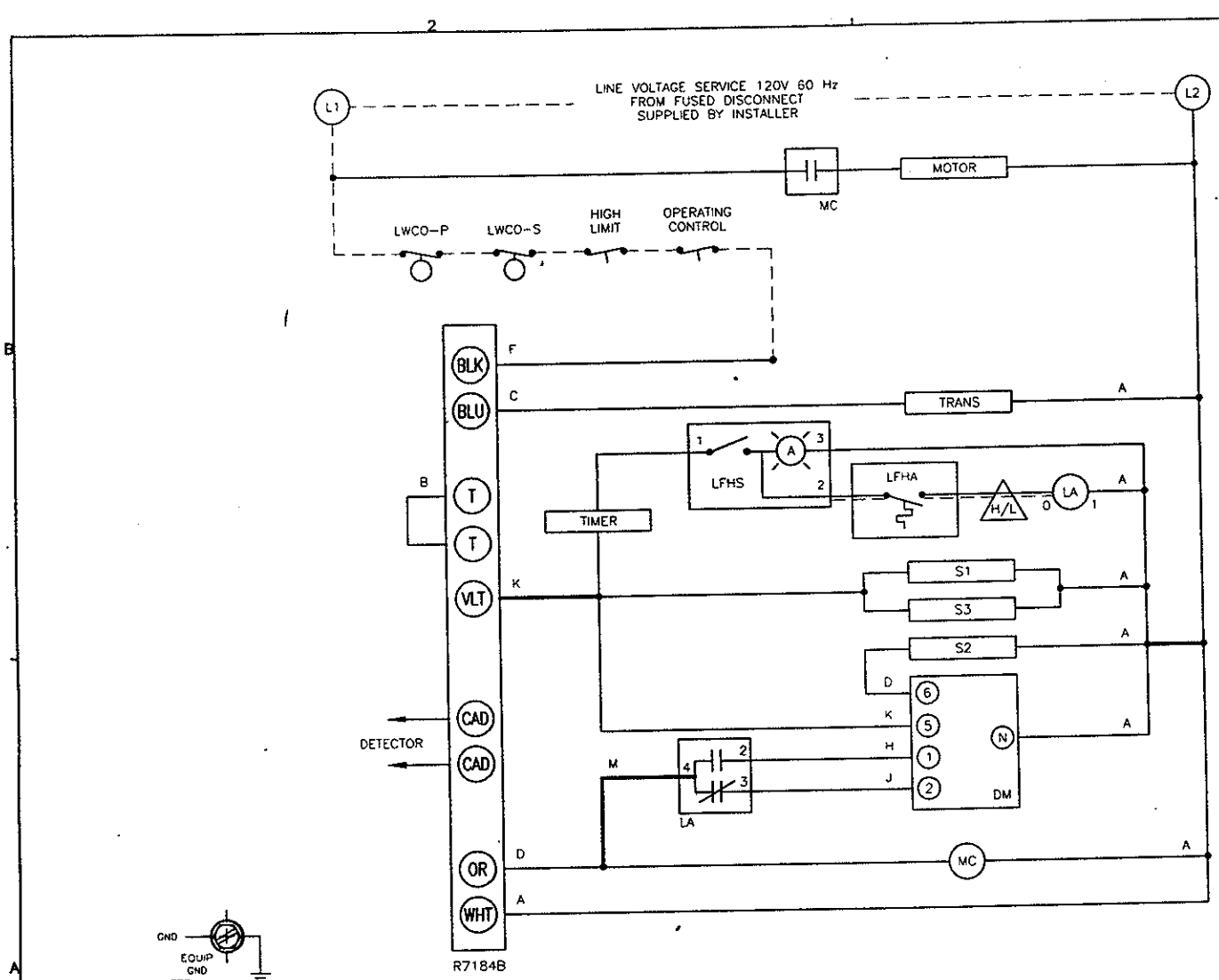


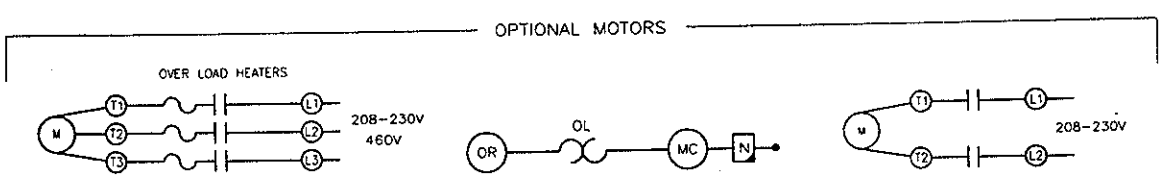
After you complete your adjustments make certain the disengaging pin has been reengaged with the damper position set between the high fire and low fire limits. Replace the actuator cover, making sure it is correctly seated, and test the burner for proper firing at low fire, high fire and in transition between low and high.

For more information, contact: **www.beckettcorp.com**

R.W. Beckett Corporation • P.O. Box 1289 • Elyria, Ohio 44036 • (800) 645-2876 • (440) 327-1060 • FAX (440) 327-1064
R.W. Beckett Canada Ltd. • Unit 3 - 430 Laird Road • Guelph, Ontario, Canada N1G 3X7 • (800) 665-6972 • FAX (519) 763-5656

Form No. 61578 09/04
Printed in U.S.A.





KEY

DM = DAMPER MOTOR
H/L = LO/HI CONTROL WIRING TAG
LA = LOW FIRE AIR RELAY
LFHA = LOW FIRE HOLD AQUASTAT
LFHS = LOW FIRE HOLD SWITCH
LWCO-P = LOW WATER CUTOFF - PRIMARY
LWCO-S = LOW WATER CUTOFF - SECONDARY (IF USED)
M = MOTOR
MC = MOTOR CONTACTOR
S1, S3 = ON/OFF VALVE
S2 = HIGH/LOW VALVE
TRANS = IGNITION TRANSFORMER

LEGEND

= CONTACT/DAMPER COIL
= LIGHT
= WIRING SUPPLIED BY INSTALLER
= CROSSOVER WIRES
= FACTORY JUMPER, TO BE CUT FOR FIELD WIRING TIE-IN

WIRE COLOR

A - WHITE
B - BLACK
C - BLUE
D - ORANGE
E - BROWN/RED
F - RED
G - BROWN
H - RED/WHITE
J - BLUE/WHITE
K - VIOLET
L - BLACK/RED
M - BLACK/WHITE
P - GREEN

MOTOR WIRE - 14GA.
ALL OTHER WIRE - 16 GA.

UNSPECIFIED WIRE COLORS BASED ON COMPONENTS

LIGHT COLOR

R = RED
G = GREEN
A = AMBER

NOTES

1. LOCATE HIGH/LOW OPERATOR BETWEEN DAMPER MOTOR AND LFHS.

DESCRIPTION: CF1400 / CF2300 LOW/HIGH/OFF R7184B CONTROL			Beckett COMMERCIAL
DRAWN/REV. BY: TB	CHECKED BY: RM	DRAWN/REV. DATE: 12/07/06	REVISION: 1
LAST CHANGE: ADDED OPTIONAL AQUASTAT			SCHEMATIC NO.: 6998004

OPERATING INSTRUCTIONS & PARTS MANUAL

HIGH PRESSURE DIRECT-DRIVE BLOWERS

MODELS 2C940, 2C820, 4C108, 4C329 AND 4C330

FORM 5S2052
06820
0390/073/5M

READ CAREFULLY BEFORE ATTEMPTING TO ASSEMBLE, INSTALL, OPERATE OR MAINTAIN THE PRODUCT DESCRIBED. PROTECT YOURSELF AND OTHERS BY OBSERVING ALL SAFETY INFORMATION. FAILURE TO COMPLY WITH INSTRUCTIONS COULD RESULT IN PERSONAL INJURY AND/OR PROPERTY DAMAGE! RETAIN INSTRUCTIONS FOR FUTURE REFERENCE.

Description

Dayton direct-drive high pressure blowers are used for small exhaust systems where air is laden with dust or where dust-collection bags are necessary. Applications include handling long stringy material, paper trim, fiberous material such as textile scrap, wool and ensilage. Not suitable for coarse material. Heavy or abrasive dust. Dynamically balanced self-cleaning cast aluminum wheels. 16 GA housing and motor base. Maximum operating temperature 180°F (82°C). Finished in baked-on gray enamel. Blower can be assembled for CW or CCW rotation and any one of eight standard discharge positions. See Figure 2. Dayton motors packed separately when blowers are ordered complete.

General Safety Information

1. Follow all local electrical and safety codes, as well as the National Electrical Code (NEC) and the Occupational Safety and Health Act (OSHA).
2. Blower must be securely and adequately grounded. This can be accomplished by wiring with a grounded, metal-clad raceway system by using a separate ground wire connected to the bare metal of blower frame, or other suitable means.
3. Always disconnect power source before working on or near a motor or its connected load. If the power disconnect point is out-of-sight, lock it in the open position and tag to prevent unexpected application of power.
4. Be careful when touching the exterior of an operating motor — it may be hot enough to be painful or cause injury. With modern motors this condition is normal when operated at rated load and voltage — modern motors are built to operate at higher temperatures.
5. Protect the power cable from coming in contact with sharp objects.
6. Do not kink power cable and never allow the cable to come in contact with oil, grease, hot surfaces, or chemicals.
7. Make certain that the power source conforms to the requirements of your equipment.
8. When cleaning electrical or electronic equipment, always use an approved cleaning agent such as dry cleaning solvent.
9. Not recommended as an explosion proof blower. Do not use where explosive fumes or gases are present.
10. If blower is operated without an inlet or outlet duct, guard openings in accordance with OSHA regulations to prevent contact with rotating blower wheel.

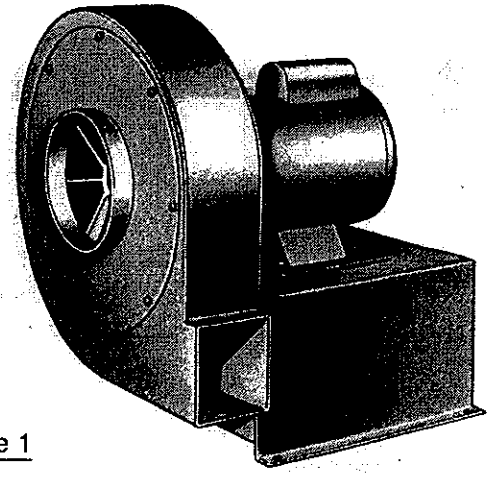


Figure 1

⚠ WARNING ⚠

KEEP HANDS AWAY FROM INLET WHILE BLOWER IS IN OPERATION.

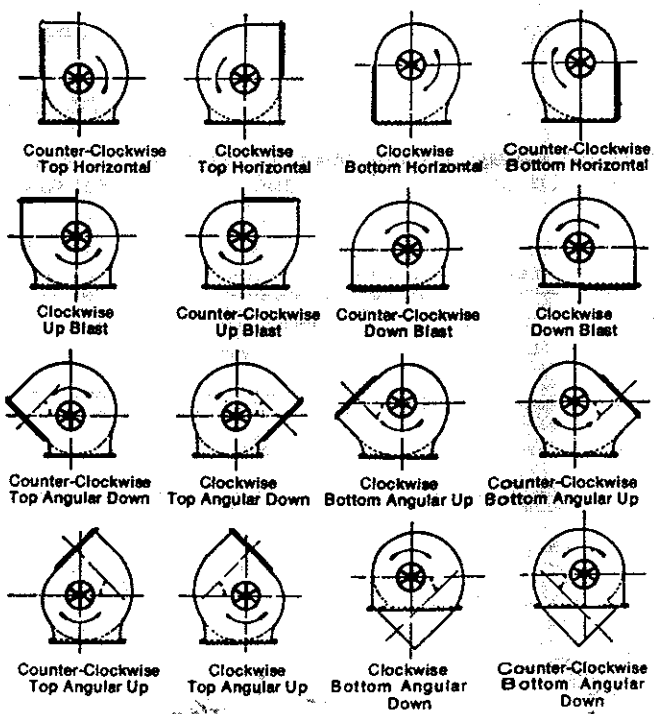


Figure 2

Specifications

MODEL	WHEEL DIA.	WHEEL W	WHEEL BORE	HIGH-PRESSURE BLOWER DIMENSIONS A	B	C	D	E	F	G	H	J	K	L	O	P	R	S	V	X ADJ. MIN.	X ADJ. MAX.
2C940	7¾"	2 5/16"	½"	11"	8"	3"	3"	5"	7"	½"	5⅜"	4⅞"	5⅞"	5⅞"	12¼"	4"	6⅝"	5½"	—	8¼"	9¾"
2C820	9	2 13/16	½	12⅛	8	3½	3½	5⅝	7	½	6⅜	5¾	6⅞	6¾	12¾	5	7½	6⅜	—	9⅛	10⅝
4C108	10 9/16	3	⅝	14¾	9	4	3½	6⅞	7½	¾	7¼	6½	8	7⅝	14	6	8⅝	8¼	—	11⅜	12⅞
4C329	12½	3	⅞	17	11¼	5	4	8	9¾	¾	8¼	7½	9	9⅝	17	7	10	7⅛	—	10⅝	10⅝
4C330	13½	4⅜	1⅛	17½	11¼	7⅛	5¾	8	9½	1	10½	9⅝	11⅜	11	18⅞	8	11½	8⅛	7¼	12⅝	12⅝

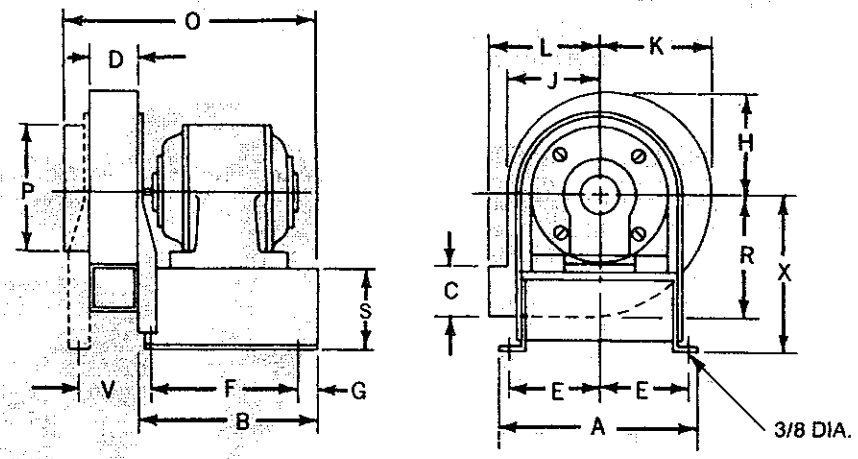


Figure 3

Performance

MODEL	HP REQ'D.	MOTOR FRAME	VOLTS	MOTOR TYPE	CFM AIR DELIVERY AT 3450 RPM 1" SP	2" SP	3" SP	4" SP	5" SP	6" SP	7" SP	8" SP	SHPG. WT.
2C940	1/3	48	115	Split	290	230	160	—	—	—	—	—	13
2C820	1/3	48	115	Split	530	470	415	335	165	—	—	—	17
4C108	1	56	115/230	Cap. (†)	800	745	680	610	510	375	225	—	25
4C329	3	145T	230/460	3-Ph.	1200	1140	1070	1010	940	870	790	695	37
4C330	5	182T	230/460	3-Ph.	2140	2030	1930	1820	1710	1615	1500	1375	64

(†) Also available in 208-230/460, 60Hz, 3-Phase.

