AGNICO EAGLE

HOPE BAY MINE

Incinerator and Composter Waste Management Plan

JANUARY 2026
VERSION 7

Revisions

Version #	Date	Section	Summary of Changes	Author
0	May 2009		Initial issuance of Incinerator Management Plan	HBML
1	February 2012		Update and revise Incinerator Management Plan	HBML
1.1	March 2012		General document revision	HBML
2	September 2015		Updated to TMAC ownership and format, added glossary, added plan implementation information, update 2AM- Licence number references and requirements, add related documents and relevant legislation tables, updated information on incinerators in use, updated ash management section, included reference to NPRI reporting, added contingencies section	TMAC
3	December 2017		General document revision	TMAC
4	March 2017		Update with new incinerator specifications and O&M manual. In addition, updated throughout to consider the recently issued Amended Type "A" Water Licence 2AM-DOH1335 (Amendment No. 2) for the Doris-Madrid Project and a new Type "A" Water Licence No. 2AM-BOS1835 for the Boston Project	TMAC
5	March 2019		2019 Update	TMAC
6	March 2023	Throughout	Updated to Agnico Eagle ownership and format, inclusion of composter waste management.	Agnico Eagle
7	January 2026	Throughout	Changes throughout this version of the plan include minor clarifications and updates. Additions are marked in right-hand margin as follows: 	Agnico Eagle
		Section 2.2.2	Updated expectation of waste that will enter the composter.	
		Section D1.2	Updated to reflect no incinerator at Boston.	
		Appendix C	Included instruction manual for Brome Incinerator.	

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Glossary

Term	Definition
3Rs	Reduce, Reuse, and Recycle
Agnico Eagle	Agnico Eagle Mines Limited
CCME	Canadian Council of Ministers of the Environment
CWS	Canada-wide Standards
GHG	Greenhouse gas emissions
GN	Government of Nunavut
GN-DOE	Government of Nunavut Department of the Environment
NIRB	Nunavut Impact Review Board
NPRI	National Pollutant Release Inventory
NWB	Nunavut Water Board
PCDD	Poly-chlorinated dibenzo-p-dioxin
PCDF	Poly-chlorinated dibenzo-furan
PPE	Personal protective equipment
PVC	Poly-vinyl chloride
The Plan	Incinerator and Composter Waste Management Plan

1. Introduction

This *Incinerator and Composter Waste Management Plan* (the Plan) has been prepared by Agnico Eagle Mines Limited (Agnico Eagle) in accordance with the water licenses held by Agnico Eagle. The Plan is intended primarily for use by Agnico Eagle and its contractors to ensure that best practices for domestic waste management are followed, and that the conditions of water licenses and project permits are met.

This Plan is structured in a manner such that one document pertaining to domestic waste incineration and composting is approved and implemented across all Hope Bay project sites, while still addressing site- and licence-specific needs. The main document outlines Agnico Eagle's approach to domestic waste stream segregation, incinerator and composter management. Appended modules provide details for each site and the associated water licence. In the event of a new water licence, or an existing licence amendment, only the specific modules pertaining to that licence and site will need to be revised. This is intended for consistency and efficiency across operations and for compliance management.

1.1. Objectives

The main objective of this Plan is to ensure domestic waste incinerators and composters are operated in a safe, efficient and environmentally-compliant manner. Consistent with Agnico Eagle's intent to be a responsible operator, these objectives are described as follows:

- Compliance with the Environmental Guidelines for the Burning and Incineration of Solid Waste (Government of Nunavut Environmental Protection Division);
- Compliance with the Environment Canada Technical Document for Batch Waste Incineration;
- Compliance with the Canadian Council of Ministers of the Environment Canada-Wide Standards for Mercury Emissions and Dioxins and Furans;
- Compliance with Project Certificate and Water Licence requirements;
- Prevention of public health risk;
- Protection of the operator;
- Protection of air by reducing air emissions;
- Reducing greenhouse gas emissions;
- Protection of surface and ground water;
- Protection of land;
- Protection of local flora and fauna species; and
- Conservation of resources.

This Plan has been developed to ensure that these factors are built into the operational approach at Hope Bay. It discusses the importance of waste management and reduction of specific waste streams to ensure Canada-wide Standards (CWS) for dioxins, furans and mercury are achieved.

1.2. Relevant Legislation and Guidance

1.2.1. Incinerator

Table 1.1 provides a summary of federal and territorial regulations and associated guidelines applicable to incineration.

Table 1.1: List of Federal and Territorial Regulations Applicable to Incineration

Regulation/Guideline	Year	Governing Body	Relevance
Canada Wide Standards for Dioxins and Furans	2001	Canadian Council of Ministers of the Environment (CCME)	Contains stack testing requirements triggered by waste volumes incinerated, numeric targets for dioxins and furans.
Canada Wide Standards for Mercury Emissions	2000	CCME	Contains numeric targets for mercury.
Technical Document for Batch Waste Incineration	2010	Environment Canada	Contains recommendations for batch waste incineration to achieve emissions compliance.
Environmental Guideline for the Burning and Incineration of Solid Waste	2012	Government of Nunavut Department of Environment (GN-DOE)	Identifies pollutants of concern, outlines best management practices for burning of wastes, types of wastes that can be burned, and ash management.
Environmental Guideline for Industrial Waste Discharges into Municipal Solid Waste and Sewage Treatment Facilities	2011	GN-DOE	Provides the criteria that determine if process residuals (including incinerator ash) may be disposed in a municipal landfill, or is classified as a hazardous waste.

CWS are intergovernmental agreements developed under the CCME. CWS can include qualitative or quantitative standards, guidelines, objectives and criteria for protecting the environment and reducing risks to human health. Canada has identified dioxins, furans and mercury as emission products that need to be managed as they pose a potentially significant health and environmental threat. Hope Bay's Project Certificate and Nunavut Water Board's (NWBs) Water Licence states that these emissions must be in compliance with the CWS for dioxins, furans and mercury. The Technical Document for Batch Waste Incineration was issued by Environment Canada in January 2010 and is intended to act as a guideline for owners and operators of various incinerators. The technical document focuses on batch waste incinerators ranging in size from 50 to 3,000 kg of waste per batch. Batch waste incinerators are those that operate in a non-continuous manner (i.e., they are charged with waste prior to the initiation of the burn cycle, and the door remains closed until the ash has cooled inside the primary chamber). Batch waste incineration is the type of incineration process utilized at Hope Bay for domestic wastes.

The document recommends and describes a six-step process for batch waste incineration:

- Step 1 – Understand Your Waste Stream;
- Step 2 – Select the Appropriate Incinerator (or Evaluate the Existing System);
- Step 3 – Properly Equip and Install the Incinerator;
- Step 4 – Operate the Incinerator for Optimum Combustion;

- Step 5 – Safely Handle and Dispose of Incinerator Residues; and
- Step 6 – Maintain Records and Report.

The batch waste incineration document addresses proper system selection, operation, maintenance and record keeping, with the goals of achieving the CWS for dioxins/furans and mercury and reducing releases of other toxic substances.

The Environmental Guideline for the Burning and Incineration of Solid Waste produced by the Government of Nunavut provides guidance for incineration and ash disposition best management practices to reduce risk to the environment.

The Environmental Guideline for Industrial Waste Discharges into Municipal Solid Waste and Sewage Treatment Facilities governs deposition of process residuals into municipal landfills in Nunavut, but the *Non-hazardous Waste Management Plan* and the *Hazardous Waste Management Plan*, contains similar criteria to determine acceptable wastes for landfilling at Hope Bay, or for determining alternate disposition of incinerator bottom ash classified as a hazardous waste if sampling determines it contains pollutants of concern.

1.2.2. Composter

In Nunavut, there is currently no organics waste strategy. However, guidelines developed for Nunavut focus on diverting materials from disposal and proper safe management. According to the Government of Nunavut (GN), in an effort for planning for effective solid waste management, there are plans to focus its resources on a number of targeted initiatives. The plans include the development of a Nunavut-wide Solid Waste Management Strategy, whose purpose is to evaluate all aspects of waste management with a focus on available land, fencing, environmental concerns, recycling, re-use, segregation, sequestration, composting and various other options. The Nunavut *Environmental Protection Act* (Nunavut, 2010) prescribes the requirements for activities relating to the environment.

A guideline from Environment and Climate Change Canada, dated 2017 and entitled, “Solid Waste Management for Northern and Remote Communities, Planning and Technical Guidance Document,” provides guidance on the complex waste management issues faced by northern and remote communities and provides planning and technical guidance and best practices relevant to the northern communities. Composting is included in the solid waste management diversion strategies in this guideline and states that diverting organic waste from landfills through composting reduces greenhouse gas emissions (GHG). According to the guidance document, compost output is considered residual waste if it is sent to landfill for disposal, and composting represents an opportunity for northern and remote communities to reduce leachate quantity and improve leachate quality, reduce GHG emissions, preserve landfill capacity and produce a compost product that can be used for other purposes.

The final compost product from the composting process at Hope Bay is proposed to be used as overburden for remediation, to promote vegetation growth in areas impacted by operations as part of progressive reclamation, or prepared for offsite disposal. Agnico Eagle may explore other potential uses of the

compost product in the future. In Nunavut, there are no regulations or guidelines specific to the quality or uses of compost product, however, guidelines for compost quality and categorization exist at the federal level. Accordingly, Agnico Eagle will adhere to the CCME Guidelines for Compost Quality (2005) for compost usage across the site.

1.2.2.1. Guidelines for Compost Quality

The CCME Guidelines for Compost Quality is intended to act as a guideline to ensure a consistent, high quality compost product that is safe for all users. The guidelines apply to compost produced from any organic feedstock and apply to the quality of compost rather than the composting process. Should a reclamation project demonstrate a useful application for compost, these guidelines will be applied to the compost used. The compost guidelines are based on four criteria, including trace elements, foreign matter, maturity, and pathogens.

1.2.2.2. Categorization of Compost

Based on the CCME Guidelines for Compost Quality, two compost categories exist for trace element concentrations and foreign matter. Categories A (unrestricted use) and B (restricted use) are based on the end use of the compost material.

- **Category A** – Compost which can be used in any application, such as agricultural lands, residential gardens, horticultural operations, the nursery industry, and other businesses.
- **Category B** – Compost that has a restricted use because of the presence of sharp foreign matter or higher trace element content. Category B compost may require additional control when deemed necessary by a province or territory.

Please note that for a compost to meet the unrestricted use category, it must meet the unrestricted (Category A) requirements for all trace elements and sharp foreign matter. If the compost fails one criterion of the guideline for unrestricted use but meets the criteria for restricted (Category B) use, then it is classified as a Category B product. Products that do not meet the criteria for either Category A or B must be used or disposed of offsite.

1.3. Related Documents

The documents listed in Table 1.2 are expected to be referenced and utilized in conjunction with the Incinerator and Composter Waste Management Plan.

Table 1.2: List of Documents Related to the Incinerator and Composter Waste Management Plan

Document Title	Relevance
Non-hazardous Waste Management Plan	Describes management of non-hazardous solid waste segregated from the incinerator waste stream and disposal of incinerator ash.
Hazardous Waste Management Plan	Describes management of items such as batteries, aerosol containers and other materials not acceptable for incineration or landfilling.
Air Quality Management Plan	Describes the air quality monitoring programs associated with the Hope Bay Mine, including stack testing of incinerators.
Kitchen Food and Waste Handling Storage	Describes proper handling and storage procedures of food wastes by all personnel at Hope Bay.
Incinerator Ash Sampling	Describes the procedure for collecting composite ash samples to be submitted for laboratory analysis.

The Plan is supported by a set of working procedures that provide detailed instructions on such topics as waste sorting, operation of specific models of incinerators in use, and ash sampling protocols. The procedures contain the various forms and checklists required to ensure the appropriate records are maintained concerning all incinerator operations.

1.4. Plan Implementation

In accordance with the requirements of the General Conditions of the applicable water licenses, this Plan will be implemented following its submission, subject to any modifications proposed by the NWB as a result of the review and approval process.

This Plan will be periodically reviewed and updated as required as the Mine moves through operations and final closure and reclamation.

2. Incineration and Composter Management

Waste management at Hope Bay has made substantial advances and improvements since activity in the Mine area started. Dedicated facilities allow for centralized collection, sorting and proper packaging for various forms of waste products. This may include on-site incineration, composting, or preparing waste for transport to a waste transfer station for further recycling, treatment, or disposal. To reduce GHGs and air emissions, any waste that meets the requirements for composting on-site will be sent to the composter, otherwise it will be screened to ensure it meets the requirements for incineration on site. For more information regarding hazardous or non-hazardous waste management at Hope Bay refer to the following documents:

- *Hazardous Waste Management Plan*; and
- *Non-hazardous Waste Management Plan*.

Under no circumstances does Agnico Eagle allow personnel or contractors to burn hazardous waste. Hazardous waste and industrial waste are kept separate and temporarily stored according to regulations until shipped off site for disposal or recycling at approved facilities. Site incinerators are only approved to burn “domestic” camp waste such as kitchen waste, food scraps, camp room and restroom garbage, cardboard, paper and sewage sludge cake.

2.1. Waste Stream Management

2.1.1. Waste Stream Composition and Segregation

The first steps to ensuring that effective and compliant incineration and composting occurs is to ensure proper waste segregation so that inappropriate wastes do not make it into the waste stream destined for the incinerator or composter, as well as to understand the resulting composition of the wastes.