Based on standard test codes of (AMCA) Air Moving and Conditioning Association

⚠ CAUTION

Must not be used where static pressure is less than shown in table. Severe motor overload will result. Motor overload protection, closely matched to motor full-load current, is highly recommended.

LIMITED WARRANTY

DAYTON ONE-YEAR LIMITED WARRANTY. High pressure direct drive blowers, Models 2C940, 2C820, 4C108, 4C329, & 4C330, are warranted by Dayton Electric Mfg. Co. (Dayton) to the original user against defects in workmanship or materials under normal use for one year after date of purchase. Any part which is determined by Dayton to be defective in material or workmanship and returned to an authorized service location, as Dayton designates, shipping costs prepaid, will be, as the exclusive remedy, repaired or replaced at Dayton's option. For limited warranty claim procedures, see PROMPT DISPOSITION below. This limited warranty gives purchasers specified legal rights which vary from state to state.

LIMITATION OF LIABILITY. To the extent allowable under applicable law, Dayton's liability for consequential and incidental damages is expressly disclaimed. Dayton's liability in all events is limited to, and shall not exceed, the purchase price paid.

WARRANTY DISCLAIMER. Dayton has made a diligent effort to illustrate and describe the products in this literature accurately; however, such illustrations and descriptions are for the sole purpose of identification, and do not express or imply a warranty that the products are merchantable, or fit for a particular purpose, or that the products will necessarily conform to the illustrations or descriptions.

Except as provided below, no warranty or affirmation of fact, expressed or implied, other than as stated in "LIMITED WARRANTY" above is made or authorized by Dayton.

PRODUCT SUITABILITY. Many states and localities have codes and regulations governing sales, construction, installation, and/or use of products for certain purposes, which may vary from those in neighboring areas. While Dayton attempts to assure that its products comply with such codes, it cannot guarantee compliance, and cannot be responsible for how the product is installed or used. Before purchase and use of a product, please review the product application, and national and local codes and regulations, and be sure that the product, installation, and use will comply with them.

Certain aspects of disclaimers are not applicable to consumer products; e.g., (a) some states do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you; (b) also, some states do not allow limitations on how long an implied warranty lasts, consequently the above limitation may not apply to you; and (c) by law, during the period of the Limited Warranty, any implied warranties of merchantability or fitness for a particular purpose applicable to consumer products purchased by consumers, may not be excluded or otherwise disclaimed.

PROMPT DISPOSITION. Dayton will make a good faith effort for prompt correction or other adjustment with respect to any product which proves to be defective within limited warranty. For any product believed to be defective within limited warranty, first write or call dealer from whom product was purchased. Dealer will give additional directions. If unable to resolve satisfactorily, write to Dayton at address below, giving dealer's name, address, date and number of dealer's invoice, and describing the nature of the defect. Title and risk of loss pass to buyer on delivery to common carrier. If product was damaged in transit to you, file claim with carrier.

Manufactured for Dayton Electric Mfg. Co., 5959 W. Howard St., Chicago, IL 60648

Assembly

1. Attach base upright to the motor mounting base as shown in the exploded view. Hand tighten (4) 1/4-20 x 1/2" bolts, washers, and nuts through slotted holes in base upright. Place motor on motor base and align the center hole of the base upright with the motor shaft. Secure the four 1/4-20 bolts. Models 4C329 and 4C330 have a welded motor base assembly.

2. Bolt the housing to the base upright in the desired discharge position using #10 x 3/8 or 5/16-18 x 3/4" self tapping bolts. Blower is clockwise rotation. Refer to exploded view showing clockwise bottom horizontal discharge.

3. With the motor shaft through the center hole of the base upright, align the mounting holes of the motor to the pre-drilled holes in the motor base. Install two bolts to retain proper motor alignment but do not tighten. Mount the wheel to the motor shaft. Refer to exploded view drawing.

4. Mount the inlet ring to the housing and secure with #10 x 3/8" or 5/16-18 x 3/4" self tapping bolts.

5. Slide the wheel toward the inlet ring so there is at least 1/4" clearance between the wheel and cone. The motor shaft should extend through the hub of the wheel so when the setscrews are securely tightened, they will make contact with the motor shafts.

6. Install the remaining nuts, bolts, and washers (not provided) to the motor mounting holes of the motor and secure to the blower motor base.

Installation

1. Make sure all bolts and screws are tightened before mounting on a rigid, flat, level foundation. Bolt the blower securely into position.

2. Check the interior of the fan housing to be sure it is free of debris. Rotate the wheel to insure that it is not rubbing or binding. Check the clearance of the wheel and the inlet ring, If rubbing exists, loosen the bolts on the ring and shift the ring until clearance is obtained. If still rubbing, loosen the set screw on the wheel and shift the wheel rearward to obtain clearance. Retighten the set screw.

Operation

1. Before connecting the motor to the electric supply, check the electrical characteristics as indicated on the motor nameplate to insure proper voltage and phase.

⚠ CAUTION

A ground wire must run from the blower motor housing to a suitable electrical ground such as a properly grounded metallic raceway or a ground wire system.

2. After electrical connections are completed, apply just enough power to start the unit. Be sure that the rotation of the wheel is correct as indicated by directional arrows on the unit. If proper rotation, apply full electrical power.
3. With the air system in full operation and all ducts attached, measure current input to the motor and compare with the nameplate rating to determine if the motor is operating under safe load conditions.

Maintenance

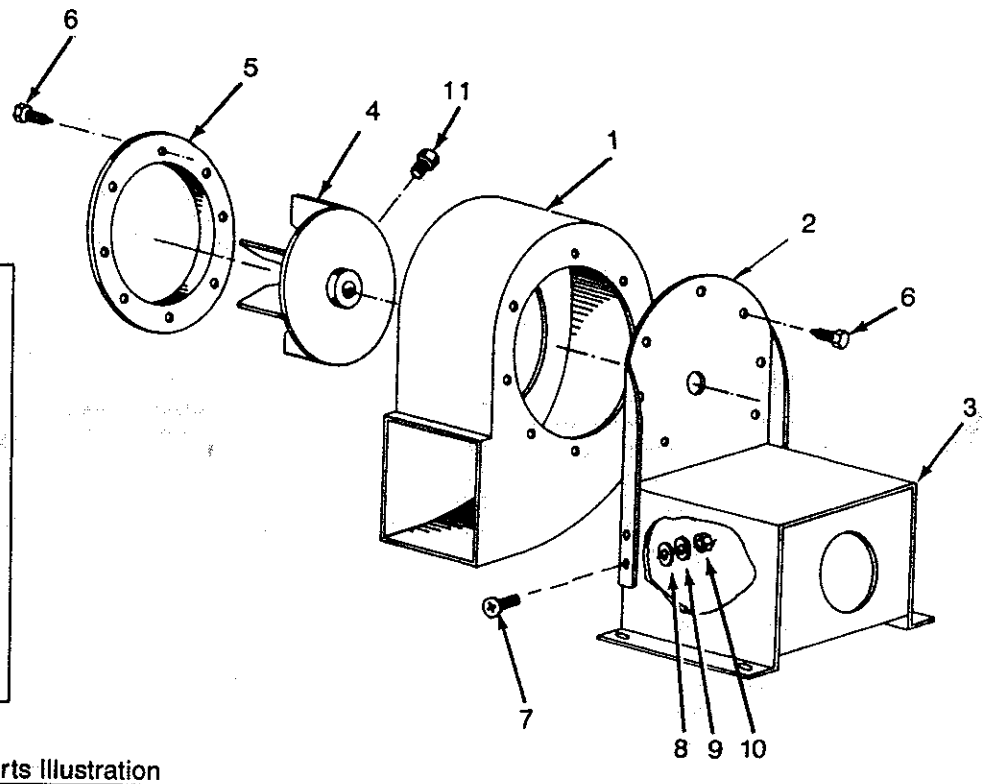
⚠ CAUTION

Before attempting any repair work, be certain that all power to the motor and electrical accessories are turned off and locked in the off position.

A. Periodically remove dirt from blower wheel and housing.
B. Check tightness of wheel setscrews.
C. After disconnecting the power source, check the wiring to see if insulation is damaged or frayed.
D. Relubricate motor per manufacturer's instructions. Remove any excess lubricants.

Troubleshooting Chart

SYMPTOM	POSSIBLE CAUSE(S)	CORRECTIVE ACTION
Noise.	1. Foreign objects in housing. 2. Loose setscrew on wheel. 3. Incorrect wheel rotation.	1. Remove. 2. Tighten. 3. Reverse rotation.
Motor bearing noise.	Lack of bearing lubrication.	Lubricate.
Excessive vibration.	1. Loose wheel on shaft. 2. Loose mounting bolts. 3. Motor out of balance. 4. Wheel out of balance. 5. Accumulation of material on wheel.	1. Tighten setscrews. 2. Tighten. 3. Replace. 4. Replace or rebalance. 5. Clean.
Motor overloaded.	System static pressure less than 1" water column.	Increase system static pressure.



ORDER REPLACEMENT PARTS BY CALLING TOLL FREE

1-800-323-0620

Please provide the following information:

- Model Number
- Serial Number (if any)
- Parts Description and Number as shown in Parts List

Address parts correspondence to:

Parts Company of America
1657 Shermer Road
Northbrook, IL 60062-5362

Figure 4 — Replacement Parts Illustration

Replacement Parts List

REF. NO.	DESCRIPTION	PART NO. FOR MODEL:				
		2C940	2C820	4C108	4C329	4C330 (‡)
1	Housing scroll	201-08-4005-5	201-09-4003-5	201-11-4005-5	201-12-4004-5	201-14-4005-5
2	Base upright	618-08-7001-5	618-09-7001-5	618-11-7002-5	—	—
3	Motor base assembly	203-08-7001-5	203-09-7001-5	203-11-7005-5	203-12-4016-5	203-14-4011-5
4	Wheel	602-08-4001-5	602-09-4001-5	602-11-4002-5	602-12-4004-5	602-14-4003-5
5	Inlet ring	609-08-4002-5	609-09-4001-5	609-11-4003-5	602-12-4003-5	609-14-4001-5
6	Hex hd. screw	#10 x 3/8" 8 Req'd.	#10 x 3/8" 14 Req'd.	#10 x 3/8" 14 Req'd.	5/16-18 x 3/4" 16 Req'd.	5/16-18 x 3/4" 16 Req'd.
7	Slotted machine screw*	1/4-20 x 1/2" 4 Req'd.	1/4-20 x 1/2" 4 Req'd.	1/4-20 x 1/2" 4 Req'd.	—	—
8	Flat washer*	1/4 4 Req'd.	1/4 4 Req'd.	1/4 4 Req'd.	—	—
9	Split washer*	1/4 4 Req'd.	1/4 4 Req'd.	1/4 4 Req'd.	5/16 16 Req'd.	5/16 16 Req'd.
10	Hex nut*	1/4"-20 4 Req'd.	1/4"-20 4 Req'd.	1/4"-20 4 Req'd.	—	—
11	Setscrew	†	†	†	†	†

NOTE — Models 4C329 and 4C330 have welded 1 piece motor base & upright assembly.
(‡) Model 4C330 has inlet upright supports (not shown) to support housing. Order by P/N 617-13-7002-5.
(*) Standard hardware item, available locally.
(†) Available with wheel.

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 3) 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

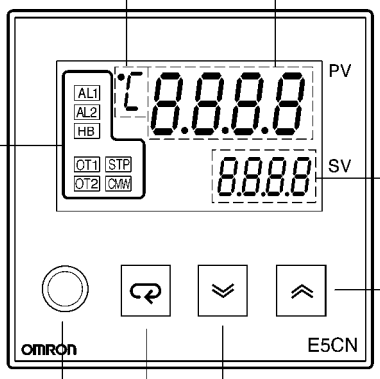
■ HEATER BURNOUT ALARM SPECIFICATIONS

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

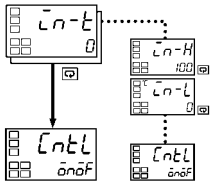
On previous Controllers, sensor input type, alarm type and control period were set on DIP switches. These hardware settings are now set in parameters in setup menus. The ◎ and ⮌ keys are used to switch between setup menus, and the amount of time that you hold the keys down determines which setup menu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

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

1. ON/OFF Control

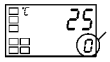
Typical Application Examples

- Changing Parameters



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

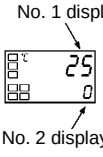
- Changing Set Values



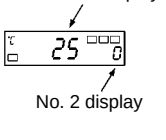
Use the ⮟ or ⮝ keys to change the set value displayed in the setup menu.

Display

E5CN



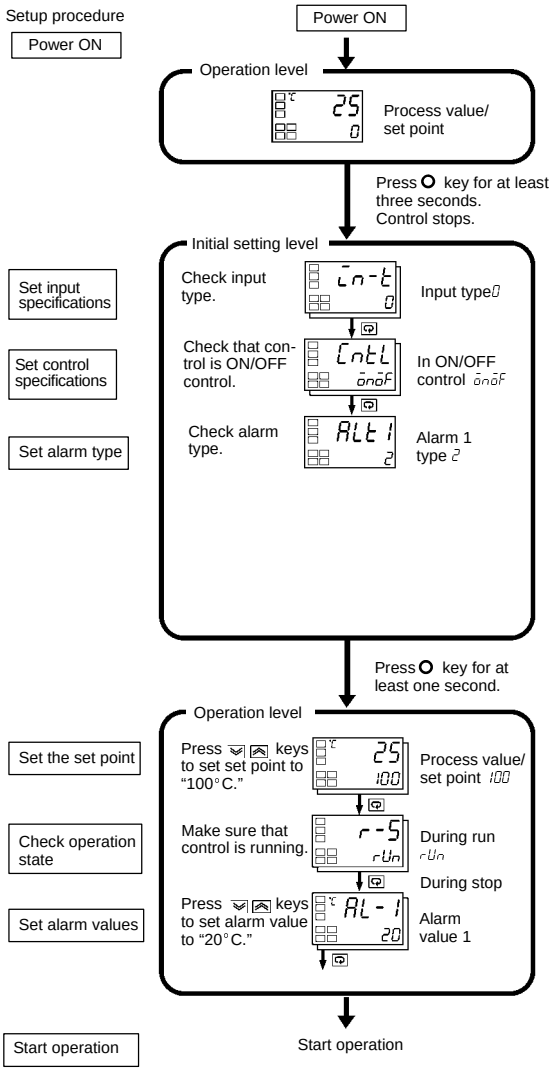
E5GN



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

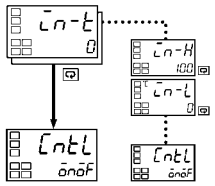
Change only the alarm value 1 and set point.
The rest must be left as default settings.



2. PID Control Using Auto-tuning

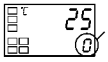
Typical Application Example

- 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

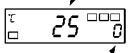
E5CN

No. 1 display

No. 2 display

E5GN

No. 1 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

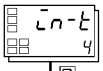
Process value/ set point

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

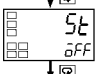
Set control specifications

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)

Check alarm type

Check alarm type.

Alarm 1 type 2 (upper-limit alarm)

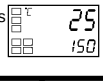
When set to ON, self-tuning operates. Recommended settings: 20 seconds for the relay output and 2 seconds for the SSR output.

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

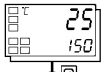
Set to on for executing AT and to oFF for stopping AT.

Press O key for less than one second.

Operation level

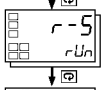
Set operation status

Make sure that set point is "150°C."



Process value/ set point 150

Make sure that control is running.



During run

Set alarm values

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

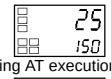
Alarm value 1 30

Start operation

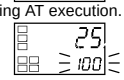
Start program execution

PV/SP

After AT execution.



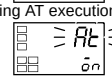
During AT execution.



While AT is being executed, SP will flash.

After AT execution.

During AT execution.

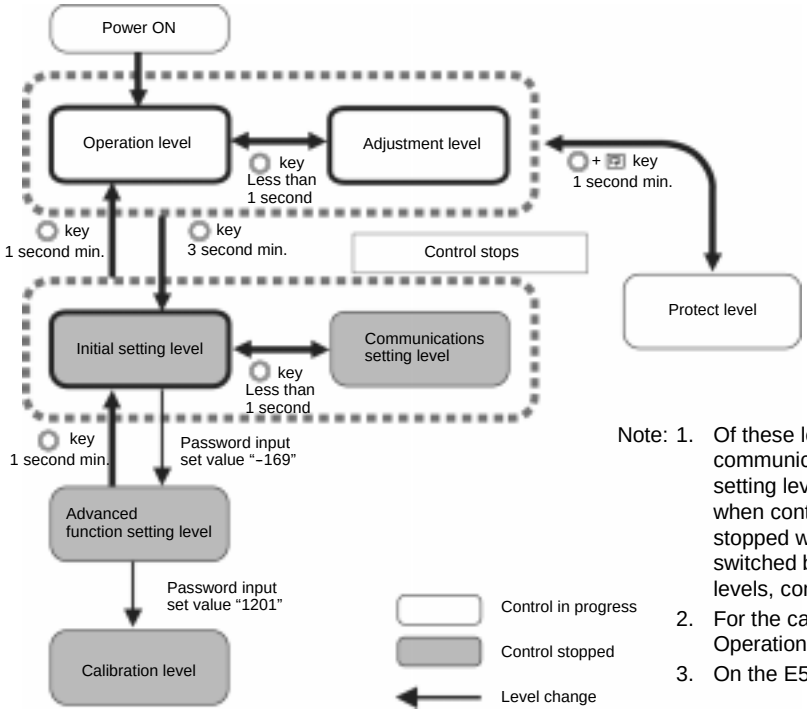


Specification Setting After Turning ON Power

■ 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

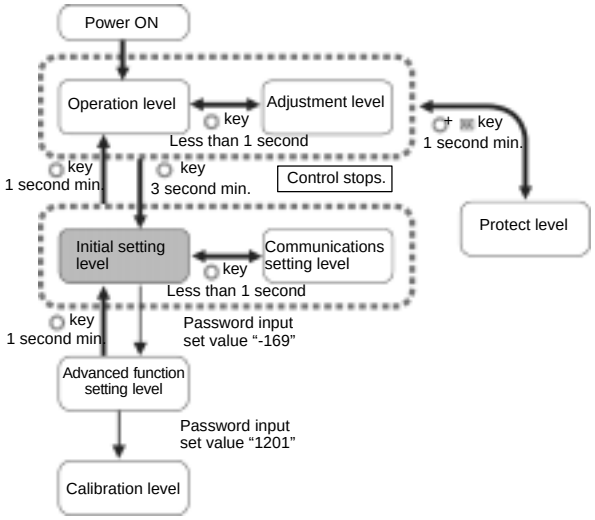
To select this level, you must enter the password (“1201”) in the advanced function setting level. This level is for offsetting deviation in the input circuit.

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.

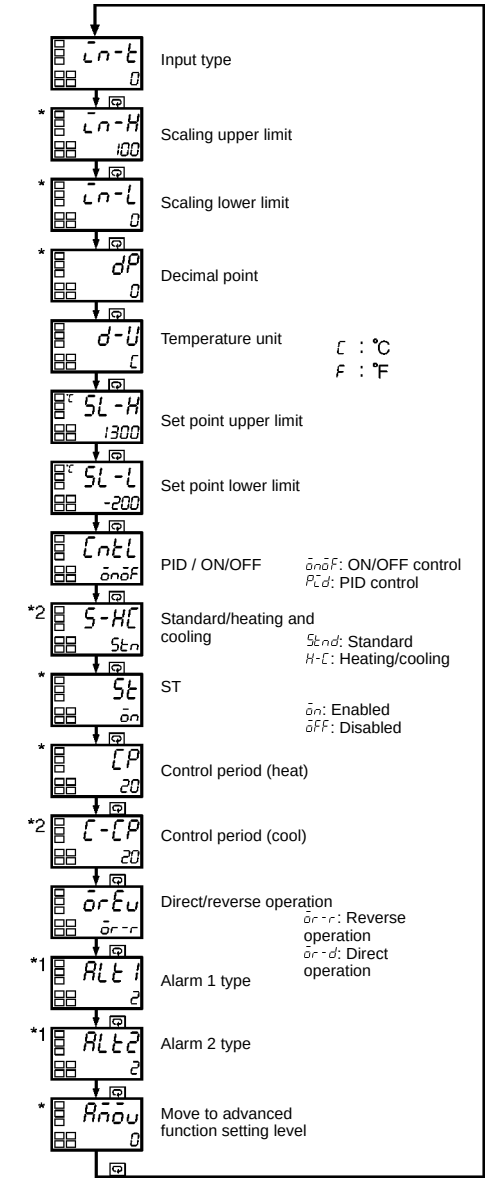


The move from the operation level to the initial setting level, press ◎ key for three seconds or more.

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

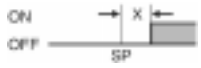
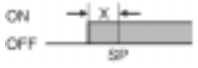
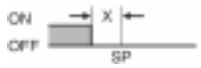
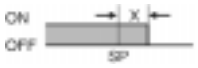
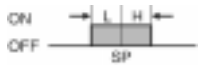
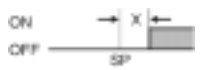
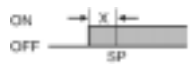
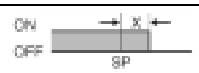
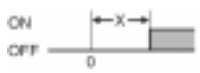
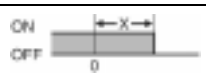
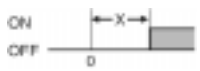
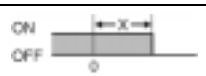
When using the platinum resistance thermometer input type, follow the specifications listed in the following table.

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.

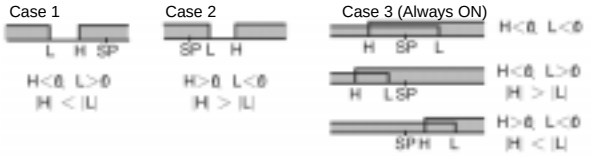
■ ALARM 1 AND ALARM 2

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

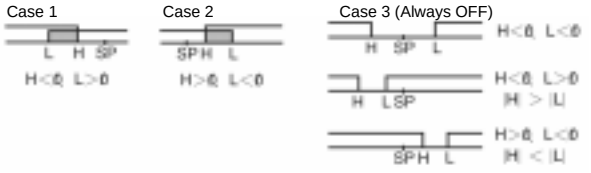
Set Value	Alarm Type	Alarm Output Operation	
		When X is positive	When X is negative
0	Alarm function OFF	Output OFF	
1*1	Upper- and lower-limit (deviation)		*2
2	Upper-limit (deviation)		
3	Lower-limit (deviation)		
4*1	Upper- and lower-limit range (deviation)		*3
5*1	Upper- and lower-limit with standby 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.

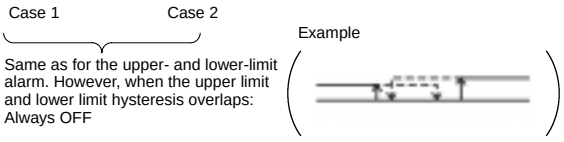
*2: Set value: 1, upper- and lower-limit alarm



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



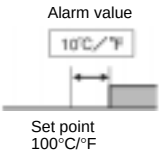
*4: Set value: 5, upper- and lower-limit with standby sequence



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

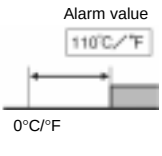
- **When an alarm type other than the absolute-value alarm is selected**

(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**

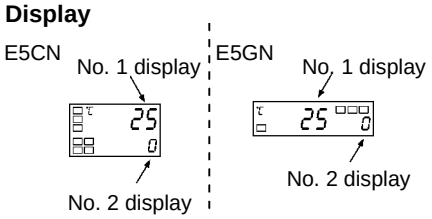
(For alarm types 8 to 11)
The alarm value is set as an absolute value from the alarm value of 0°C/F.

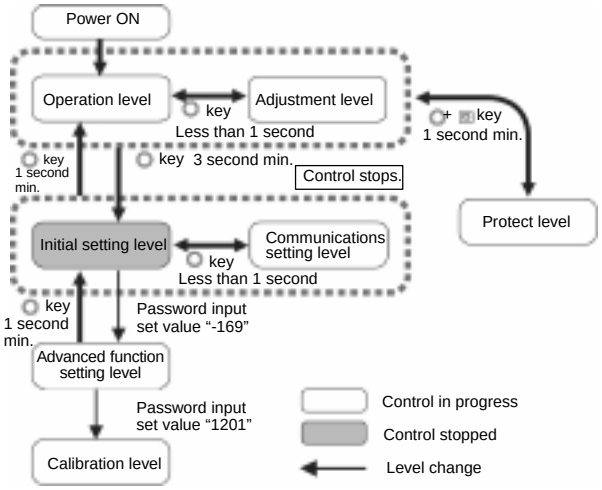


■ PARAMETERS

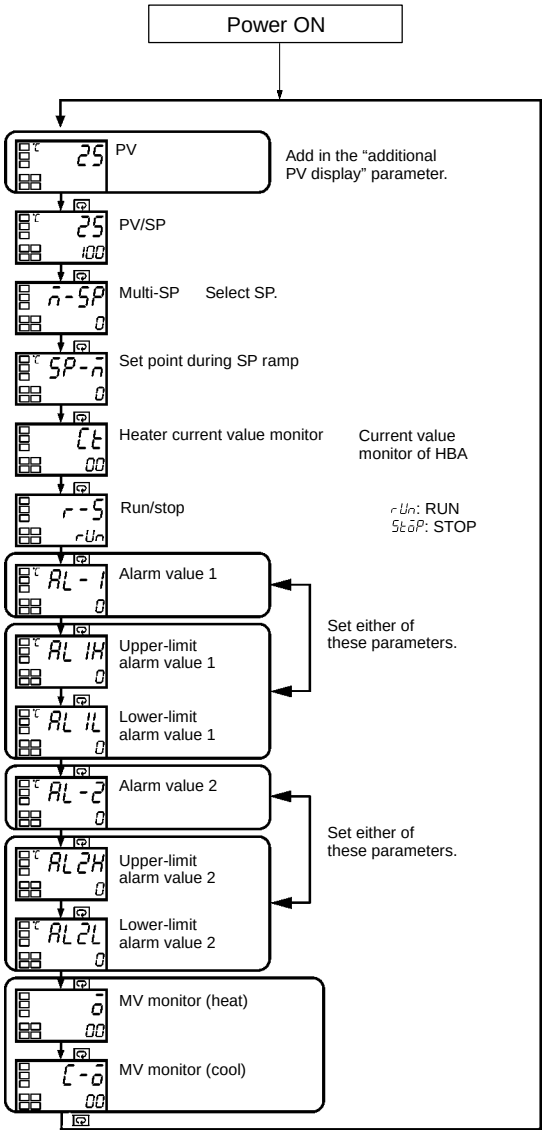
Parameters related to setting items for each level are marked in boxes in the flowcharts and brief descriptions are given as required. At the end of each setting item, press the mode key to return to the beginning of each level.