Only appropriate domestic camp waste is permitted for incineration and composting. All wastes are segregated at the source to ensure non-burnable waste streams do not enter the feed stock for the incinerator or composter. All “burnable” waste is placed in specifically identified waste containers with transparent bags and in bins located throughout the camp facilities.

2.1.1.1. Acceptable Wastes for Composting

- Organic matter including food (e.g., coffee grounds and tea bags, eggs and egg shells, fruit and vegetable peelings, meat, chicken and fish including bones, nut shells, pasta, rice, sauces and gravy, solid dairy products, table scraps and plate scraping, etc.);
- Paper and cardboard; and
- Dead animals (small size only).

2.1.1.2. Unacceptable Wastes for Incineration and Composting

Materials that are not listed above are unacceptable for incineration and composting. These materials include, but are not limited to:

- Food containers and wrappings including plastics that are contaminated by food;
- Uncontaminated plastics, including chlorinated plastics;
- Inert materials such as concrete, bricks, ceramics, ash;
- Bulky materials such as machinery parts or large metal goods such as appliances (shipped south and recycled in an accredited facility);
- Radioactive materials such as smoke detectors;
- Potentially explosive materials such as propane tanks, other pressurized vessels, unused or ineffective explosives;
- Other hazardous materials such as organic chemicals (PCBs, pesticides), other toxics (arsenic, cyanide);
- Electronics (shipped south and recycled in an accredited facility);
- Batteries (shipped south and recycled in an accredited facility);
- Asbestos;
- Drywall board;
- Vehicles and machinery (shipped south and recycled in an accredited facility);
- Fluorescent light bulbs;
- Whole tires;
- Waste oils;
- Flammable or combustible petroleum hydrocarbons unsuitable for its purpose due to the presence or contaminants or loss of original properties (such as gasoline, diesel fuel, aviation fuel, kerosene, naphtha or fuel oil);
- Any materials containing mercury;
- Used oil that exceeds the Maximum Impurity Limits ;
- Waste oil with a flash point of less than 37.7 deg C;
- Paint; and
- Solvents.

Prior to loading the waste batches in the incinerator or composter, the feed material is visually inspected by the operator to ensure it does not contain inappropriate waste materials.

When encountered, inappropriate waste material is removed from the incinerator feed, where possible. If the inappropriate waste is too intermixed with the incinerator feed, the bag will be rejected and not incinerated. Removed inappropriate wastes and rejected batches will be stored and handled in accordance with the *Hazardous Waste Management Plan*. The waste feed inspections shall be recorded on the appropriate forms, and issues with proper segregation and sorting at source in the waste management stream will be addressed by identifying the source or root cause of the issue, re-enforcing or improving training of site personnel, providing additional labelled receptacles, or implementing other measures as needed.

2.1.2. Reduce, Reuse and Recycle

Agnico Eagle has adopted the 3Rs of waste management: Reduce, Reuse, and Recycle. The objective of these activities is to divert as much material from becoming a waste (hazardous or otherwise) and therefore reduce the total volume of wastes requiring handling, storage, transportation and disposal. Some of the most significant actions in this regard include:

Reduce:

- Purchasing only the required amounts of materials and buying in bulk when the opportunity is available.
- Employing inventory control methods in an attempt to ensure that quantities of materials are completely utilized.
- Establishing maintenance schedules that are consistent with the equipment manufacturers' suggested replacement.
- Maintaining and protecting materials to prevent damage and breakage.
- Eliminating unnecessary plastic and bulky packaging by buying kitchen supplies in bulk (i.e., ketchup, salad dressings, syrups, etc.).
- Cutting down on plastic food packaging.
- Substituting less hazardous chemicals where possible.
- Selecting products that provide the maximum "life-of-material".

Re-Use:

- If appropriate, collect and return materials to the system (i.e., equipment, operations, etc.) following maintenance or repair.
- Waste oil burners will be used to heat selected facilities.
- Oil/water separators are used onsite to reduce the amount of contaminated water requiring shipment off site.
- If appropriate, filter and/or use additives to replenish lost properties of material in order to extend its useful life.
- Testing to ensure items (i.e., batteries) are "spent" before removing from service.

Recycle:

- Commercial companies are used to the maximum extent practical to recycle appropriate materials on a fee-for-service basis.
- Explore waste management options that allow for the recycling of a material or product instead of disposal.

2.1.3. Prevention of Wildlife Attraction

Agnico Eagle is required by the Water Licence and Project Certificate to manage food wastes to prevent attraction of wildlife, and if necessary, incinerate food wastes. A comprehensive program exists to educate site personnel on the importance of proper food waste (or other potential attractant) management to

ensure animals are not attracted to worksites. All food waste is returned daily to the main camp facilities so it is captured in the domestic waste stream. Collection and transfer of food wastes is performed so that these attractants are stored safely, moved between facilities securely, segregated and sent for composting and as a last resort, to reduce wildlife attraction, are burned in the incinerator promptly.

2.1.4. Targeting Pre-cursors to the Formation of Dioxins and Furans

Chlorine, in almost any form, is the key component required for dioxin and furan formation. Reducing or removing the chlorinated material that enters incinerators through waste segregation and composting, is the first minimization strategy to reduce the formation of dioxins and furans. Removing all chlorine compounds is extremely difficult because chlorine is used in the manufacture of a large variety of products, and in many cases there are no substitutes. Poly vinyl chloride (PVC) containing products are, however, eliminated from the incinerator waste stream to the extent possible. Sewage sludge also generally contains chlorinated compounds. Agnico Eagle may incinerate adequately dried sewage sludge or alternatively store this material in biodegradable bags (in a secure location not accessible to wildlife) until it can be buried in the overburden stockpile or beneath tailings in the Tailings Impoundment Area.

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:

- **Metals:** The inorganic component of the waste is largely made of metal-containing materials. During combustion, it is possible for these metals to become catalysts for the formation of dioxins and furans and it is, therefore, important that metal be eliminated from the waste stream destined for incineration. The metals include foils, batteries, nails and screws, painted wood products, aerosol cans, etc.
- **Plastic:** Plastics, particularly PVC, must be eliminated from the incinerator waste stream to the extent possible. The chlorine compounds contained in PVC and plastics are an ideal building block for the formation of dioxins and furans.
- **Medical Waste:** Medical waste can potentially be the biggest source of dioxin- and furan-forming material. Medical waste contains 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. Agnico Eagle avoids incinerating these materials to the extent possible by segregating them from the incinerator waste stream.

By following these waste segregation guidelines the extent of dioxin and furan formation will be reduced.

2.1.5. Management Response

Current waste segregation practices, including composting, greatly reduce the volume of plastics, metals, glass, and other potential catalysts for dioxin and furan formation from ending up in the incinerator waste stream.

Containers are set up throughout camp buildings to collect batteries, aerosol cans, food cans and glass containers, domestic plastic containers (toiletries, etc.), refundable cans/bottles and medical wastes. Separate labelled waste containers are available for plastic construction debris, cardboard, non-burnable wood and rags/absorbent pads. All kitchen grease is securely stored for offsite disposal and does not enter the incinerator waste stream.

2.2. Composter

Composting is an efficient means of reducing the mass and volume of organic waste generated, thus reducing GHGs and air emissions (such as dioxins and furans). Prior to the introduction of the in-vessel composter, organic material at the Hope Bay facility was being sent to the on-site incinerator. The incineration process utilizes fuel for its operation. Diverting the organic waste to the composting operation provides an opportunity to reduce the volume of waste and avoid fuel consumption and emissions typically associated with burning the organic material in an incinerator.

The composter is housed where waste management activities (i.e., the incinerator) are already conducted, and within the approved mine footprint.

2.2.1. Compost Waste Stream

Acceptable and unacceptable material for the composter is provided in Section 2.1.1.

2.2.2. Waste Volumes

V7

It is expected that approximately 830 kg of waste will enter the composter weekly. This includes food waste from back-of-kitchen, and cardboard. As camp capacity increases, the on-site waste management team will assess if increased processing requirements are required.

2.2.3. Composter Description and Installation

Agnico Eagle selected the Brome 624A in-vessel composter from the Brome series. A composter operating manual has been provided in Appendix C for the Brome series of composters. This manual must be referred to for all installation, operational and maintenance requirements.

Precautions must be followed for the indoor installation of this composting equipment as per the composter operating manual and include the following:

- Plan a ventilation shaft or a sanitary drain that exits the building for the elimination of composting gas and odours;
- Do not place the air exit near an air intake, a door or a window;
- Take care to place the system in a separate room to avoid any contact with human food preparation or food storage areas to minimize contamination risks;
- Make sure the building's foundation can support the weight of the composter when it's both empty and full; and

- Allow sufficient space around the composter to provide ease of movement related to composting operations (addition of matter, collecting compost at the exit, etc.).

The building where the composter is located allows personnel to operate and repair the composter in a temperature-controlled environment. If unplanned maintenance is required for the composter, the incinerator provides an alternate means for handling compostable waste.

During daily composter operation, waste is segregated at the source to ensure non-compostable waste streams do not enter the composter. Collected compostable waste are stored in dedicated waste containers, located throughout the Hope Bay Mine where organic material may be produced.

2.2.4. How the Composter Works

The Brome series in-vessel composter consists of an insulated cylinder that rotates according to pre-set timed intervals. The rotation of the cylinder allows the material inside of the chamber to mix while providing aeration. Aeration is important to provide oxygen for the microorganisms that are digesting organic material to make the compost. Heat will be produced during the composting process from the breakdown of organic material by the microorganisms.

The composter will operate in a continuous-feed manner. As more material is added and the cylinder rotates, the digesting material is moved along the vessel and is then discharged at the cylinder's extremity through an opening that also serves as an air inlet for oxygen. The amount of finished compost depends on the rotation intervals and the amount of organic material added to the vessel. Key performance indicators such as temperature and humidity will be developed with the composter supplier during commissioning, based on the model of composter selected and the site conditions.

2.2.5. Chemical Process

The composter uses an aerobic, biological process involving the succession of various microorganisms decomposing organic materials and converting them into a biologically stable product. The predominant types of microorganisms present during composting are bacteria, fungi and actinomycetes. Composting is different than the decay process that occurs in nature, as composting is monitored and controlled, aerobic conditions are maintained and includes a high-temperature phase for a specified amount of time (e.g., above 55 ˚C) that reduces or eliminates pathogens and weed seeds.

Almost any organic material is suitable for composting, as described in Section 2.1.1. The composter requires a certain ratio of carbon-rich materials, or "browns," and nitrogen-rich materials, or "greens." Examples of brown carbon-containing materials are paper and cardboard. Nitrogen-containing materials are fresh or green, such as kitchen scraps. Food scraps provide nitrogen to the system whereas paper and cardboard provide high carbon values. A specific strategy is used to achieve the required balance of nitrogen-rich and carbon-rich materials fed into the composting system such that optimum conditions are provided for the bacteria in the composter.

2.2.6. Process Duration

An agricultural mixer is used to break down and mix the material, which is then transferred to the composter. The breakdown of materials increases the surface area to volume ratio and allows for increased aeration and biological activity within the composter.

The compostable material spends a minimum of nine days in the composter. During the composting process the operators review the temperature of the compost within the composting chamber to ensure proper targets are being reached (between 55˚C and 65˚C). The operators visually inspect the compost for foreign matter and check that the texture and consistency of the compost appear normal. Depending on the amount of material composted, the material may have a residency time of between 9-20 days in the composter, during which time the cylinder completes one full revolution at regular intervals throughout the day. Rotating the material causes an aerobic environment to be maintained for maximum bacterial growth. The bacteria generate heat, water, and gases such as carbon dioxide during aerobic respiration. The insulated composting chamber traps heat and produces favorable temperatures for aerobic respiration. Gases produced during the composting (e.g., carbon dioxide) process is ventilated from the building using a hood vent at the output of the composting unit. The compost is discharged once the material has reached the end of the composting cylinder. Compost is only discharged during the cylinder revolutions, and thus the amount of product being discharged can be manipulated based on the time intervals between revolutions and the amount of product added to the composter.

2.2.7. Output

As the compost is discharged, it runs across a screen/sifter that removes any large material that may have been accidently introduced into the composter. The material discharged from the composter is typically equal to roughly half of the tonnage fed into the composter. Most of the weight loss will be due to the dehydration of the material as it breaks down. The solid decomposed material is discharged and stored in a bin. The full bin of compost is then transported for use, for storage, or to the waste management area for disposal as part of closure and progressive reclamation.

2.2.7.1. Disposing of Residual Materials

The residual material that is discharged from the composter mainly consist of materials that are too large to fit through the sizing screen/sifter. The residual materials are sorted into incinerator waste, recyclable material, landfill material, or hazardous goods that will be shipped off site. Larger organic material may be reintroduced into the mixer to begin the composting process again. If the composting process does not break down the material effectively after the second cycle, or if the composter is temporarily out of service for any reason, the material will then be sent to the incinerator.

2.2.8. Odour and Dust Control

Since the composter is in an enclosed area, a ventilation shaft or a sanitary drain that exits the building for the elimination of composting gas and odours is included in the building design. Odours during the

operation of the equipment is mitigated by sweeping the floor, cleaning up any organic matter debris on or around the composter, and removing any material that has fallen on the floor.