Display

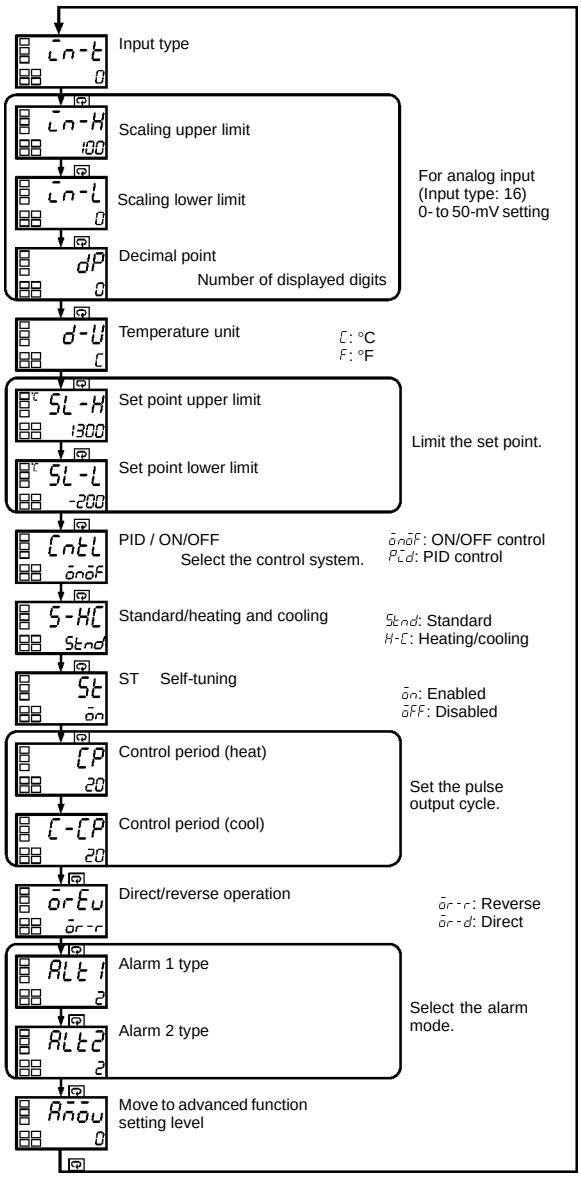




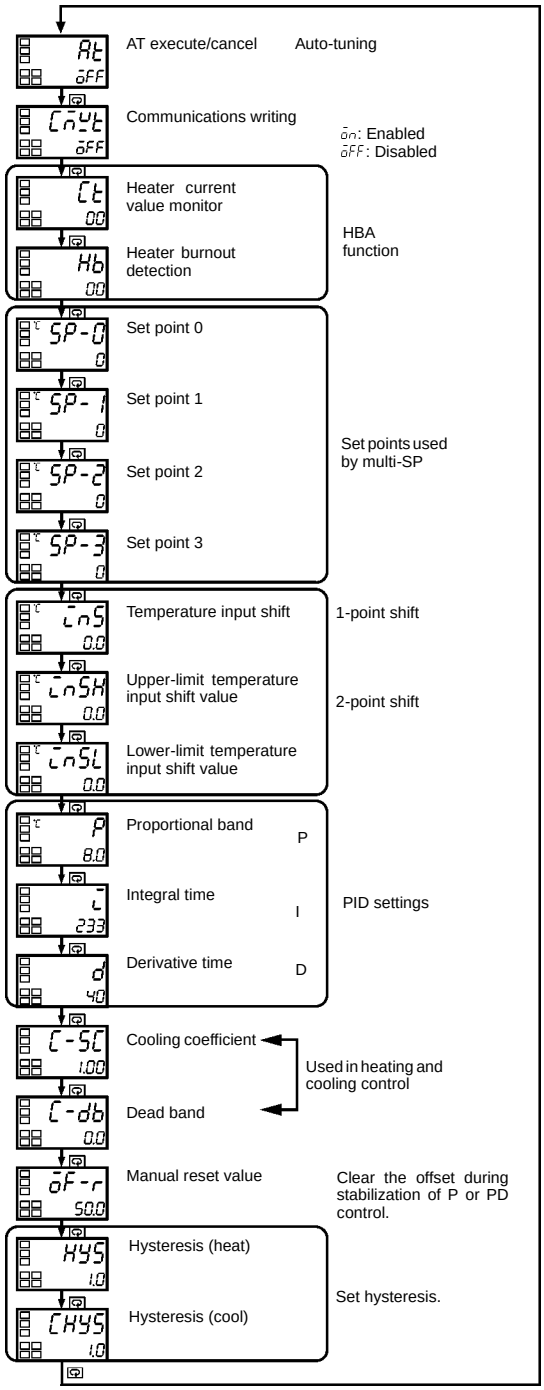
Operation Level



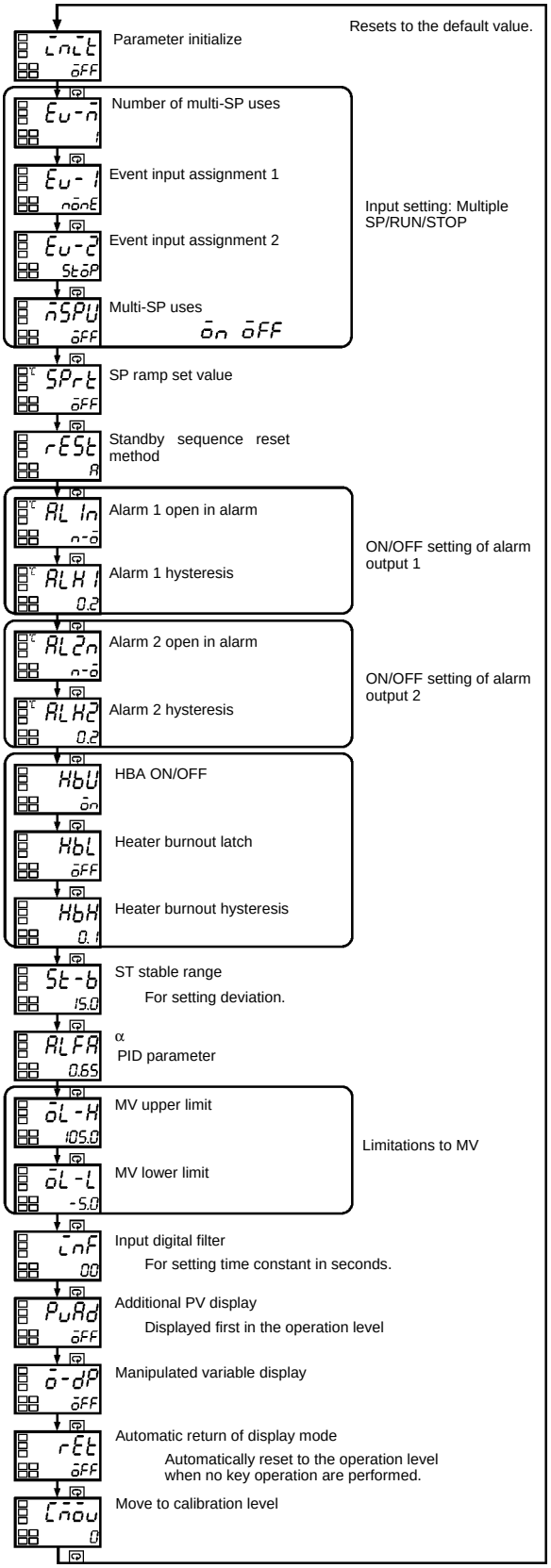
Initial Setting Level



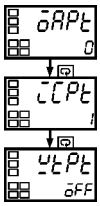
Adjustment Level



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

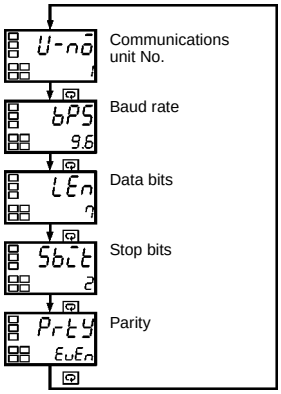
Set the E5CN/E5GN communications specifications in the communications setting level. For setting communications parameters, use the E5CN/E5GN panel. The communications parameters and their settings are listed in the following table.

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.)

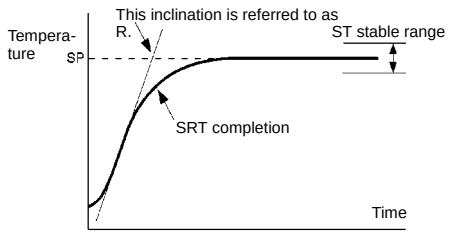
If the SP is changed while SRT is being executed and if SRT completion conditions are satisfied, no PID change will take place.

Stabilization State

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

Balanced State

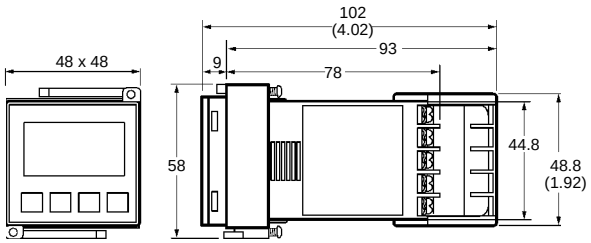
Output is 0% for 60 seconds and measured values fluctuate within the width of the stable range.



Dimensions

Unit: mm (inch)

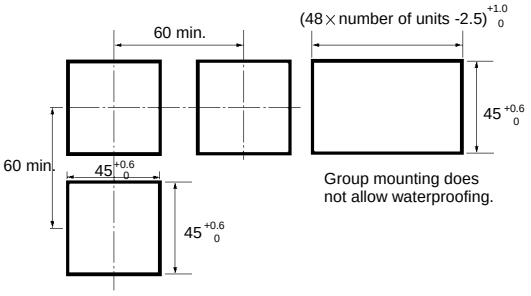
■ E5CN



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

Panel Cutouts

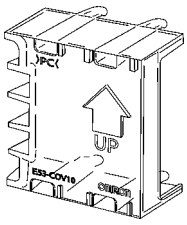
Mounted Separately **Group Mounted**

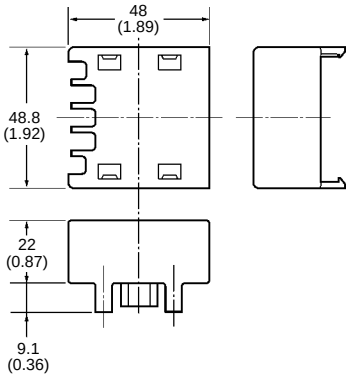


- Recommended panel thickness is 1 to 5 mm.
- Group mounting is not possible in the vertical direction. (Maintain the specified mounting space between Controllers when they are group mounted.) To mount the E5CN so that it is waterproof, apply the waterproof seal to the E5CN.
- When two or more E5CNs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

■ TERMINAL COVER

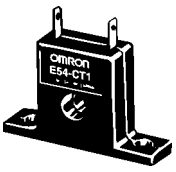
E53-COV10

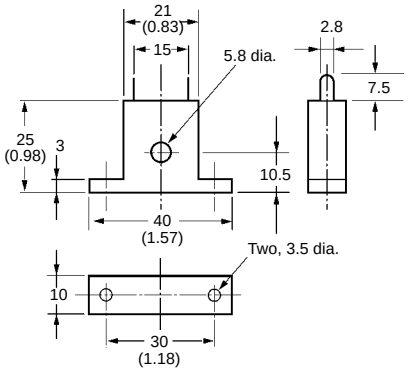




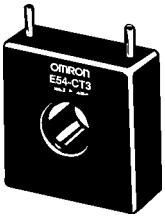
■ CURRENT TRANSFORMER (SOLD SEPARATELY)

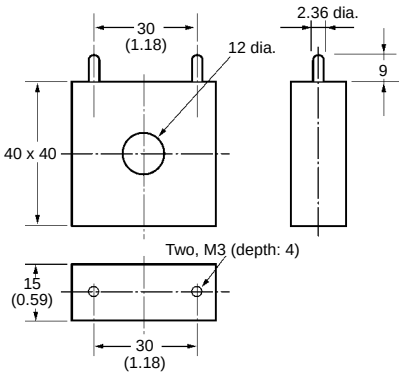
E54-CT1





E54-CT3





Installation

SETTING UP OPTION BOARDS

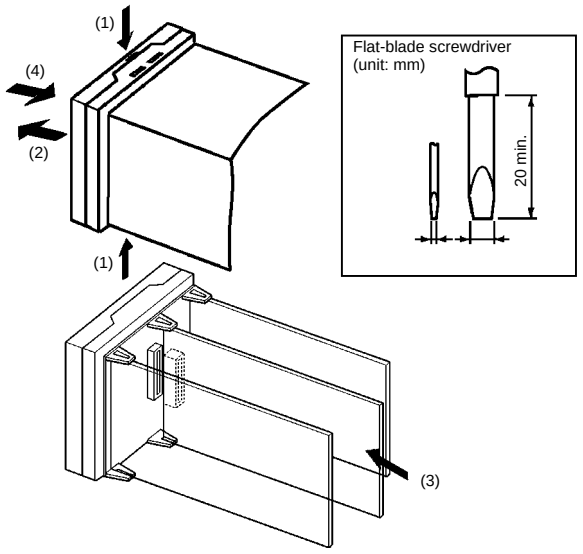
If communications, event input, or heater burnout functions are required, mount the E53-CNH03 Communications Board or the E53-CNHB Event Input Board. The heater burnout function is supported on either of these two Option Boards.