Careful monitoring of the composting process using appropriate carbon to nitrogen ratios as discussed with the supplier, as well as using regular log book entries and adherence to the procedures and recipes will aid in avoiding the generation of odours. The monitoring of humidity is an important factor in controlling odours from the composting process. Composting often proceeds well at a moisture content of 40-60% by weight. At lower moisture levels, microbial activity is limited. At higher levels, the process is likely to become anaerobic and foul-smelling.

2.2.9. Introduction of Invasive Species

Composting is monitored and controlled. Aerobic conditions will be maintained and includes a high temperature phase for a specified amount of time (e.g., above 55 ˚C) that reduces or eliminates pathogens and weed seeds. Adherence to the composting instructions will avoid concerns over introduction of invasive species.

2.3. Dioxin and Furan Emissions

Poly-chlorinated dibenzo-p-dioxins (PCDDs) and poly-chlorinated dibenzo-furans (PCDFs), commonly known as dioxins and furans, respectively, are predominantly a result of human activity. These substances are toxic, persistent, and bio-accumulative. Due to their extraordinary environmental persistence and capacity to accumulate in biological tissues, dioxins and furans are slated for virtual elimination.

Dioxin and furan contamination found in soil, water, sediments, and tissues are the subject of national guidelines for dioxins and furans. The CWS Dioxin/Furan guideline for incineration is 80 pg I-TEQ/m3, where pg = picogram, I-TEQ = international toxic equivalent, m3 = cubic metre.

The exact mechanism of dioxin and furan formation in incinerators is poorly understood, but generally they form during the thermal breakdown of organic materials in the presence of transition metals and chlorinated compounds. Dioxin formation takes place as the flue gas cools from the initial 1,000°C to about 250°C, with peak dioxin and furan formation occurring in the range of 650°C to 250°C.

Regardless of how dioxins and furans are formed, certain operating conditions increase the potential for formation of these compounds including:

- Incomplete combustion of fuel;
- An oxidizing atmosphere;
- Presence of a chlorine source;
- Fly ash surfaces (carbon source);
- Fly ash with degenerated graphite structures; and
- Presence of catalytic metals (copper, iron, manganese, zinc, etc.).

2.3.1. Management Response

Dioxin and furan emissions from incinerators may be reduced by:

- Reducing or removing certain waste types from the incinerator waste stream as described above through appropriate waste sorting techniques, including composting;
- Placement of waste in the incinerator chamber and operating the incinerator according to manufacturer specifications to ensure optimal burning efficiency and provide adequate destruction of dioxins and furans; and
- Use of Pre-Operational, Operational and Maintenance Checklists and Log Books to ensure that the unit is operated in a safe and efficient manner.

Agnico Eagle Hope Bay Mine will continue to reduce dioxins and furans through segregation and composting, however Agnico Eagle has selected and will continue to select incinerator technology that should reduce the extent to which dioxins and furans can form. This is achieved through the following mechanisms:

- Use of dual or secondary chamber incinerator technology with a clear burn process defined which eliminates spurious burn conditions and operator error.

- Operating each incinerator unit within the manufacturer specifications to achieve adequate temperatures and residence time. This should allow the materials to be combusted completely so that no precursors are available for dioxin and furan formation during cooling.

2.4. Mercury Emissions

Waste incineration has historically been responsible for a portion of the mercury emitted in Canada; however reductions in emissions have been apparent nationwide since the implementation of the CWS and the requirement to monitor specific emissions. Improved exhaust gas controls can reduce emissions of acid gases and fine particulates in addition to new activated carbon injection systems that decrease emissions of mercury and dioxins and furans.

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.

Emission limits are expressed as the concentrations of specific compounds and elements present in the exhaust gas exiting the stack of the facility. New or expanding facilities are expected to comply with the standard upon attaining normal full scale operation, while the limits for existing facilities are capable of being met using generally available technology (or waste diversion). Larger facilities are subject to annual stack testing to verify compliance with the limit. Mercury emission limits are presented in Table 2.1.

Table 2.1: Canada-wide Standard for Mercury Emissions

Source	Mercury Standard
Municipal waste incineration	20 µg/Rm3
Hazardous waste incineration	50 µg/Rm3
Sewage sludge incineration	70 µg/Rm3
Medical waste incineration	20 µg/Rm3

µg = microgram, Rm3 = reference cubic metre

2.4.1. Management Response

Any waste stream that may contain mercury, including thermostats, thermometers, light bulbs, etc., is disposed of at an off-site facility. These items are placed in labelled collection containers located throughout the camp and facility. Waste management employees screen for all possible mercury contaminated waste and ensure all relevant regulations are adhered to regarding handling, storage and transport for offsite disposal. For more information regarding the regulations and waste shipment procedures please refer to the *Hazardous Waste Management Plan*.

2.5. Incinerator Capacity and Operations

Incinerator capacity has been selected to ensure timely and effective management of the volumes of burnable domestic waste generated at Hope Bay. Incinerator details, including model, capacity, location, status and reference to operating details and manuals are provided in the site-specific modules appended to this plan.

2.5.1. Management Response

The Hope Bay site waste management facilities are closely supervised and waste management personnel are present to monitor incinerator burns and document burn conditions and other relevant information. Incinerator units may be enclosed within shelters to ensure efficiency of the burn process is optimized.

Employees are trained prior to commencement of work so that they are aware of the operational procedure and capacity of the incinerator, and health and safety risks associated with the incinerator and its operation.

2.5.1.1. Burn Process Operational Overview

Batch waste incineration is a process that occurs through charging the incinerator unit with a discrete load or quantity, and allowing a complete burn cycle to finish before the next load is burned. This process is critical to the efficiency of the burn. Standard operating procedures outline the process to prepare and properly load each incinerator in accordance with manufacturer instructions to optimize burn efficiency.

2.5.1.2. Batch Preparation of Waste

Using categories defined by the supplier of the incinerator, the approximate waste composition of a batch is determined for each incinerator model used. Understanding the typical waste stream composition is important as it leads to key opportunities for waste management generally and specifically for incineration control on site. Periodic audits of the waste stream using incinerator logs and operational checklists will guide continuous improvement of batch preparation processes.

Daily record keeping and operator experience will assist in ensuring batches are prepared consistently and within the capacity of the specific incinerator unit. The weight of the various waste categories loaded into the incinerator determine the proper batch composition for efficient burn cycles.

An appropriate load composition would roughly be represented by:

55% Food Waste / 23% Paper or Cardboard Waste / 22% Other

2.5.1.3. Health and Safety

All incinerators at Hope Bay will be operated in accordance with the manufacturer's instructions. All operators will have appropriate training before being tasked with operating any unit or handling waste and will include the identification of any potential hazards that could be encountered while performing these tasks. Standard operating procedures outline the appropriate personal protective equipment that is required by all personnel operating the incinerator system.

2.5.1.4. Training

Personnel with the responsibility of operating incinerators at Hope Bay will be required to read and comprehend this Plan, the Operating and Maintenance Manual(s) relevant to the unit they will be operating, and any Standard Operating Procedures that support this Plan or provide site-specific information required for safe and effective incinerator operations.

In addition, an on-site training program will be provided to cover all aspects of incinerator management including: equipment pre-checks, operation, maintenance, monitoring, and record keeping. The training also includes identification of activity related risks, knowledge and use of job-specific personal protective equipment (PPE), as well as proper handling, storage, and disposal of all ash generated from the facility. A supervised competency evaluation is conducted for all trainees.

The training is both job-specific and equipment-specific and is provided to any site personnel assigned the responsibility to oversee, inspect, maintain, or monitor the incinerator.

2.6. Ash Management

Bottom ash in the incinerator can contain pollutants of concern including mercury, lead and cadmium. These residuals in the ash can be reduced to acceptable levels with proper segregation of non-burnable items from the incinerator feed stock and through maximizing efficient burn practices. The *Environmental*

Guideline for Industrial Waste Discharges into Municipal Solid Waste and Sewage Treatment Facilities published by the Government of Nunavut in 2011 establishes the criteria for determining whether the bottom ash from open burning or incineration is appropriate for disposal in a landfill.

2.6.1. Management Response

The incinerator ash sampling program established for Hope Bay will determine the proper disposition of bottom ash. Once the combustion chamber of the incinerator is cool, the incinerator operator will remove the ash from the previous burn cycle before reloading the incinerator. During ash removal, the operator will inspect and clean the combustion air holes, inspect the burner tip for damage, and will also collect ash samples for analysis.

The remaining ash is placed into metal containers to be weighed. Once weighed and documented, these contents are then transferred into a labelled drum. When full, this drum is sealed and stored to await results of the ash sampling.

A composite sample of ash is sent to an external laboratory for analysis of:

- Leachable metals;
- Leachable mercury;
- Leachable benzene, toluene, xylenes, and ethylbenzene;
- Paint filter; and
- Flash point.

The details of this sampling program can be found in standard operating procedures for ash sampling for the site incinerators and burn pan. Results of the sampling will determine if the ash can be disposed of as non-hazardous waste (landfilled) or must be treated as hazardous waste and managed in accordance with the site *Hazardous Waste Management Plan*. Ash sampling analysis records are maintained on site, and may be conveyed offsite to receivers of ash shipments if warranted. Hazardous waste shipments will follow the Transportation of Dangerous Goods regulations as well as the Interprovincial Movements of Hazardous Waste regulations. The Waste Management Facility maintains a tracking report of all ash shipped from Hope Bay. Certificates of Disposal for waste shipped off site are provided by the off-site waste handling facility. This is provided so waste generators can demonstrate to regulatory authorities that their waste is being handled by an approved facility and that the waste was disposed according to applicable federal and territorial regulations.

2.7. Fuel Storage

Incinerator units are supplied by dedicated diesel fuel tanks.

2.7.1. Management Response

The fuel storage, secondary containment and fuel delivery lines are subject to regular inspection. There are also spill kits available nearby in the event of a spill or leaking fuel line.

3. Monitoring and Evaluation

3.1. Inspections

Routine inspections of the incinerator, composter, and associated facilities will be conducted by a qualified individual prior to every use of the incinerator as per stand operating procedures.

Detailed standard operating procedures for each type of incinerator unit and the composter contain the specific inspection checklists that are utilized. All raw data records from the operation of the incinerator will be retained for inspection by the appropriate authorities.

3.2. Monitoring

3.2.1. Composter

As described in Section 1.2.2, Agnico Eagle will adhere to the CCME Guidelines for Compost Quality if compost is used for reclamation purposes. In addition, compost output is visually inspected each time it exits the sieve as described in Section 2.2.6.

Should Agnico Eagle decide to explore other options for potential uses of compost, further analytical testing will be undertaken as detailed in relevant compost quality guidelines.

Maintenance of the composter is scheduled annually or as specified by the Brome supplier/manufacturer. This maintenance is performed to evaluate the insulation and structural integrality of the cylinder. This is undertaken so that the composter is functioning at its optimal standard.

3.2.2. Incinerator Stack Testing

The Water Licence requires that Agnico Eagle demonstrate that the incinerator is in compliance with the CCME CWS for air emissions of dioxin, furan and mercury. A third-party service provider is used for monitoring emissions when the stack testing requirement is triggered. The requirement for stack testing is outlined in the CWS for dioxins and furans and the CWS for Mercury, with triggers related to operational state, volumes and types of wastes burned. The testing is conducted when the thresholds for monitoring are met, unless otherwise approved by Environment Canada, and in accordance with the project *Air Quality Management Plan*.

The following parameters are required to be monitored based on the CWS:

- Dioxin;
- Furan; and
- Mercury.

Results of sampling are reported annually to the NWB and the Nunavut Impact Review Board (NIRB), and emissions data is used for calculating and reporting non-fugitive (point source) emissions to the National Pollutant Release Inventory (NPRI).

3.3. Documentation and Reporting

Detailed records for the operation of the incinerator and composter will be maintained. Any out-of specification situations will be raised immediately and the incinerator and/or composter should not be used until maintenance or remedial measures have been applied. To demonstrate appropriate operation and maintenance of the incinerator or composter, the facility will maintain records containing, at minimum, the following information:

- A list of all staff who have been trained to operate the incinerator; type of training conducted and by whom; dates of the training; dates of the refresher courses;
- All preventative maintenance activities undertaken on the equipment;
- Records of operation of the incinerator;
- Records of quantities and types of waste incinerated;
- Summarized annual auxiliary fuel usage;
- The quantity and disposal location of incinerator residual ash;
- The quantity and type of materials composted as well as the quantity of compost produced; and
- Results of any stack emission monitoring and ash sampling information.

3.3.1. Monthly Waste Summary

A monthly summary tracks incinerator burns per day, the weight and type of waste prior to the burn and the amount of ash produced. Notes from daily operations are included in this summary. A chart is produced that compares the volume of waste burned to the amount of ash produced. This information is used to determine any trends apparent in the incineration process and identify opportunities where improvements could be implemented. The summary of waste burned during the calendar year is also used for calculations and reporting to the NPRI, by June 1 each following year.

4. Contingencies

One incinerator is utilized at the Hope Bay Mine, however two remain on site but are not utilized. In the event the active incinerator is not operable, there are currently two others on site that can be used. If temporary stockpiling is required, all food waste is packaged and stored securely from access by wildlife until functioning of the incinerator can resume.