Option Boards

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

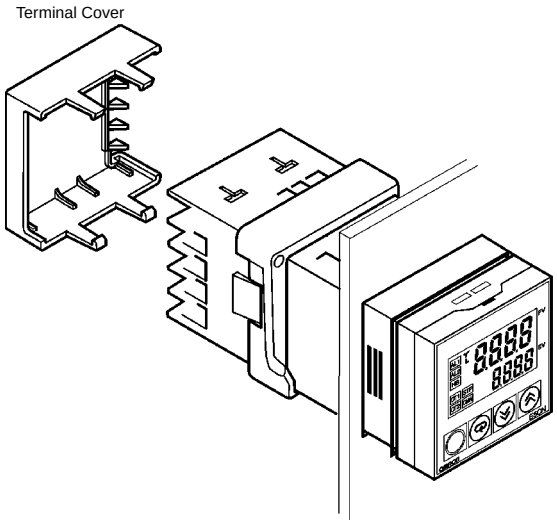
Note: Terminal label: x1

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).

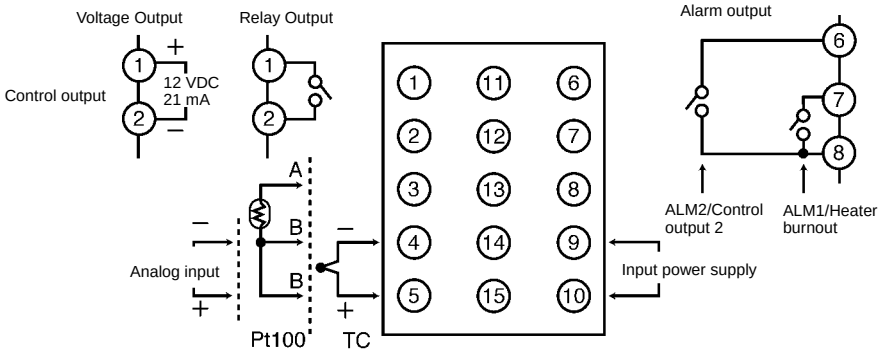
Attaching the Terminal Cover

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.

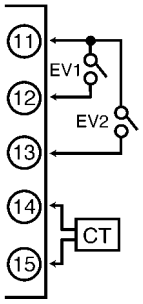


Two input power supplies are available: 100 to 240 VAC or 24 VDC.

E5CN OPTION BOARDS

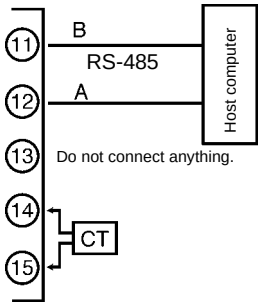
E53-CNHB Event Input Unit

Event Input/Heater Burnout Detection



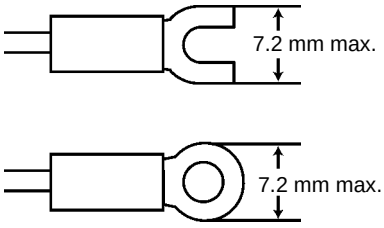
E53-CNH03 Communications Board

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

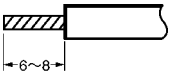
Use crimp terminals that match M3.5 screws. M3.5 x 8 self-rising screws are used.

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

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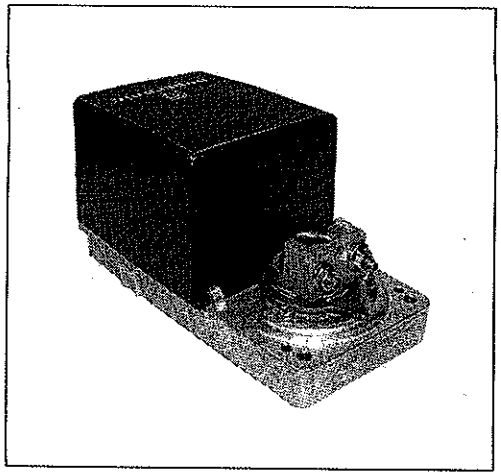
neptronic®

Actuator
Specification & Installation instruction



Feature:

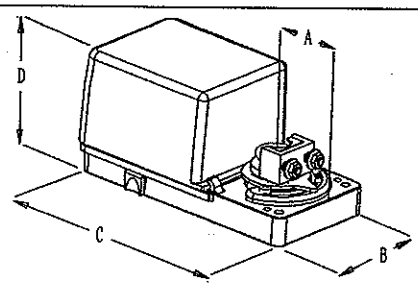
- Mounts easy on round & square shaft (with option –8).
- External clutch for manual adjustments.
- Maintenance free.
- Position indicator.
- Control signal fully programmable.
- The fastest actuator of the world (model BM_ _ _FF).
- Fail safe by *Enerdrive System* [1] (on model 060 & 080).
- Auxiliary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



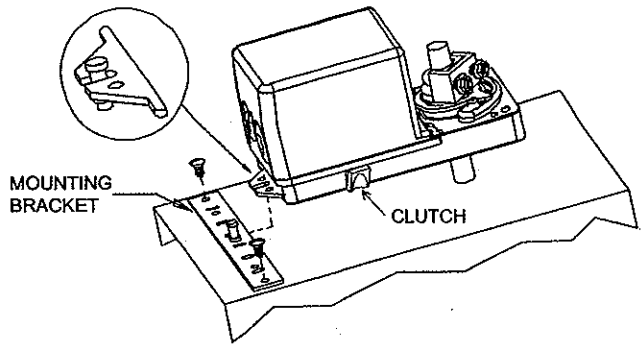
Dimension		Inches	Metric (mm)
A		1.50	38.1
B		3.26	82.8
C		6.60	167.5
D	model 000 & 060	3.01	76.4
	model 020 & 080	3.72	94.5

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

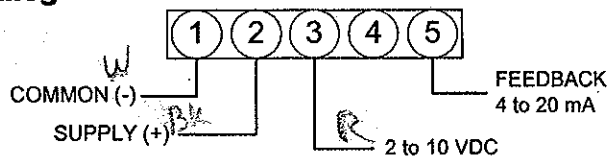
Mechanical installation



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

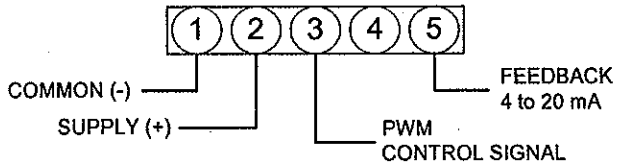
Analog



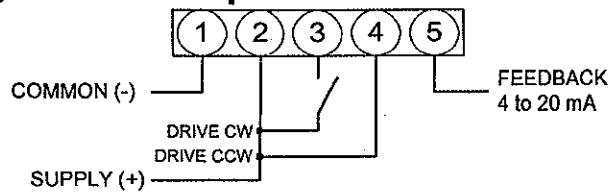
For 4 to 20 mA control signal

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

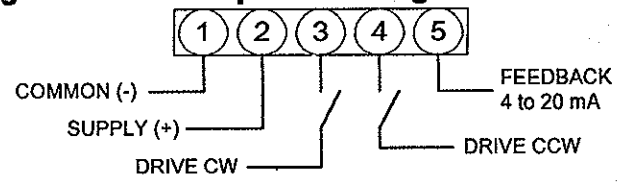
PWM



Digital – 3 wire / 2 position



Digital – 4 wire / 3 point floating



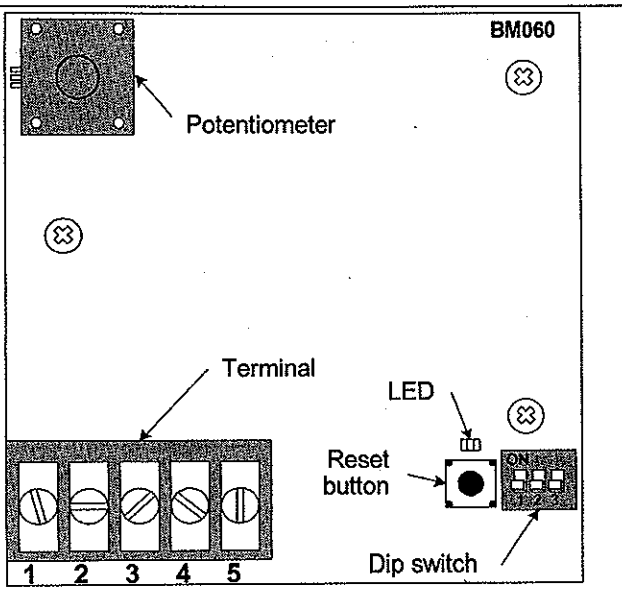
Special consideration for Digital control

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.

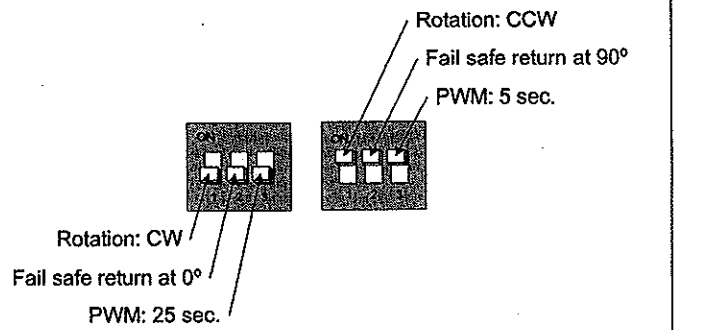
For 2 to 10 VDC output feedback

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.

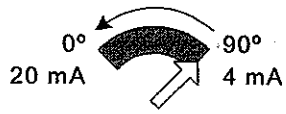
Feedback selection (CCW direction)

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.

Marathon Sensors Inc.

Oxymit™ Transmitter
Operators Manual

Marathon
Sensors Inc.

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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.

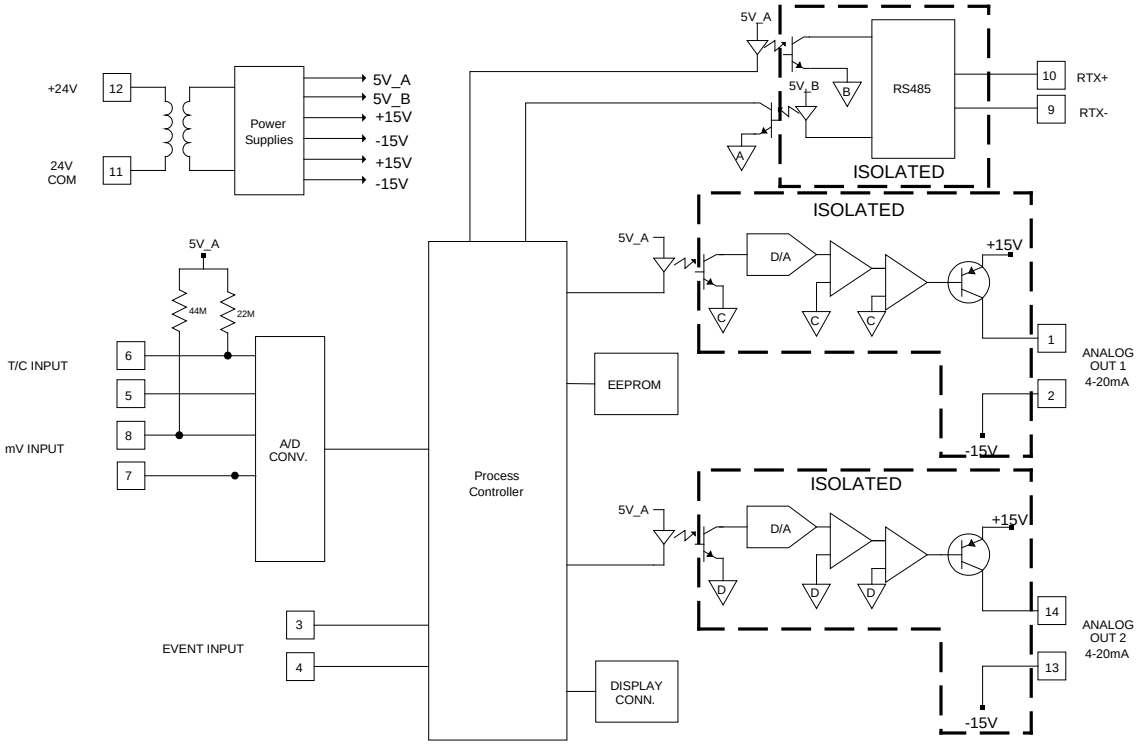


Figure 1 BLOCK DIAGRAM

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.