Should Agnico Eagle determine the need to add additional composters to the on-site operation, the Plan will be reviewed and updated to reflect this change to the operation.

5. References

Canadian Council of Ministers of the Environment. (2000). *Canada-wide standards for mercury emissions*. Canadian Council of Ministers of the Environment. https://ccme.ca/en/res/cws_mercury_emissions_e.pdf

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Government of Nunavut, Department of Environment. (2012). *Environmental guideline for the burning and incineration of solid waste*. Government of Nunavut. https://assembly.nu.ca/library/GNedocs/2012/001321-e.pdf

Module A: Doris

Conformity Table

Licence	Part	Item	Topic	Report Section
2AM-DOH1335	F	1	The Licensee shall implement the following waste management plans as approved by the Board: Hope Bay Project Incinerator Management Plan.	Full Document
	F	6	The Licensee shall dispose of all food Waste in an incinerator designed for this purpose and meets the requirements of the Canada-Wide Standards for Dioxins and Furans and Canada Wide Standards for Mercury emissions or other standards as they become available	Section 1.1, 2.2, 2.3

A1 Introduction

A1.1 Overview of Doris Incineration Compliance

It is the aim of Agnico Eagle to continue implementing the practices that reduce the probability of formation of pollutant compounds during waste incineration. In addition, Agnico Eagle will comply with the relevant CWS for Incinerator emissions, through effective waste segregation and efficient burn practices.

A2 Incinerator Management at Doris

Two incinerators for the Doris project are currently located at the Roberts Bay laydown waste management facility and are inactive. Two older incinerators units are CY-2050-A-FA models with a capacity of burning 75 kg of waste per hour. The operating manual for these units is provided in Appendix A.

The active incinerator at Doris is a CY-100-CA-D model with a capacity of three (3) Batches/Day and about 150 to 185 kg/Batch. The CY-100-CA-D is a dual-chamber incinerator, operated under starved-air conditions with batch feeding. The operating manual for this unit is provided in Appendix B.

Waste management at Doris involves comprehensive sort-at-source and segregation of domestic wastes generated at the Doris Camp, return of all food waste attractants from remote worksites to the Doris Camp domestic waste stream, and collection of wastes for transfer to the centralized waste management area at Roberts Bay for timely incineration.

A3 Monitoring and Evaluation

Agnico Eagle is required to report the results of Incinerator Stack Testing in the 2AM-DOH Licence Annual Report by March 31 of each year when stack testing is required. A third-party consultant is contracted to conduct the test, and their report is forwarded to the NWB and NIRB; in addition, the results are summarized in annual reporting to those agencies.

Bottom ash for incinerators located at Doris Camp is sampled as outlined in Section 2.5.1 of the main body of this Plan.

Records of materials deposited to the landfill, including qualifying incinerator ash, is reported annually to the NWB per the relevant requirements of the Licence.

Module B: Windy

Conformity Table

Licence	Part	Item	Topic	Report Section
2BE-HOP2232	D	3	The Licensee is authorized to dispose of all acceptable food waste, paper waste and untreated wood products in an incinerator.	Main Document and this Module

B1 Introduction

The Type B Water Licence No. 2BE-HOP2232 issued to Agnico Eagle by the NWB allows the incineration of approved waste streams.

A New Windy Camp is permitted under the current water licence 2BE-HOP2232, but has not yet been constructed. Windy camp was dismantled and therefore is not actively producing waste. Waste produced in support of the Regional Exploration surface drilling program or generated during water management and licence compliance activities executed under this licence is transported to Doris Camp and managed as part of the Doris Camp waste stream. This waste undergoes the same comprehensive sort-at-source and segregation processes as domestic wastes generated at the Doris Camp. Waste is collected and transferred to the centralized waste management area at Robert Bay for timely incineration.

The plan addresses all relevant aspects of waste stream management, and the operation, maintenance and monitoring of incinerator units used to burn permitted wastes. The plan includes the management and disposal of all residual ash waste generated by the operation of the incinerator.

B1.1 Overview of Windy Incineration Compliance

Domestic waste is managed as part of the Doris Camp waste stream. Agnico Eagle continues to implement best practices that reduce the probability of formation of pollutant compounds during waste incineration.

B2 Incinerator Management at Doris

There is no incinerator operated at Windy.

B3 Monitoring and Evaluation

Agnico Eagle is required to report a summary of waste disposal activities in the 2BE-HOP2232 Licence Annual Report by March 31 of each year. No wastes are currently deposited under the 2BE-HOP2232 Licence. All incinerator monitoring is reported under the 2AM-DOH1335 Licence Annual Report; however, no wastes are currently deposited.

Module C: Madrid (Exploration and Operation)

Conformity Table

Licence	Part	Item	Topic	Report Section
2BB-MAE1727 (Exploration)	E	17	The Licensee is authorized to dispose of all acceptable food waste, paper waste and untreated wood products in an incinerator.	Main Document and this Module
2AM-DOH1335 (Operations)	F	1	The Licensee shall implement the following waste management plans as approved by the Board: Hope Bay Project Incinerator Management Plan.	Full Document
	F	6	The Licensee shall dispose of all food Waste in an incinerator designed for this purpose and meets the requirements of the Canada Wide Standards for Dioxins and Furans and Canada Wide Standards for Mercury emissions or other standards as they become available.	Section 1.1, 2.2, 2.3

C1 Introduction

Both the Type B Water Licence No. 2BB-MAE1727 and the Type A Water Licence No. 2AM-DOH1335 issued by the NWB allows the incineration of approved waste streams.

The Plan has been prepared to address the requirement specified in Part F, Item 6 of the 2AM-DOH1335 Water Licence, and also includes the plan for incineration throughout the Hope Bay belt. The plan addresses all relevant aspects of waste stream management, and the operation, maintenance and monitoring of incinerator units used to burn permitted wastes. The plan includes the management and disposal of all residual ash waste generated by the operation of the incinerator.

C1.1 Overview of Madrid Incineration Compliance

Domestic waste will not be incinerated at Madrid. Any domestic waste produced at Madrid will be transported to Doris for treatment.

C2 Incinerator Management at Madrid

There is no incinerator operated at Madrid at this time.

C3 Monitoring and Evaluation

Agnico Eagle is required to report a summary of waste disposal activities in the 2BB-MAE1727 Licence Annual Report by March 31 of each year. No wastes are currently deposited under the 2BB-MAE1727 Licence. All incinerator monitoring is reported under the 2AM-DOH1335 Licence Annual Report.

Module D: Boston (Exploration and Operation)

Conformity Table

Licence	Part	Item	Topic	Report Section
2BB-BOS1727 (Exploration)	D	3	The Licensee is authorized to dispose of all acceptable food waste, paper waste and untreated wood products in an incinerator.	Main Document and this Module
2AM-BOS1835 (Operations)	F	1	The Licensee shall implement the following waste management plans as approved by the Board: Hope Bay Project Incinerator Management Plan.	Full Document
	F	7	The Licensee shall dispose of all food Waste in an incinerator designed for this purpose and meets the requirements of the Canada-Wide Standards for Dioxins and Furans and Canada Wide Standards for Mercury emissions or other standards as they become available.	Section 1.1, 2.2, 2.3

D1 Exploration

D1.1 Introduction

The Type B Water Licence No. 2BB-BOS1727 issued by the NWB allows the incineration of approved waste streams.

The Plan has been prepared to address the requirement specified in Part F, Item 7 of the 2AM-BOS1835 Water Licence, and also includes the plan for incineration throughout the Hope Bay belt. The Plan addresses all relevant aspects of waste stream management, and the operation, maintenance and monitoring of incinerator units used to burn permitted wastes. The plan includes the management and disposal of all residual ash waste generated by the operation of the incinerator.

D1.1.1 Overview of Madrid Incineration Compliance

Agnico Eagle will continue to implement best practices that reduce the probability of formation of pollutant compounds during waste incineration.

D1.2 Incinerator Management at Boston

V7

There is currently no incinerator at Boston. Instead, there is a burn pan for combustible materials. All residual waste ash generated by the operation is transported to Doris Camp for disposal. Currently, the Boston facility is in Care and Maintenance with no activity at the site.

D1.3 Monitoring and Evaluation

Agnico Eagle is required to report a summary of waste disposal activities in the 2BB-BOS1217 Licence Annual Report by March 31 of each year. No wastes are currently deposited under the 2BB-BOS1217 Licence. All incinerator monitoring is reported under the 2AM-BOS1835 Licence Annual Report.

D2 Operations

D2.1 Introduction

The Plan has been prepared to addresses all relevant aspects of waste stream management, and the operation, maintenance and monitoring of incinerator units used to burn permitted wastes. The plan includes the management and disposal of all residual ash waste generated by the operation of the incinerator for the Hope Bay Belt. Agnico Eagle's vision is to continue to utilize existing plans for all developments on the Hope Bay belt, and modify the plans as required and at the appropriate stage of permitting or development of the Mine.

D2.2 Incinerator Management at Boston

When the Boston Camp enters into the operational phase of the project, the same point source waste segregation and efficient burning practices achieved at Doris Camp and Madrid will be applied.

D2.3 Monitoring and Evaluation

As per 2AM-BOS1835 requirements, Agnico Eagle reports a summary of waste disposal activities in their Annual Reports to the NWB by March 31 of each year.

Appendix A: Operating and Maintenance Manual CY-2050-A-FA

Forced Air Incineration Systems

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 knowledgeable, and hence a better operator. Table 1 outlines the contents of this manual.

Table 1 Organization of Manual

Chapter 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 the incinerator capacity.
3	**System Description** The components of both the single-chamber and dual chamber 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 gas.

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.

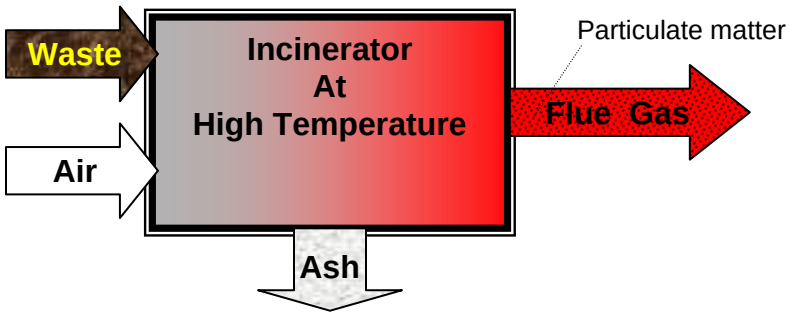

Figure 1 Schematic Diagram of Incineration Process

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. And in remote areas where wildlife is present, scavenging can be prevented by incineration.

In some cases, incineration is used to recover the energy contained in the waste in the form of electricity, steam, hot fluids or hot air. And 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, 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 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 particulate matter.

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.

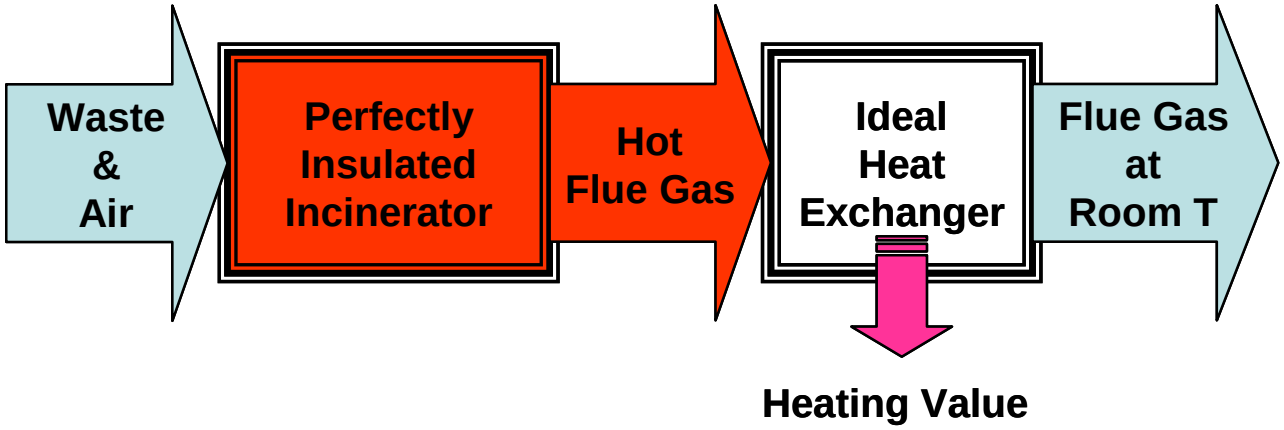

Figure 2 The Concept of Heating Value

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).

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

2.5 Different Expressions for Heating Value

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

To be noted also is the basis on which the heating value is expressed, which can be (a) as fired, (b) dry basis or (c) ash free. The distinction is illustrated in Figure 3. An understanding of the different bases can be gained by noting that heating value is a property of 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".

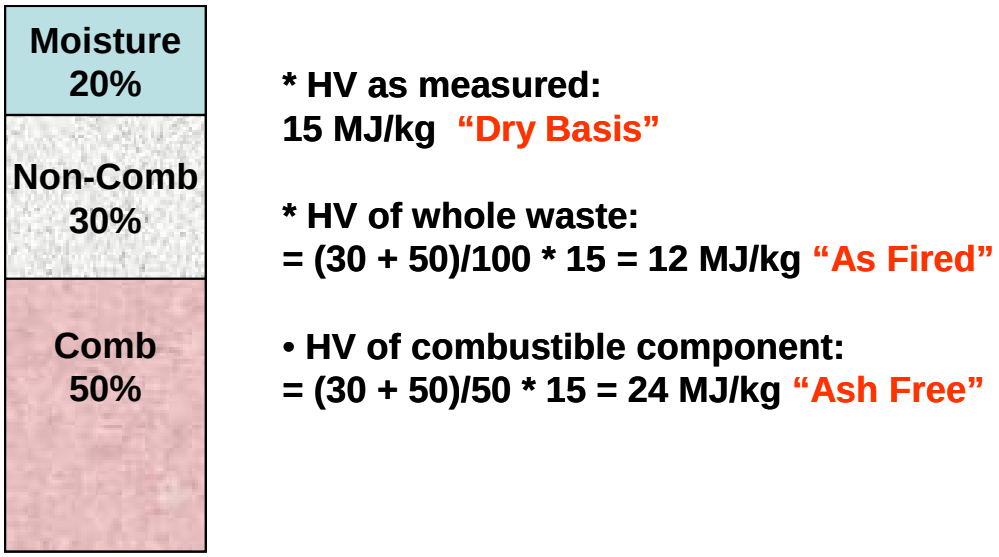

Figure 3 Different Bases for Expressing Heating Value (HV)

2.6 Examples of waste characteristics

Approximate 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 abbatoir, 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. In general, the higher the heating value, the lower is the capacity in terms of kg/h that can be incinerated. This can be explained by noting that a waste that has a higher heating value requires more air per unit mass than that required to incinerate a waste with a lower heating value. To put it another way, for the same amount of air, more mass of a waste with a lower heating value can be incinerated.

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, insufficient amount of air would generate black smoke.

Unfortunately, waste composition is not always known. Nevertheless there may be indications 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

3 SYSTEM DESCRIPTION

3.1 Different Models

Westland's forced air incinerators are of two types:

- Single-chamber, referred to as the Primary Chamber; and
- Dual-chamber, which has an additional Secondary Chamber.

The term forced air denotes the use of one blower or two blowers to "force" combustion air into the combustion chamber(s).

Different sizes are produced, and the auxiliary fuel can be diesel, propane or natural gas, as specified by the user. Key design parameters of the different models are summarized in Table 5.

The combustion air blower characteristics are shown in Table 6. [6] Beckett's Oil Burner model SF is used when diesel is the auxiliary fuel. [7] When propane or natural gas is used, a Midco Incinomite burner is used. [8] The information sheets and manuals can be found in Appendix A: Information sheets and Manuals for Burners and Blowers.

3.2 System components

Regardless of the model of your incinerator, the components are similar. Figure 4 shows a schematic diagram of the dual-chamber design. If your incinerator is single-chamber,

[6] http://www.eccohtg.com/links/Product%20Listing/Ventilation%20Products/Miscellaneous%20Fans.pdf

[7] http://www.beckettcorp.com/res2.htm

[8] http://www.midcointernational.com/products/incinomite/

then ignore the Secondary Chamber and the associated burner and blower. Figure 5 and Figure 6 show photographs of the Single-Chamber (CY-1050-FA) and Dual-Chamber (CY-2050-FA) designs, respectively. Table 7 summarizes the components and their functions.

Table 5 Key Design Parameters of Westland's Forced Air Incinerators

Model	Air Blower Series No.	Burner Rating		PC Volume		Approximate Maximum Capacity* (Type 3 Waste)	
		1000 Btu/h	GJ/h	ft^3	m^3	lb/h	kg/h
CY-1013-FA	AMU 400	350	0.37	13	0.37	90	40
CY-1020-FA	AMU 400	490	0.51	20	0.5	110	50
CY-1050-FA	AMU 625	700	0.73	50	1.3	245	112
CY-2020-FA	PC: AMU 400 SC: AMU 245	PC: 490 SC: 280	PC: 0.51 SC: 0.29	20	0.5	110	50
CY-2050-FA	PC: AMU 625 SC: AMU 225	PC: 700 SC: 280	PC: 0.73 SC: 0.29	50	1.3	245	112

Notes: PC: Primary Chamber; SC: Secondary Chamber. * Actual capacity depends on properties of the waste being incinerated; see Table 2 for waste properties.

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Table 6 Combustion Air Blowers Characteristics

MODEL	HP	RPM	AIR DELIVERY (CFM AT R.P.M. SPECIFIED)							
			Free Air	1/8" SP	1/4" SP	3/8" SP	1/2" SP	3/4" SP	1" SP	1-1/4" SP
AMU-75	1/60	3000	75	61	54	43	–	–	–	–
AMU-130	1/70	1550	130	107	87	30	–	–	–	–
AMU-245	1/20	1550	245	225	210	190	162	–	–	–
AMU-400	1/12	1550	400	380	365	340	315	200	–	–
AMU-525	1/4	1725	525	500	480	460	420	240	120	–
AMU-625	1/4	1725	625	600	560	540	500	420	280	100
AMU-845	1/2	1725	845	825	790	760	730	650	570	425
AMU-1100	1/3	1140	1100	1050	1000	950	860	700	–	–
Tested by The Nozzle Chamber Method as directed in A.M.C.A. Bulletin #210 Figure #4										