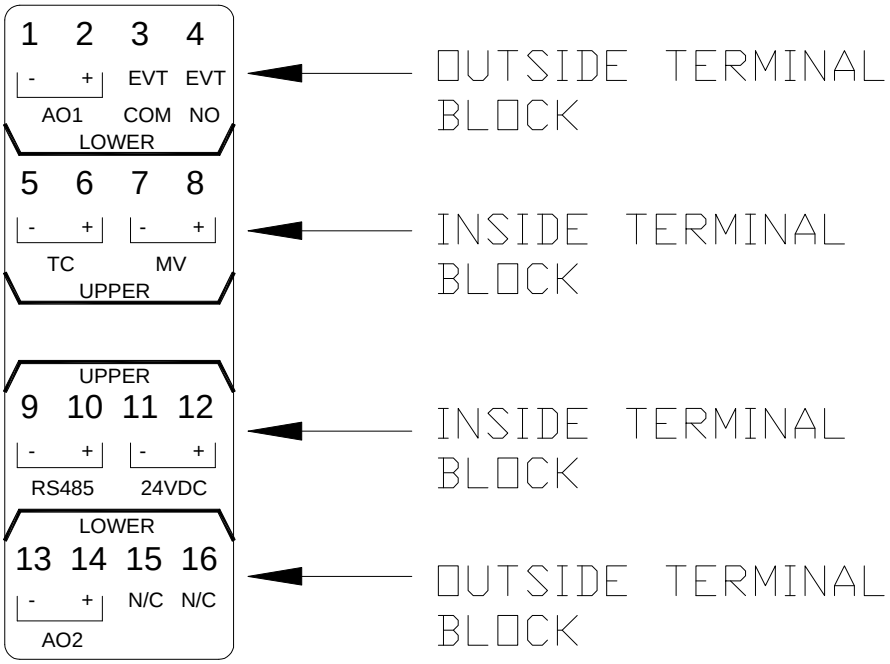


Figure 2 Terminal Layout

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

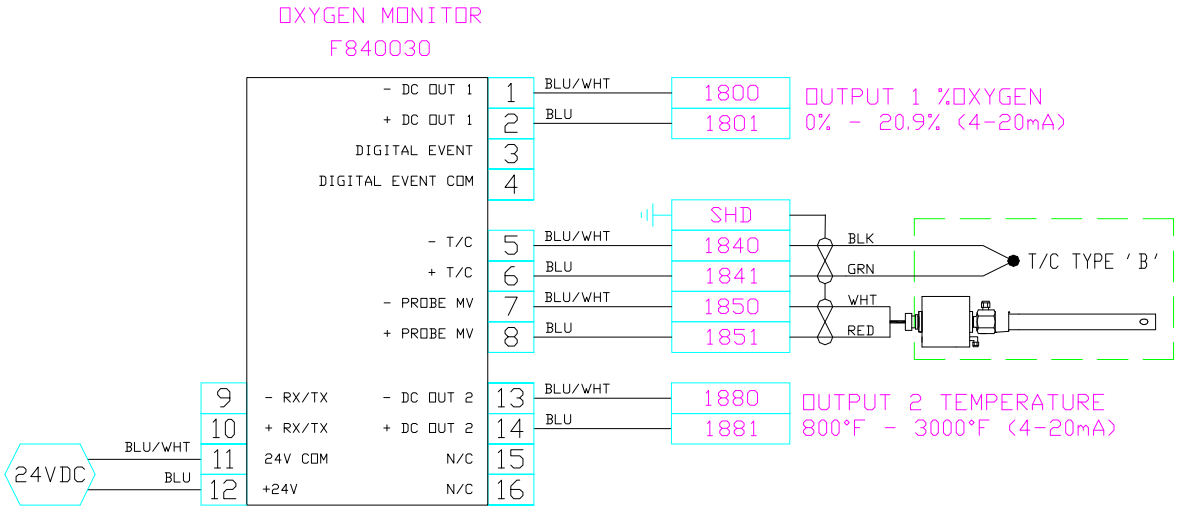


Figure 3 Schematic Connections

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.

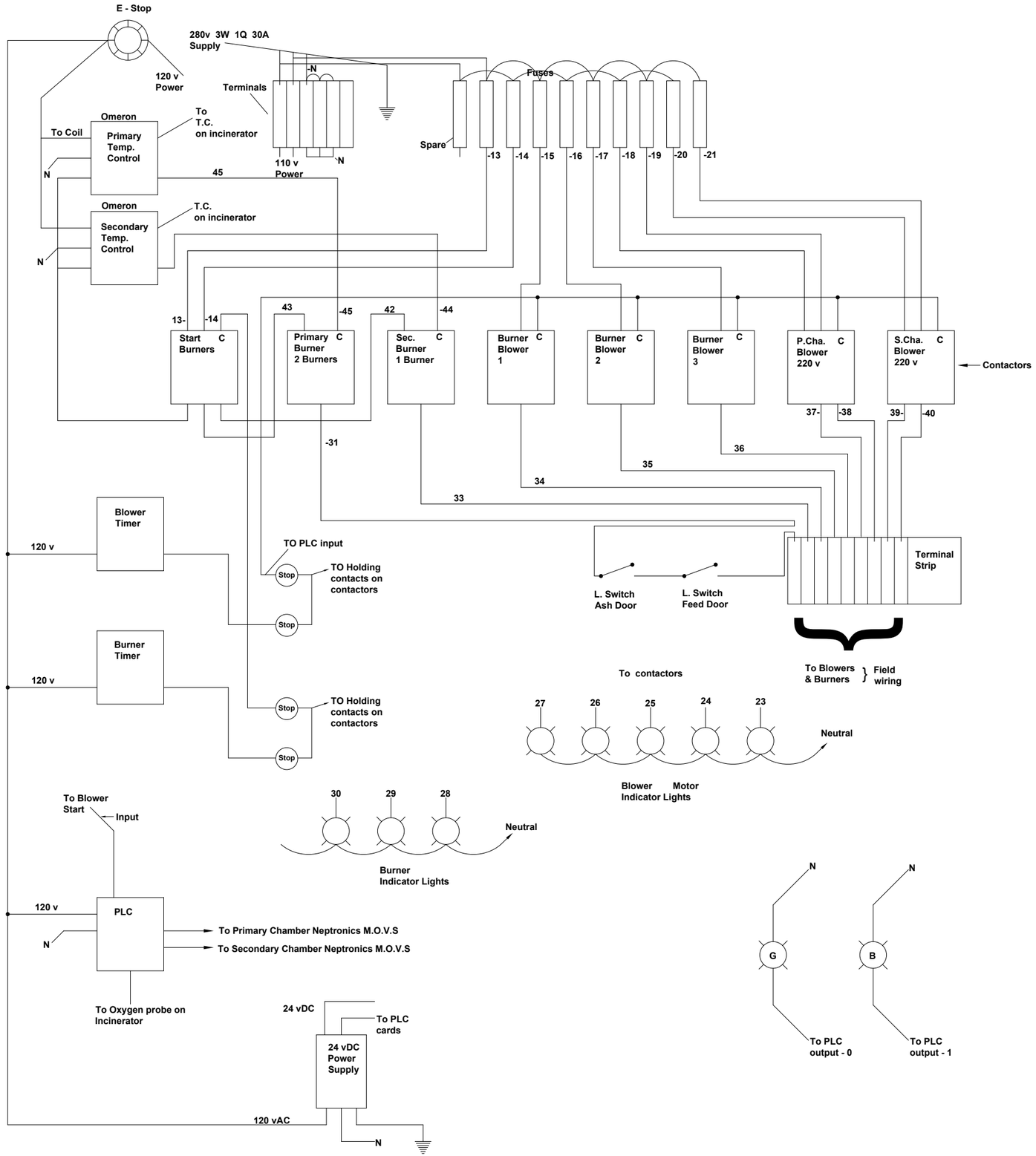
SECTION 14: OTHER INFORMATION

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

Approved by Shop:

Date:_____

Signature:_____



WESTLAND ENVIRONMENTAL SERVICES INC.			
Model:	**Incinerator CY-100-CA-'D'-'O'**		
Date:	11-09-07	**Electrical Wiring Diagram**	
Drawn By:	YP		
Rev. :	Ø		
Scale:		**Dwg-No:**	9 - 3

Appendix E
Model CY-100 SOP Manual

STANDARD OPERATING PROCEDURE (SOP)

INCINERATOR

MODEL CY-100-CA-D-O

HISTORY OF SOP REVISIONS

Revision Number	Revision Date	Description of Revisions	Revised By	Approved By
0	June 2009	Initial issuance of Model CY-100-CA-D-O Standard Operating Procedure	SRK Consulting	

STANDARD OPERATING PROCEDURE
INCINERATOR
MODEL CY-100-CA-D-O

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1 Introduction

1.1 Purpose

This *Standard Operating Procedure – Incinerator Model CY-100-CA-D-O* has been developed to ensure the operation of the Westland Model CY-100-CA-D-O incinerator located at the Robert Bay site, Hope Bay Project is undertaken in a safe, environmentally responsible and efficient manner.

The objectives of managing and the appropriate incineration of wastes are numerous. Consistent with HBML's intent to be a responsible operator, these objectives are described as:

- Prevention of public health risks
- Protection of the operator(s)
- Protection of surface waters
- Protection of groundwaters
- Protection of lands
- Protection of local species
- Conservation of resources
- Compliance with regulatory and permit requirements

This Standard Operating Procedure has been developed to ensure that, to the maximum extent possible, these objectives are foremost in HBML'S operational approach to activities at the Hope Bay project.

1.2 Scope

This *Standard Operating Procedure – Incinerator Model CY-100-CA-D-O* applies to the management and operation of the Model CY-100-CA-D-O incinerator to ensure that the incinerator is operated in a manner that effectively and efficiently incinerates appropriate waste streams generated at the Hope Bay project. Wastes suitable for incineration generally include food wastes, paper wastes and unusable or waste wood.

1.3 Responsibilities

The Exploration Manager has overall responsibility for this SOP and will be the party to providing the resources necessary to operate and maintain the Westland Model CY-100-CA-D-O Incinerator.

The Exploration Site Superintendent will have site responsibility to provide the on-site resources to manage operate and maintain the incinerator in accordance with the manual; conduct regular inspections of the incinerators; and provide input on modifications in operational procedures to

improve operational performance of the facility. The Exploration Site Superintendent, through his foremen, will provide daily supervision to site operational personnel on the operation of the incinerator.

The site Environmental Coordinator has responsibility to regularly review and keep this Standard Operating Procedure up-to-date; provide technical expertise to the site operational personnel, reporting on the performance of the incinerator, residuals (ash) management; conduct annual audits of the waste management stream and incineration operations; and provide an annual audit report to the Exploration Site Superintendent and Exploration Manager.

1.4 Document Control

The site Environmental Coordinator will complete a review of this procedure at least once every three years; will update the document as required and submit the updated SOP for review and approval by the Exploration Site Superintendent.

2 Description of Model CY-100-CA-D-O Incinerator

The Westland Model CY-100-CA-D-O incinerator has a manufacturer's stated capacity of 100 kg/h using diesel as the auxiliary fuel. Figure 1, 2 and 3 provides an overview of major components of the Westland Model CY-100-CA-D-O incinerator. Appendix A provides a more detailed discussion of individual components, features and functions of the incinerator.

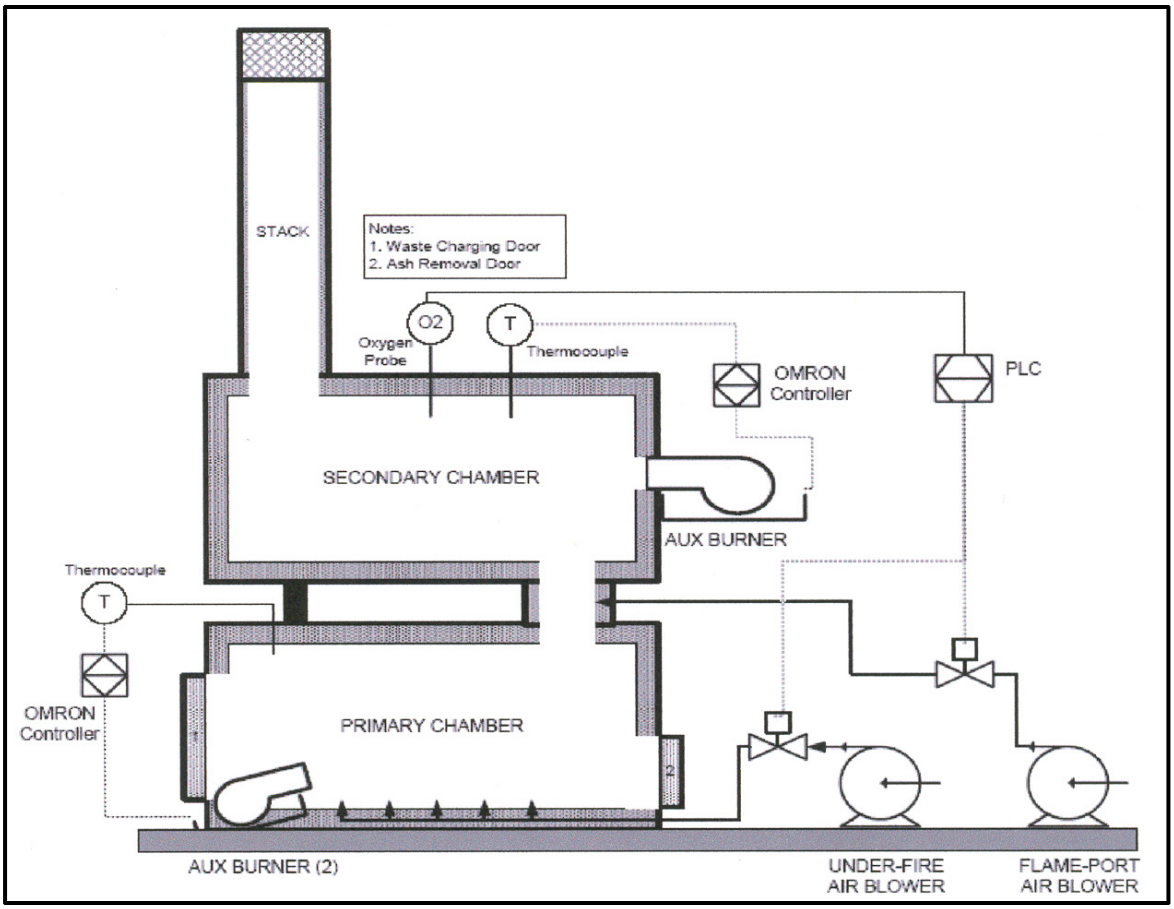


Figure 1: Schematic of Incineration System - Model CY-100-CA-D-O Incinerator

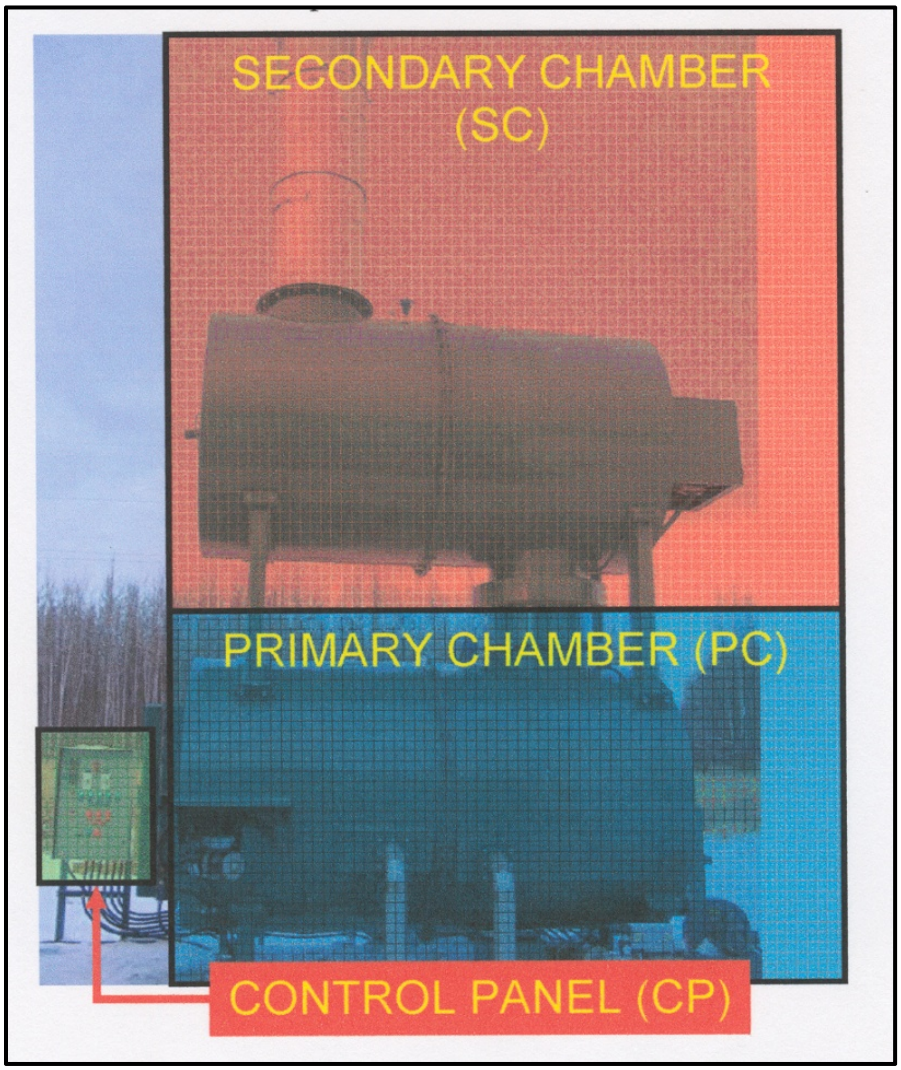


Figure 2: Overview of Model CY-100-CA-D-O Incinerator

Figure 3: Major Components of Primary & Secondary Chambers - Model CY-100-CA-D-O Incinerator

3 Operator Training & Safety

3.1 Operator Training

Persons charged with the responsibility of operating the Westland Model CY-100-CA-D-O incinerator are required to read and comprehend this SOP and the *Westland Model CY-100-CA-D-O Operating and Maintenance Manual* which is appended to this SOP as Attachment A.

In addition, an on- site training program will be developed to cover all aspects of the infrastructure associated with incinerator management , its operation, maintenance, monitoring, sample collection, preservation and record keeping. The training will also include an identification of activity related risks, knowledge and use of job specific Personal Protective Equipment (PPE), as well as training in the proper handling, storage, and disposal of all ash generated from the facility.

The training will be both job and equipment specific and will be provided to any site personnel assigned the responsibility to oversee, inspect, maintain , monitor, assess performance and report on the facilities, its discharges and discharge location. The training program will be reviewed as required by site management, with a full review of the training program completed as least once every three years.

3.2 Personal Protective Equipment

Prior to initiating any activities related to the operation of the Westland Model CY-100-CA-D-O incinerator, the operator will equip themselves with all required Personal Protective equipment.

This will include, but not necessarily be limited to the following:

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

The personal protective equipment related to specific tasks associated with the operations of the incinerator are as follows:

- Ash removal and handling:
  - NIOSH N85 respirator
- Waste charging:
  - Heat protective clothing and gloves, and
  - CSA/ANSI approved full face shield.

3.3 Specific Health and Safety Requirements for the Model CY-100-CA-D-O Incinerator

Equipment specific hazards that could potentially be encountered during interactions with the incinerator generally arise from the following (not in any order of importance):

- Contact with waste (potentially 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, general precautionary actions by any person coming in contact with the incinerator or its waste stream 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.
- Wearing appropriate personal protective equipment during ash removal.
- Using appropriate equipment and operators to move and transport heavy objects such as full ash containers.

4 Model CY-100-CA-D-O Incinerator Operations

4.1.1 Introduction

The following provides a discussion of the correct procedures that apply to the operation of Westland Model CY-100-CA-D-O incinerator.

4.1.2 Operational Procedures

The safe and effective operation of the Westland Model CY-100-CA-D-O incinerator is described by the sequential steps provided in Figure 4. All operators will diligently follow these steps.

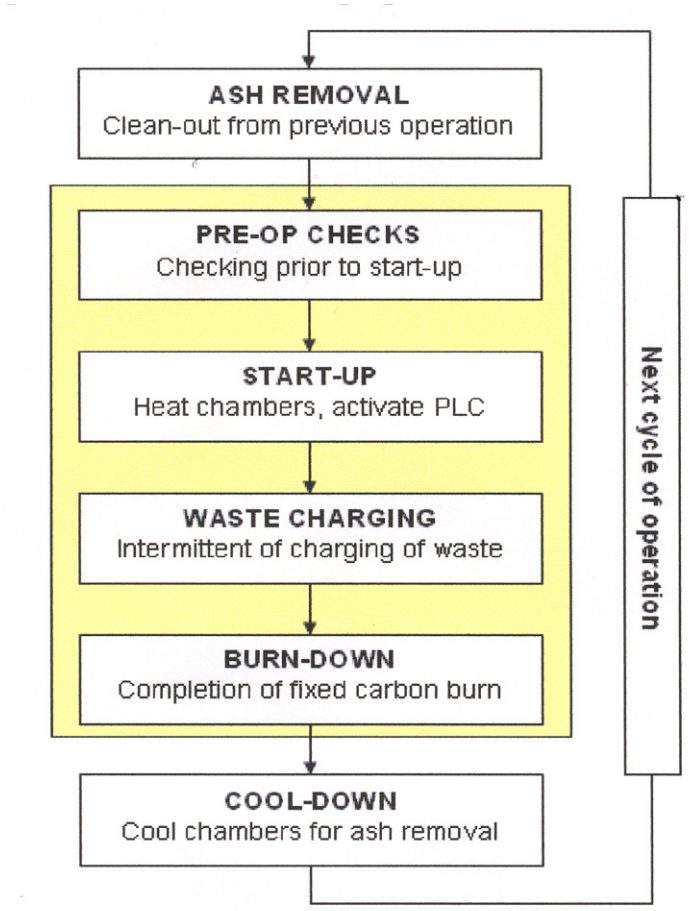


Figure 4: Model CY-100-CA-D-O Incinerator Operations Sequence

4.1.3 Waste Batch Preparation

Waste destined for incineration will be separated and bagged at its source and placed in a secure receptacle designed to prohibit access by wildlife (i.e. Bear-proof container). The material will be collected by persons designated for that purpose and immediately incinerated.

All reasonable efforts will be made by all site personnel to ensure that bagged waste destined for incineration is free of (i.e. does not contain) materials that are considered inappropriate for incineration. Materials inappropriate for incineration include, but are not necessarily be limited to:

- Cans or containers containing Aerosol (whether empty or not);
- Residual paint materials;
- Plastics of any kind;
- Batteries of any kind;
- Styrofoam of any kind;
- Tin/aluminum cans;
- Explosives of any kind;
- Sewage sludges; or,
- Metals of any kind.

The following cautionary notes must be followed:

- **NO** explosives, aerosol cans or sealed containers containing combustible liquids shall be placed in the incinerator.
- The operator shall ensure that every batch can go through the waste charging door easily, regardless of its weight. If others prepare the batches, the operator should inform them about the maximum batch size.
- Do not open batches and “rearrange” the contents.

All waste generated on site that cannot be incinerated will be managed and disposed of in an appropriate manner as described in the *Hope Bay Project – Materials Management Plan*.

4.1.4 Pre-operational Checks

The following pre-operational checks will be conducted by the operator:

- Check prevailing winds and in the event that winds are directed towards populated areas (i.e. camp) or inversion (i.e. temperature increase with altitude: a stable atmospheric condition in which air temperature increases vertically upward) are present, operator will check with supervisor before firing incinerator;
- Ensure the presence of an easily accessible fire extinguisher;
- Inspect the fire extinguisher to ensure charged and functional;

- Conduct inspection of fuel tank for leaks and containment integrity;
- Inspect fuel tank to ensure sufficient fuel for operations;
- Inspect combustion chamber to ensure chamber is empty and combustion air holes are clear;
- Inspect thermocouples (Primary & Secondary chamber);
- Inspect gasket/seal in both "charge" and "ash" door;
- Inspect refractory and under fire air holes in primary chamber;
- Inspect spark arrestor to ensure no plugging;
- Inspect power connection; and,
- Open fuel valve.

In the event that this inspection identifies an "action item" the incinerator operator will immediately inform his/her direct supervisor.

When diesel is used as incinerator fuel, it may be necessary to bleed the diesel lines (to the burners) as required.

4.1.5 Ash Removal

Typically the ash from previous operation has been left within the incinerator to cool, and ash removal is completed prior to beginning a "new" burn operation.

If the ash is to be removed, the operator shall undertake the following actions;

- Ensure that the combustion chamber is sufficiently cool.
- Do **NOT** spray water into the combustion chamber.
- While removing ash, all efforts will be made to avoid plugging the combustion air holes and damaging the burner tip.
- Use non-combustible container (i.e. a used 45 gallon drum which has been inspected to ensure no residual materials are present) to store ash.
- The use of a "remote" thermometer is recommended to check the temperatures in the various places in the primary chamber.
- Minimize dust generation – a light water spraying on ash in the container is recommended to minimize dust generation.
- Remove ash and place in appropriate container.
- Securely cover ash container.
- Label exterior of the container "Incinerator Ash" with robust label.
- Ensure appropriate disposal of ash.

4.1.6 Incinerator Start-up

The following procedures (Figure 7) shall be followed in order to initiate incineration sequence.

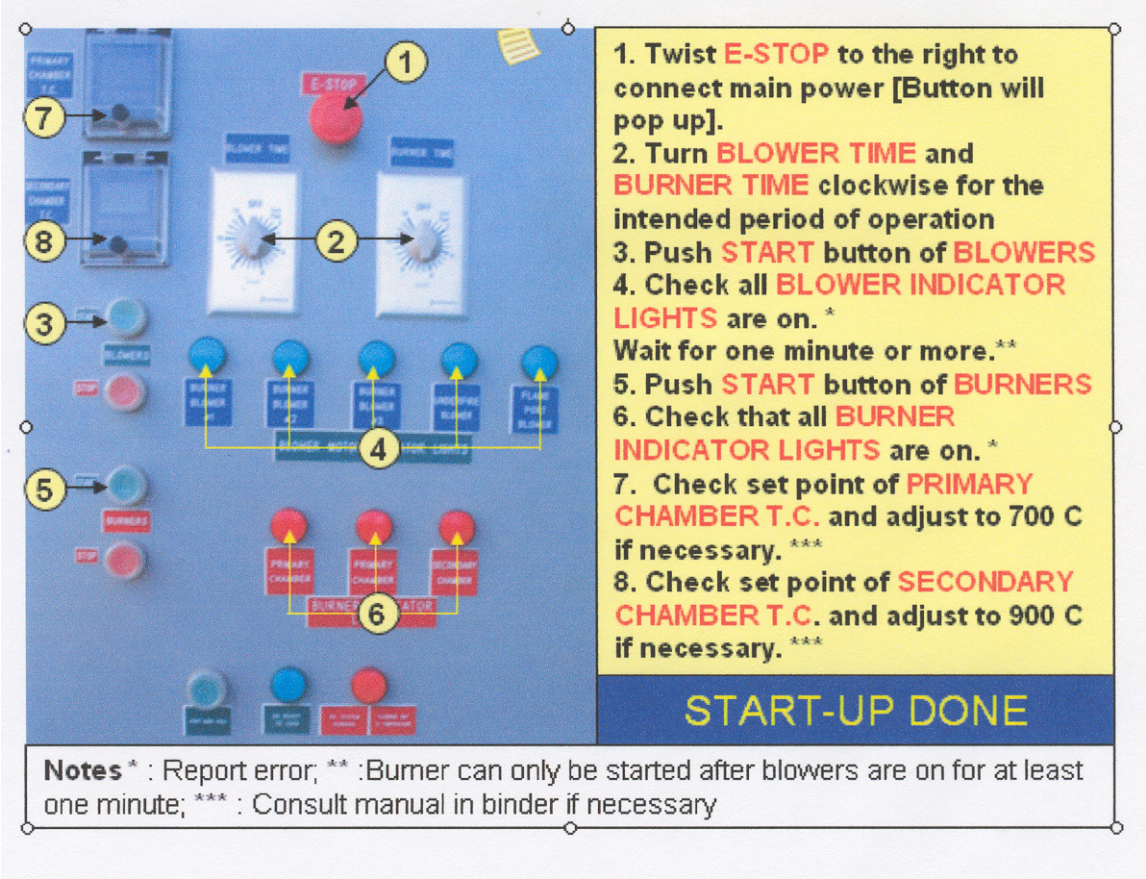


Figure 5: Model CY-100-CA-D-O Incinerator Procedures for Start-Up

Note: Temperatures in Steps 7 and 8 may be regulated: If so, the operator shall **SET THE TEMPERATURE TO THE REGULATED VALUES**

4.1.7 Waste Charging of Incinerator

The operator shall charge the incinerator in the following manner (Figure 8).