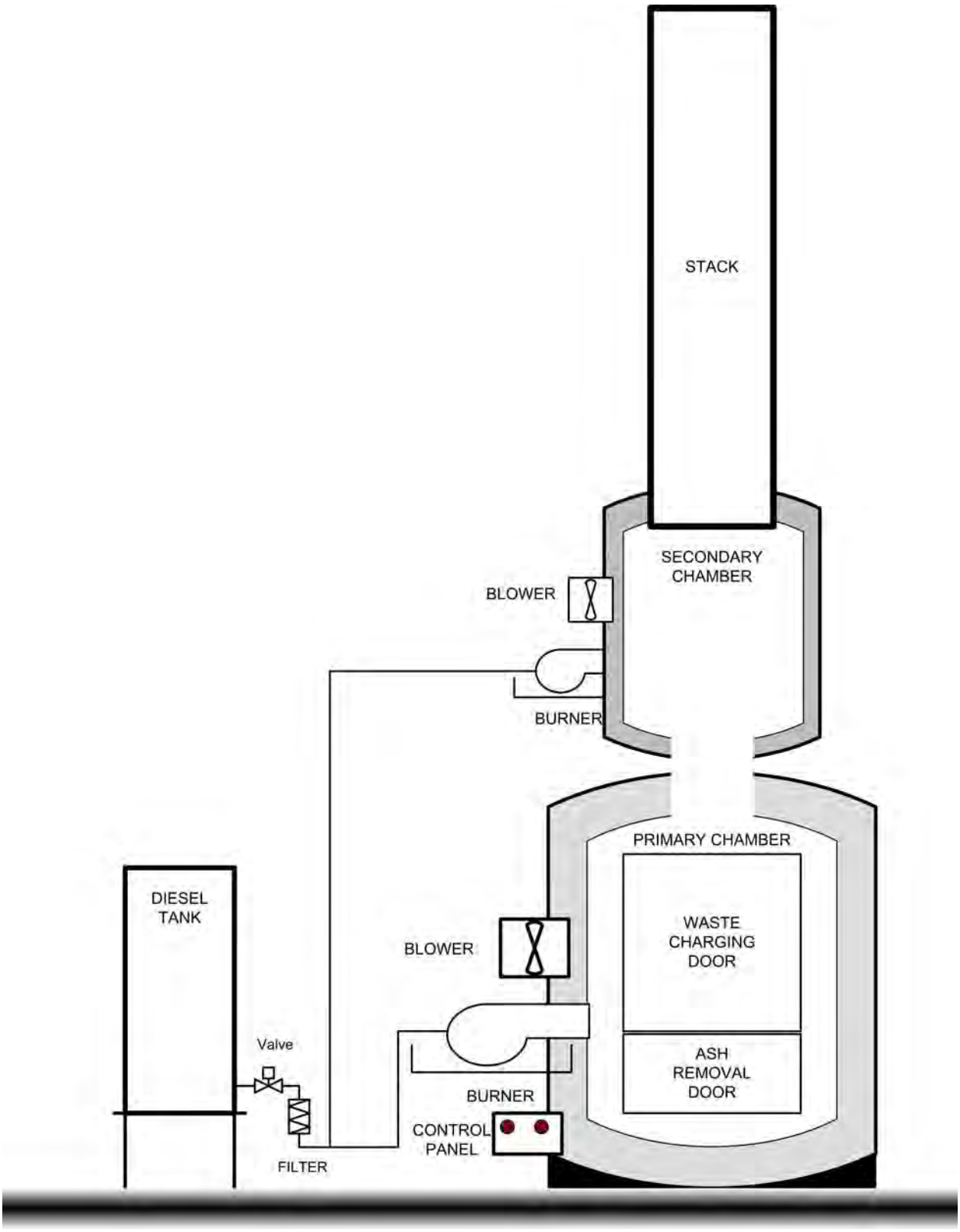


Figure 4 Schematic Diagram of Forced Air Dual-Chamber Design

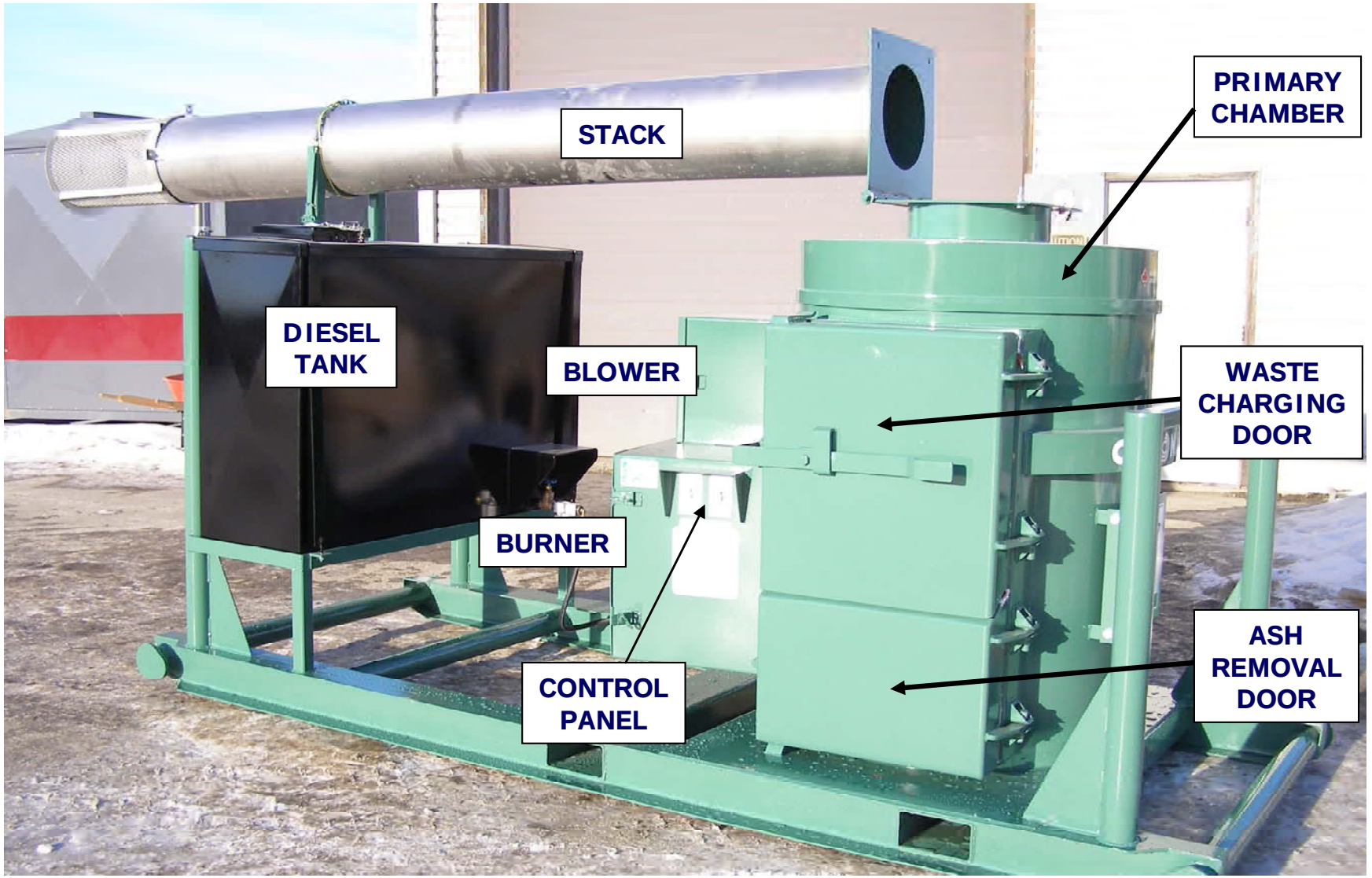


Figure 5 Photograph of the Single-Chamber Design

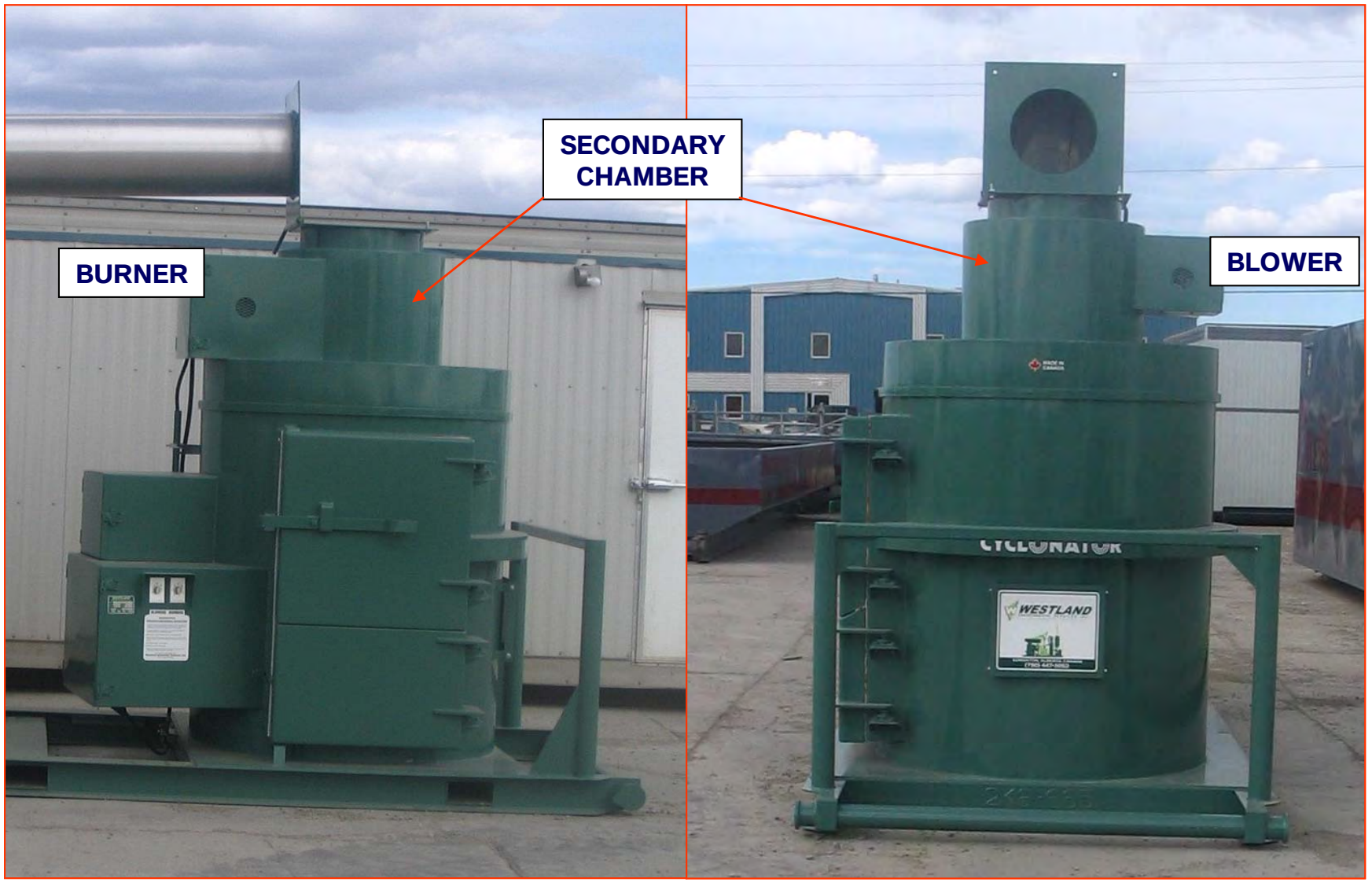


Figure 6 Photographs of the Dual-Chamber Design

Table 7 Components and Their Functions

COMPONENT	FUNCTION	DESCRIPTION
Primary Chamber	Waste combustion	WES *. Refractory lined (3 "), insulated (1")
▪ Burner	Supply heat to ignite and sustain combustion	Beckett SF or Midco Incinomite
▪ Blower	Supply air (oxygen) for combustion	AMU series
Secondary Chamber	Complete combustion	WES *. Refractory lined (3"), insulated (1")
▪ Burner	Supply heat to ignite and sustain combustion	Beckett SF or Midco Incinomite
▪ Blower	Supply air (oxygen) for combustion	AMU Series
Control Panel	Timers for burner and blower operations	Intermatic
Diesel Tank	Supply of auxiliary fuel	WES *
Valve	Cut off fuel to burner(s)	(General)
Filter	Prevent clogging of burner nozzle	LFF 22
Stack	Disperse hot flue gas	WES *. SS Stack
Electrical System	Burner and blower operations	WES *. 115 V, 60 Hz, Single Phase

Note: WES * : Manufactured in-house. Manuals for blowers and burners are in Appendix A: Information sheets and Manuals for Burners and Blowers

4 OPERATION AND MAINTENANCE

4.1 Safety equipment

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 are 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.

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 next section):
  - Inspect refractory for large cracks (not expansion cracks)

- Check combustion air hole for plugging
- Inspect door gaskets for damages

4.3 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
- (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
- Minimize dust generation
- Light water spraying on ash in the container is OK to minimize dust generation
- Dispose of ash as specified in the guidelines or regulations

4.4 Pre-operational checks

- Install stack if necessary
- Check fuel tank to make sure enough fuel (Use 5 USG/h for single-chamber, and 7.5 USG/h for dual-chamber. Actual values depend on the size of the incinerator.)
- Open fuel valve
- Re-check that combustion chamber is empty and combustion air hoes are clear
- Connect electrical plug
- Prime pump if necessary

4.5 Waste batch preparation

As previously mentioned incinerator capacity in kg/h is dependent on the heating value of the waste, which is normally not known. The nominal capacity of your incinerator is as shown in Table 5 for Type 1 to Type 3 waste, and somewhat less for Type 0.

The following cautionary notes should be followed:

- NO explosives, aerosol cans or 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 for health reasons.

4.6 Incineration

1. Re-check the burner and blower operations
2. Pre-heat the combustion chambers for 10 minutes: close doors and set the burner timer for 10 minutes
3. Load waste to Primary Chamber up to 60% of its volume
4. Start incineration: close waste charging door, set blower timer for 120 minutes and burner timer for 30 – 60 minutes depending on the amount waste loaded.
5. Check status: set timers off, open waste charging door, inspect and rake if necessary

6. If combustion is not complete, repeat Steps 4 and 5 until it is.
7. If there is more waste to be burnt, repeat Steps 3 to 6. Otherwise, go to shut-down protocol.

4.7 Shut-down

- Make sure all timers are off
- Unplug electrical connection
- Turn off fuel valve
- Un-install stack if incinerator is to be moved elsewhere.

4.8 Maintenance

In addition to the routine inspection and maintenance previously mentioned, only the burner(s) and the blower(s) require maintenance, which is quite minimum; see manuals in Appendix A: Information sheets and Manuals for Burners and Blowers. The fuel filter should be replaced every three months.

4.9 Auxiliary Fuel Consumption Rate

Figure 7 shows the volumetric flow rates of propane and diesel as a function of burner rating.

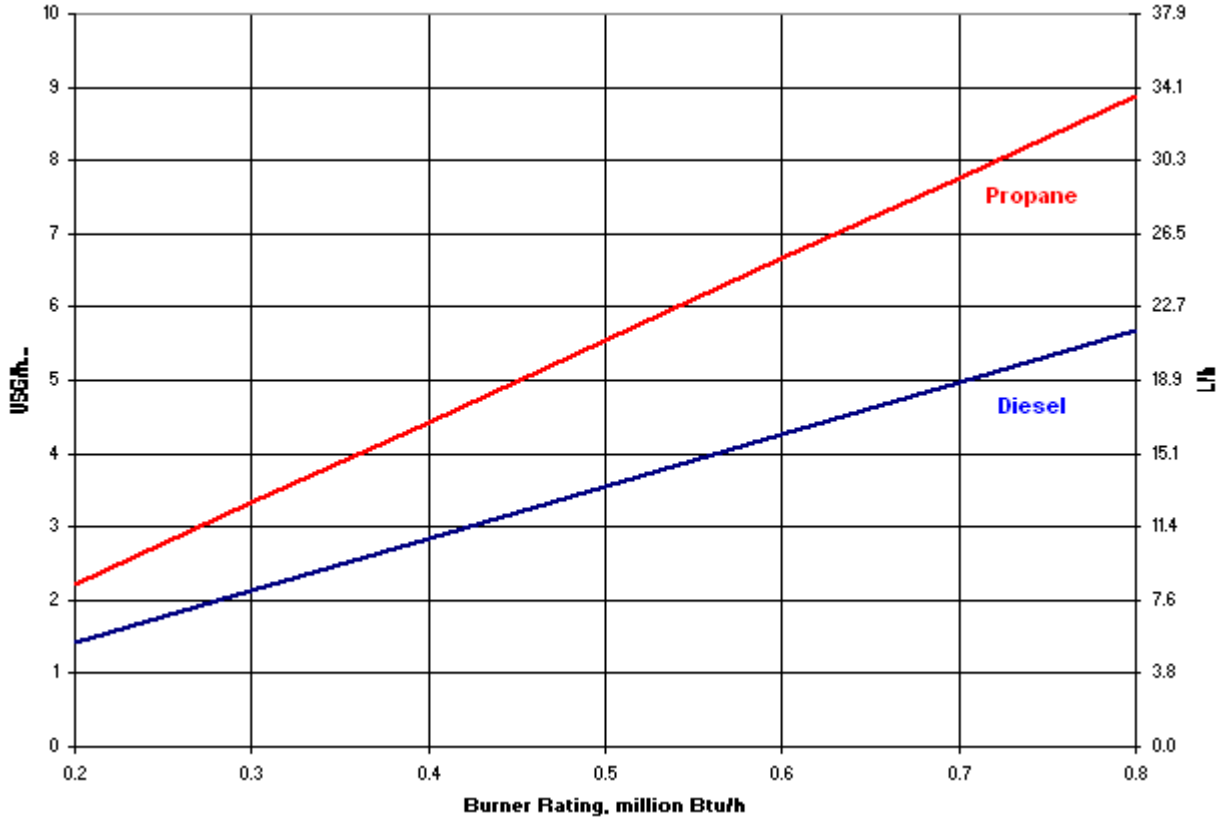


Figure 7 Consumption Rates of Propane and Diesel

5 WARRANTY

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 therefrom 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 operated and maintained the units in accordance with instructions, pamphlets or directions given or issued by Westland Environmental Services Inc. at the time of the sale and/or from time to time thereafter:
   (e) The Purchaser uses any spare parts or replacements not manufactured by or on behalf of Westland Environmental Services Inc. and supplied by it, or by someone authorized by it, or fails to follow the instructions for the use of the same:
   (f) The Purchaser misuses, or uses this unit for any purpose other than that for which it was intended or manufactured:
   (g) The defective parts are not returned to Westland Environmental Services Inc. within 15 days of repair.

6. No condition is made or is to be implied, nor is any Warranty given or to be implied as to the life or wear of the units supplied; or that they will be suitable for use under any specific conditions; notwithstanding that such conditions may be known or made known to the seller.
7. Defects in material and/or workmanship must be brought to the attention of Westland Environmental Services Inc. by written notification within ten (10) days of discovery, and repairs must be commenced within forty-five (45) days thereafter.
8. It is agreed and understood that the Purchaser is responsible for and must pay for the transporting of the defective goods or of the replacement parts to the place of repair. Premium freight charges (such as air express or air fare charges for transportation of personnel, tools and for replacement parts) and other expenses, apart from servicemen's regular straight time travel, mileage, and regular straight time labour required to repair or replace defective parts and the cost of the parts, will be paid for by the customer at Westland Environmental Services Inc. regular billing rates on usual credit terms.
9. The liability of Westland Environmental Services Inc. under this Warranty is limited to the purchase price of the unit and in no case shall a claim be advanced for more than such amount.

10. All repairs and replacements are made and furnished subject to the same terms, conditions, warranties, disclaimer or warranty and limitations of liability and remedy as applied to each new unit sold.
11. This warranty and the Purchaser's rights under it, is not transferable, or is it assignable.

DATE IN SERVICE: _____

MODEL NUMBER: _____

SERIAL NUMBER: _____

6 APPENDIX A: INFORMATION SHEETS AND MANUALS FOR BURNERS AND BLOWERS

WESTLAND
ENVIRONMENTAL SERVICES INC.
www.westlandenvironmental.com

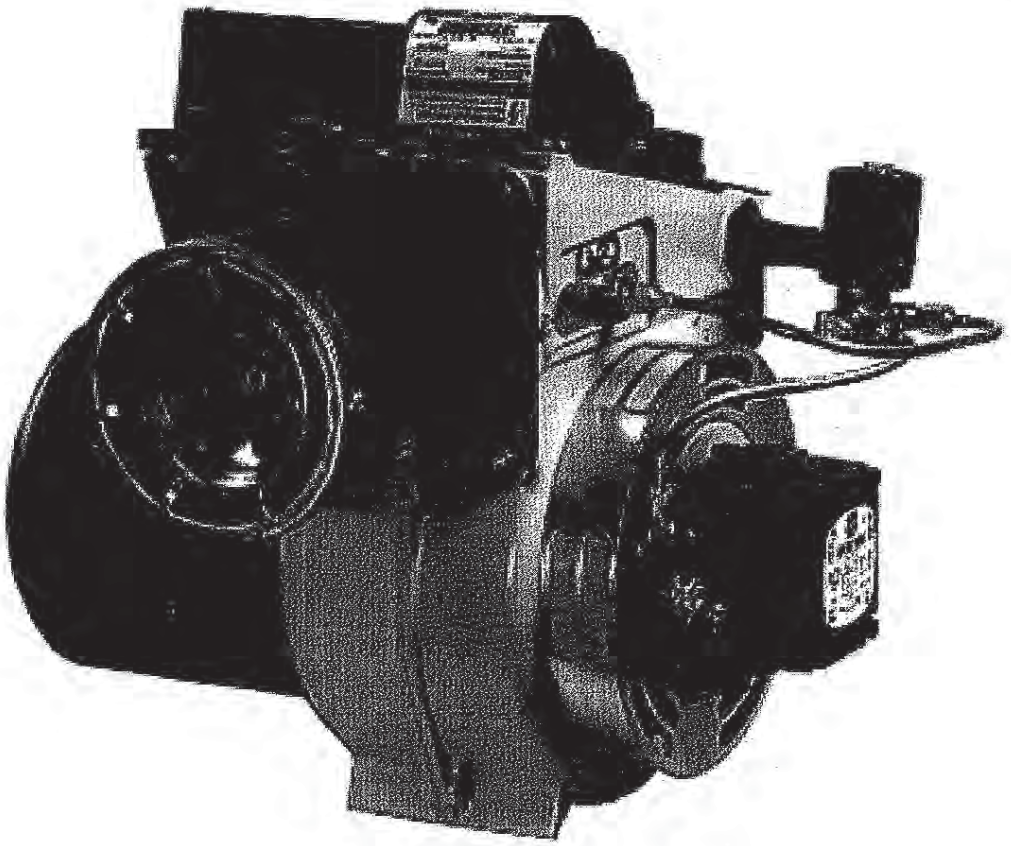
Forced Air Incinerator PARTS LIST
(CY 1013/1020/2020/1050/2050 FA "D")

Description	Part #
Gun Burner Beckett, WIC 201 x 6", diesel fired	7007006
Gun Burner Midco J83DS, natural gas or LPG fired	7009000
Air Tube Combination for WIC 201	7900188
Coupling, Flex for WIC 201	7009183
Fuel Pump A2YA7916 Suntec	7009182
Blower Wheel for WIC 201	7009184
Motor 1/3 HP for WIC 201	7009186
Transformer, Ignition "S" for WIC 201	7009187
Stainless Steel Stack, 15" dia x 10' (CY 1050/2050)	7030101
Stainless Steel Stack, 13" dia x 10' (CY 1020/2020)	7020101
Stainless Steel Stack, 10" dia x 2m (CY 1013)	
Spark Arrestor, Stainless Steel 15" (CY 1050/2050)	7030107
Spark Arrestor, Stainless Steel 13" (CY 1020/2020)	7020107
Spark Arrestor, Stainless Steel 10" (CY 1013)	
Stack crating for shipping 13" stack	7020102
Stack crating for shipping 15" stack	7030102
Nozzle (specify GPH, angle, pattern)	7006122
Gasket, Ceramic Fibre 1/8" x 2" (price per foot)	7000062
Gasket Cement, HT Silicone Tube	7000064
Refractory Cement Bag	7000120
Timer, 60 min Spring Wound	7000145
Timer, Blower 120m Spring Wound	7000146
Filter Adaptor	7001116
Filter, Fuel LFF22	7001117
Fuel Tank, 1000 L Double Wall Enviro	7041112
Delhi Blower D530 (CY 2050-models older than 2007)	7000054
AMU625 Blower (CY2050FA D)	7000058
AMU Secondary Blower 245 (CY2050/2020) (replaces the Delhi D530 on 2007 and newer models)	7000075
AMU 400 Blower (CY1020FA D) (CY 1020/ 2020/ 1013)	7000055

20204 - 110 Ave, Edmonton, Alberta, T5S 1X8, Canada. Tel: (780) 447-5052, Fax: (780) 447-4912.
Visit us at: www.westlandenvironmental.com

Models SF & SM Oil Burners

WIC 201 Burner



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

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

To the Homeowner or Equipment Owner:

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

To the Professional, Qualified Installer or Service Agency:

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

Table of Contents

Information To Be Used Only By Qualified Service Technicians

Owner's Information

To the Owner:

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

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

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

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

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

Weekly

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

WARNING **Owner's Responsibility**

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

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

Please carefully read and comply with the following instructions:

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

NOTICE

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

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

Hazard Definitions

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

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

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

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

NOTICE

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

General Information

Table 1 – Burner Specifications

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

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

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

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

• Notice Special Requirements

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

WARNING **Professional Service Required**

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

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

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

The installation must strictly comply with all applicable codes, authorities having jurisdiction and the latest revision of the National Fire Protection Association Standard for the installation of Oil-burning Equipment, NFPA 31 (or CSA B139 and B140 in Canada).

Regulation by these authorities take precedence over the general instructions provided in this installation manual.

Table 2 – Air Tube Combination (ATC) codes

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

Inspect/Prepare Installation Site

• Chimney or vent

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

• Combustion air supply

WARNING **Adequate Combustion and Ventilation Air Supply Required**

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

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

See NFPA 31 Standard for complete details.

Appliance located in confined space

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

Exhaust fans and other air-using devices

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

• Clearances to burner and appliance

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

• Combustion chamber — Burner retrofitting

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

Table 3. Chamber Dimensions

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

WARNING

Protect Steel Combustion Chamber From Burnout

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

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

Prepare the Burner

• Burner fuel unit

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

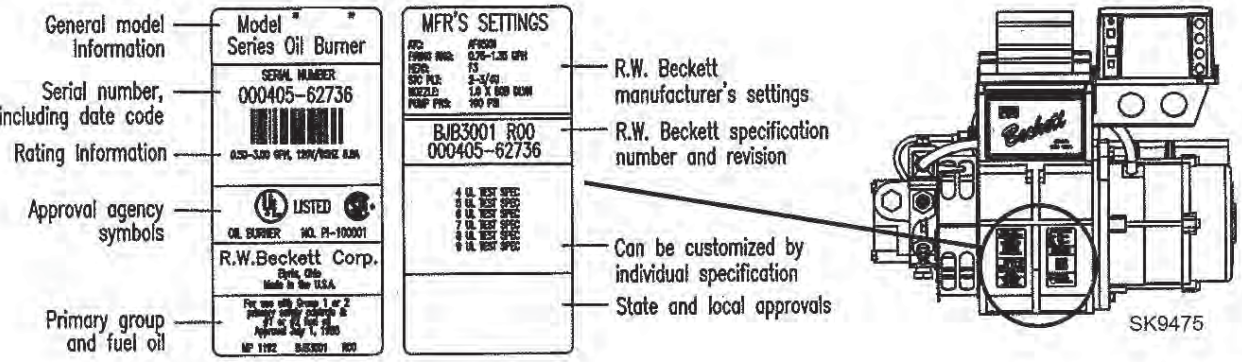
• Attach air tube (if not already installed)

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

• Install burner nozzle (if not already installed)

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

Figure 1. Burner Label Location



WARNING Correct Nozzle and Flow Rate Required

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

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

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

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

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

Table 5. Nozzle Flow Rate by Size

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

Table 6. Nozzle Spray Angles

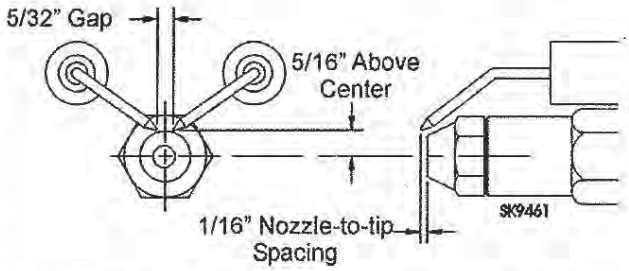
Recommended nozzle spray angles	
"F" head	70°, 80° or 90° nozzle

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

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

• Check/adjust electrodes

Figure 2. – Electrode Tip Adjustment



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

• Servicing nozzle line assembly

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

Mount Burner on Appliance

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

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

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

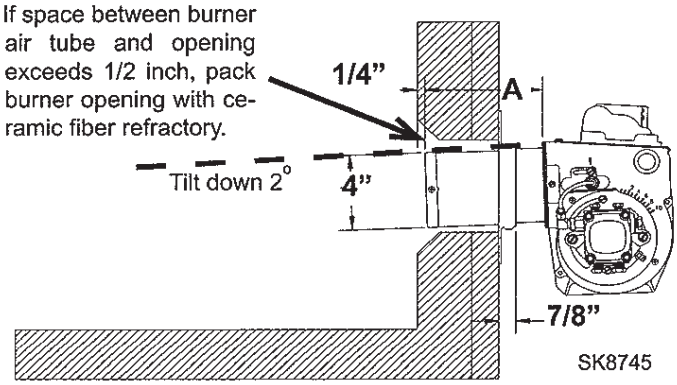
• Mounting options

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

• Mounting dimensions

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

Figure 3. – Mounting Burner in Appliance



• Connect fuel lines

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

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

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

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

CAUTION **Oil Supply Pressure Control Required**

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

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

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

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

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

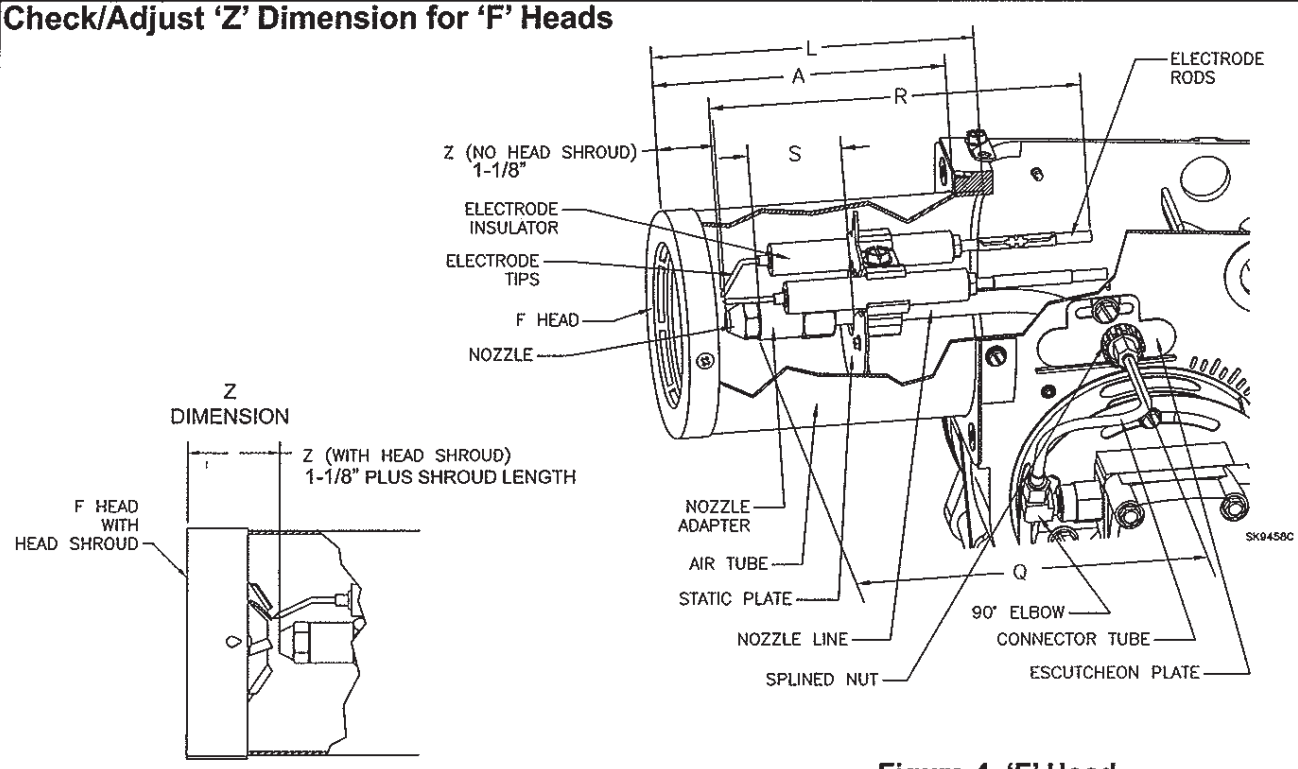


Figure 4. 'F' Head

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

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

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

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

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

• Burner Dimensions - Models SM & SF

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

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

Fuel line installation –

CAUTION Do Not Use Teflon Tape

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

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

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

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

Fuel line valve and filter –

- Install two high quality fusible-handle design shut-off valves in accessible locations on the oil supply line to comply with the NFPA 31 Standard and authorities having jurisdiction. Locate one close to the tank and the other close to the burner, upstream of the filter.
- Install a generous capacity filter inside the building between the fuel tank shutoff valve and the burner, locating both the filter and the valve close to the burner for ease of servicing. Filter should be rated for 50 microns or less.

Wire Burner

WARNING Electrical Shock Hazard

Electrical shock can cause severe personal injury or death.