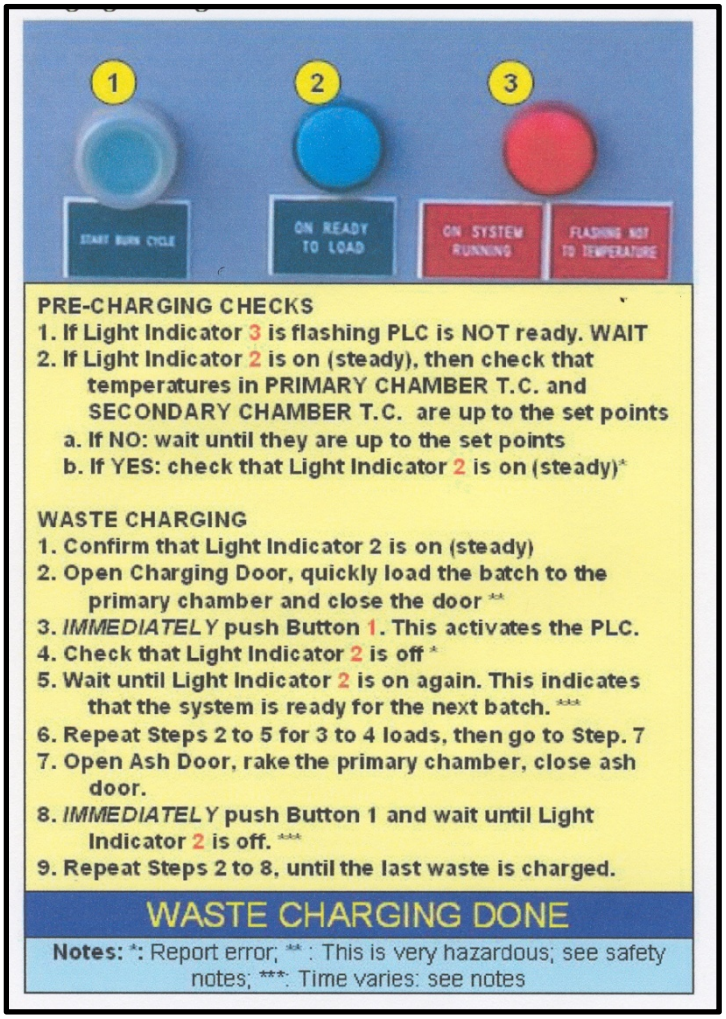


Figure 6: Model CY-100-CA-D-O Incinerator Procedures for Waste Charging

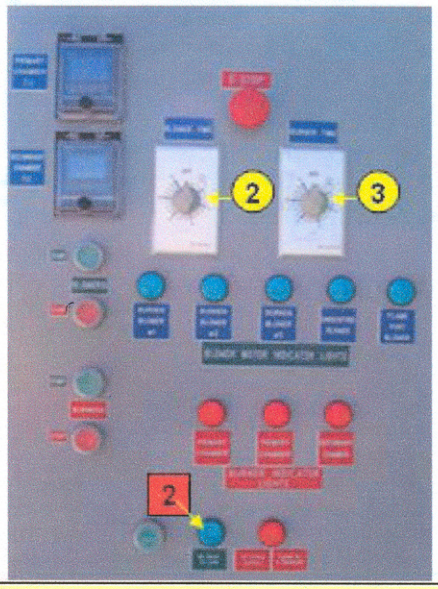
NOTE:

****** : 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].

4.1.8 Incinerator Burn-Down

The following procedure shall be followed by the incinerator operator during burn down (Figure 9).



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 7: Model CY-100-CA-D-O Incinerator Procedures for Burn Down

4.1.9 Incinerator 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 prior to the next operation of the incinerator.

5 Residuals (Ash) Management

When ash is removed from the incinerator, the operator shall undertake the following actions;

- Ensure that the combustion chamber is sufficiently cool.
- Do **NOT** spray water into the combustion chamber.
- While removing ash, all efforts will be made to avoid plugging the combustion air holes and damaging the burner tip.
- Use non-combustible container (i.e. a used 45 gallon drum which has been inspected to ensure no residual materials are present) to store ash.
- The use of a “remote” thermometer is recommended to check the temperatures in the various places in the primary chamber.
- Remove ash and place in appropriate container.
- Minimize dust generation – a light water spraying of water on the ash in the container is recommended to minimize dust generation.
- Securely cover ash container.
- Label exterior of the ash container “Incinerator Ash” with robust labelling.
- Store the securely covered ash container in an appropriate location.

Suitably labelled containers containing incinerator ash will be temporarily stored in a safe location on site until suitable transport is arranged to remove the ash for disposal in an appropriate and approved manner.

6 Model CY-100-CA-D-O Incinerator Maintenance

6.1.1 Routine Inspection and Maintenance

Routine inspections of the incinerator and associated facilities will be conducted by a qualified individual (i.e. trained operator) prior to every use of the incinerator. The inspection will include, but not necessarily be limited to:

- Inspecting all fuel lines, fuel storage facilities and secondary containment for leaks and check connections;
- Inspection of the spark arrestor to ensure no plugging;

During ash removal, the inspection will include, but not necessarily be limited to;

- Inspect refractory for large cracks (not expansion cracks)
- Check combustion air hole for plugging
- Inspect door gaskets for damages

6.1.2 Additional Maintenance and Inspection

In addition to the routine inspection and maintenance discussed in 6.1.1, the burner(s) and the blower(s) require maintenance as specified in the Westland Model CY-100-CA-D-O Operating and Maintenance Manual (Attachment A).

Table 1 provides a summary of inspections which will be conducted and the frequency of such inspections.

Table 1: Model CY-100-CA-D-O Inspections

Frequency	Component	Inspection Activity
Daily	Thermocouples (Primary & Secondary chamber)	Ensure readings are within acceptable “norms” of the primary and secondary chamber temperatures
	Contact switches	Ensure free movement and no obstruction
	Gasket/Seal in both “charge” and “ash” door	Ensure proper sealing
	Actuators (Primary & Secondary chambers)	Ensure free movement during incineration
	Refractory and under fire air holes in primary chamber	Ensure no large cracks No restriction of air holes
Weekly	Air blowers (Primary & Secondary chambers)	Ensure clean, unobstructed intakes
Monthly	External surface (Primary & Secondary chambers)	Ensure no discolouration
	Refractory in Secondary Chamber	Ensure no large cracks

In the event that the inspection identifies an "action item", operating personnel shall report the "item" to their immediate supervisor and appropriate remediation activities will be undertaken as soon as reasonably possible and as required.

6.2 Emissions Monitoring

HBML has implemented an incinerator emissions monitoring program. Under this program, emissions monitoring is conducted once per calendar year by a qualified firm retained specifically to conduct such monitoring. Monitoring includes the following parameters:

- Stack volume flow rate;
- Stack gas temperature;
- Moisture content;
- Dioxins;
- Furans; and,
- Mercury emissions.

Optional parameters for incinerator emissions monitoring will include;

- SO_2;
- NO_2
- O_2; and,
- Particulates.

The results of the emissions monitoring will be reported in the Annual Report prepared and submitted on or before March 31 of the following calendar year.

6.3 Quality Assurance/Quality Control during Monitoring

HBML will review and approve the QA/QC procedures of the qualified firm retained to conduct the air emission prior to such monitoring and provide a summary of those procedures as part of the emission monitoring reporting discussed.

6.4 Off-Specification Emissions Quality

The potential does exist for isolated, short term emissions that do not meet the discharge limits due to equipment malfunction or operator error, however, incinerator design limits the potential for such occurrences. Notwithstanding this design feature and in order to minimize the potential for such an event to happen, specific site personnel will be properly trained and assigned to regularly inspect the incinerator and to oversee the effective operation and maintenance of the facility.

Response to such an event will to identify and correct the original cause and the implementation of additional monitoring of the environment to assess the level, if any, of the impact of the discharge.

In the unlikely event that analysis does indicate that a monitoring sample exceeded the specified discharge guidelines, HBMC will, as soon as possible upon receiving the analytical results:

- Re-sample the emissions and submit the sample for appropriate analysis;
- Conduct a detailed inspection of the entire incinerator and waste stream and all associated facilities to identify the cause of the off specification discharge and ensure that the facility is operating within the prescribed parameters and operational limits;
- Correct the original cause; and,
- If necessary, implement additional monitoring to assess the level, if any, of the impact of the off specification discharge.

Due to the relatively short duration of such a condition, residual environmental effects resulting from such an event are likely to be negligible.

7 Incinerator Fuel Storage

The Westland Model CY-100-CA-D-O incinerator is fuelled by a diesel stored in tank located in immediate proximity to the incinerator.

The fuel storage, secondary containment and fuel delivery lines will be subject to regular inspection as discussed in section 4.1.4.

8 Spill Response

A site wide *Hope Bay Project – Hazardous Substances and Waste Dangerous Goods Management Plan* that covers all such materials that are or could potentially be located on the site has been developed. That plan provides material specific Standard Operating Procedures (SOPs) for the handling, transportation, storage and spill response measures for all hazardous substances and waste dangerous goods on site, including those associated with the incinerator, its fuel source and ash management.

Appropriately stocked Spill Response Kits are located in close proximity to the fuel storage area, as are relevant Material Safety Data Sheets (MSDS). The spill response kit will be inspected at least once every year to ensure that the materials are readily available and not stale dated. Any materials used from the spill kit will be replaced as soon as practical after use.

Although the potential for a spill is judged to be low, the potential does exist for such an event to happen. In any and all cases of an unanticipated discharge, spill or upset condition on the site, the policy is as follows:

1. Protect the health and safety of persons in the area.
2. Protect the environment.
3. Protect the facility and equipment.

Generally, in the event that an unanticipated discharge or spill does occur, personnel shall:

Respond Quickly Without Compromising Health and Safety

1. Identify spilled material

BE ALERT – DO NOT COMPROMISE YOUR ON SAFETY OR THAT OF OTHERS.

2. Assess the hazard of persons in the vicinity
3. Attend to injured if possible and safe to do so.
4. Assess the character of the spill
5. Inform immediate supervisor and Site Manager.
6. Stop product flow if safe to do so
7. Contain and recover spilled material as soon as possible

9 Record Keeping

A log of incinerator operations will be kept by operating personnel and will include, but not necessarily be limited to:

- Number of loads charged per day to each incinerator;
- Estimated total volume (in kilograms) of waste incinerated;
- Affirmation that pre-operational inspections (checks) were completed;
- Frequency of ash emptying;
- Estimate of total volume (in kilograms) of ash removed;
- Ash containment container type; and,
- Ash container on site storage location.

In addition, the results of the emissions monitoring will be maintained onsite and a record will be maintained on site of the number and type of ash containers and total volume (in kilograms) and all ash disposal, whether shipped off -site for appropriate disposal or disposed of on site, should approval for such disposal be realized. The results will be reported in the Annual Report prepared and submitted on or before March 31 of the following calendar year.

In addition, the site Environmental Coordinator will complete a review of this SOP at least once every three years; will update this document as required and submit the updated SOP for review and approval by the Exploration Site Superintendent.

10 Conclusion

The focus of the management and operation of the incinerators and of this *Standard Operating Procedure – Incinerator Model CY-100-CA-D-O* is on ensuring operator safety and environmental responsibility during the incineration of appropriate waste at the Hope Bay Project.

All site personnel charged with the responsibility for operating the incinerators will be appropriately trained prior to commencement of work so that they are aware of the health and safety risks associated with the incinerator and its operation.

All reasonable efforts will be made to segregate the waste stream on site to ensure that, to the extent possible only those materials suitable for incineration are burned in the incinerator, that emissions from the incinerator and residuals (ash) are managed or disposed of in an manner that protects the short-, medium- and long-term environment in the project area.

Attachment A:

Westland Model CY-100-CA-D-O Operating and Maintenance Manual

Appendix F
Incinerator Operations Checklist

INCINERATOR OPERATIONS
CHECK LIST

1	**Operator Training Completed** • SOP reviewed • Operations and Maintenance Manual reviewed
2	**Appropriate Personal Protective Equipment Employed** **General** • Heat resistant long sleeved shirt and long pants; • Long cuffed, puncture resistant gloves; • CSA approved, Grade 1 safety footwear; • CSA/ANSI approved headgear; and, • CSA/ANSI approved safety glasses. • CSA/ANSI approved full face shield **Ash Removal** • NIOSH N85 respirator
3	**Fire Extinguisher Present and Charged**
4	**Ash Removal** • Is incinerator cool • Is suitable ash container and container cover available • Is ash container label
5	**Re-Operational Checks Completed** • Is weather appropriate • Inspect fuel level, fuel tanks and connections • Inspect all door seals • Inspect chambers • Inspect air holes and blowers **DO NOT OPERATE INCINERATOR IF INSPECTION FINDS AN "ACTION ITEM"** Immediately report "Action Items" to Supervisor
6	**Incinerator pre-heated** (if required)
7	**Charging Incinerator** **DO NOT OVERLOAD BURN CHAMBER** • Place waste in incinerator • Shut door securely • Start incinerator
8	**Check that Burn is Complete** • Carefully open chamber and inspect • Rake and re-start incinerator if required • Re-charge with waste as required and re-start incinerator
9	**Allow Incinerator to Cool Before Emptying Ash** • Allow natural cooling **DO NOT SPRAY WATER IN CHAMBER TO COOL INCINERATOR**

Approved: _____ Date Posted: _____