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

• Burner packaged with appliance

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

• Burner installed at jobsite

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

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

Start Up Burner/Set Combustion

WARNING Explosion and Fire Hazard

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

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

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

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

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

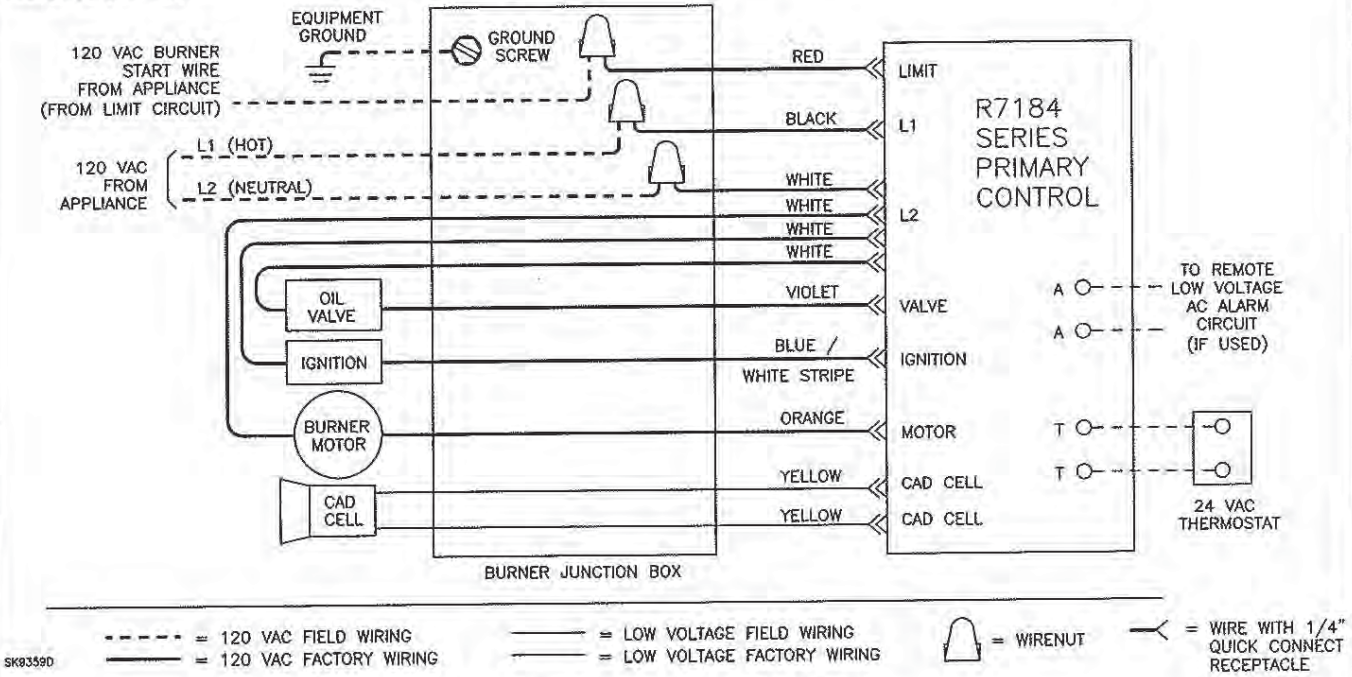
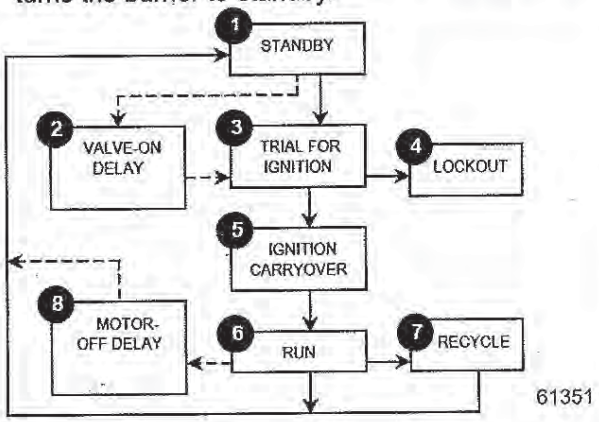


Figure 5. – Typical Burner Wiring

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



Control System Features

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

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

• Set combustion with instruments

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

Perform Regular Maintenance

WARNING **Annual Professional Service Required**

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

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

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

• Replacing the blower wheel:

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

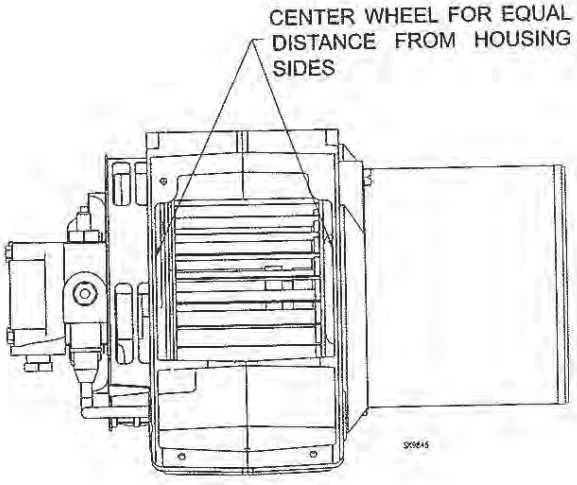
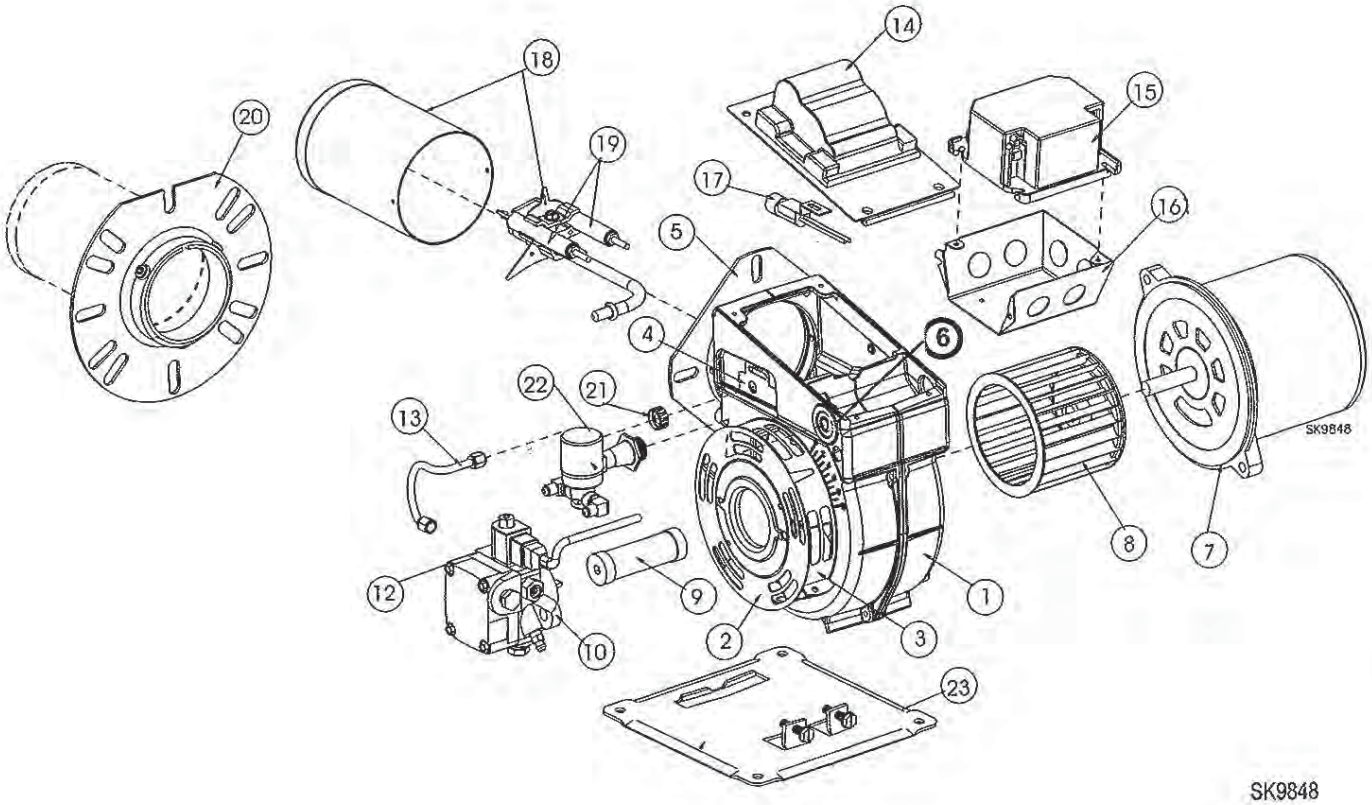


Figure 6. Blower Wheel Assembly

Burner Parts Diagram



SK9848

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

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

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

AIR MAKE-UP UNITS

AMU Series

Construction

Welded steel housing finished in grey enamel.

Application

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

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

To exhaust foul air and replace with fresh outside air.

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

Performance Data

			Air Delivery (CFM) at R.P.M. Specified							
Description	H.P.	R.P.M.	Free Air	1/8" SP	1/4" SP	3/8" SP	1/2" SP	3/4" SP	1" SP	1 1/4" SP
AMU 75	1/60	3000	75	61	54	43	-	-	-	-
AMU 130	1/70	1550	130	107	87	30	-	-	-	-
AMU 160	1/40	1600	165	150	135	120	104	-	-	-
AMU 245	1/20	1550	245	225	210	190	162	-	-	-
AMU 265	1/20	1610	265	250	233	215	185	-	-	-
AMU 400	1/12	1550	400	380	365	340	315	200	-	-
AMU 465	1/15	1530	465	430	397	357	308	-	-	-
AMU 525	1/4	1725	525	500	480	460	420	240	120	-
AMU 625	1/4	1725	625	600	560	540	500	420	280	100
AMU 845	1/2	1725	845	825	790	760	730	650	570	425
AMU 1100	1/3	1140	1100	1050	1000	950	860	700	-	-

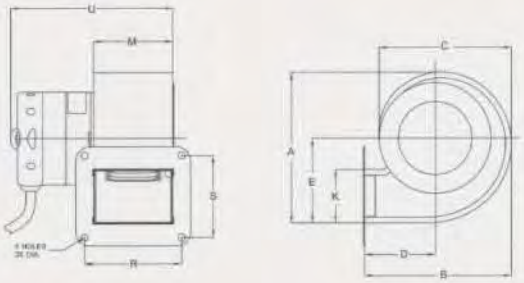
Tested by The Nozzle Chamber Method as directed in A.M.C.A. Bulletin #210. Figure #4.

Features

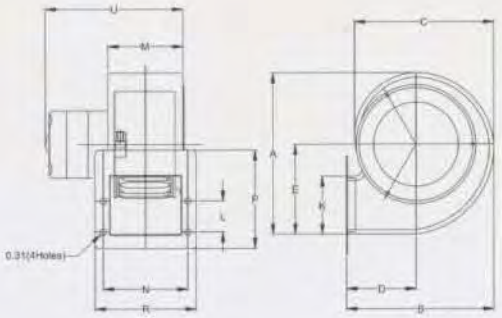
115 Volt, 60 Hz

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

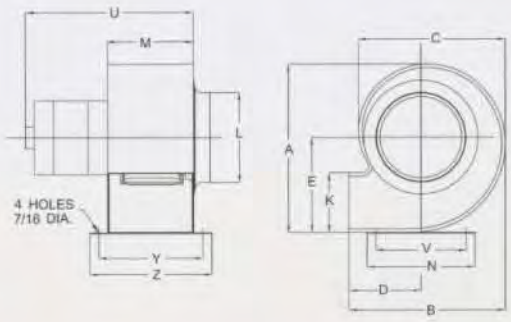
Specification Charts



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

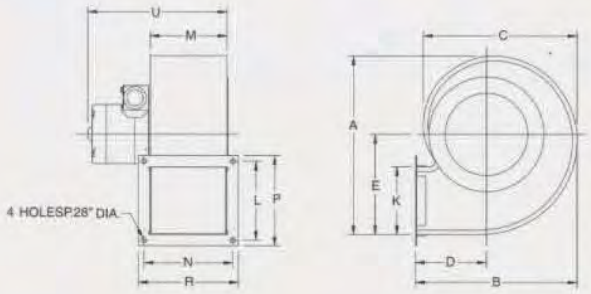


Description	A	B	C	D	E	K	L	M	N	P	R	U	Weight (lbs)
AMU 160	7.80	7.08	6.69	3.34	4.34	2.80	1.50	3.60	4.05	4.75	4.85	6.40	5.4

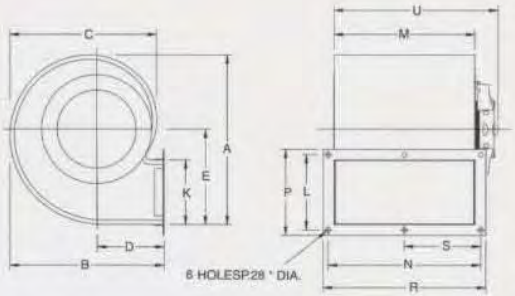


Description	A	B	C	D	E	K	L	M	N	U	V	Y	Z	Weight (lbs)
AMU 245	9.41	8.73	8.17	4.0	5.33	3.36	5.0	4.75	6.0	9.0	5.0	5.75	6.75	8
AMU 400	10.61	9.76	9.24	4.44	6.01	3.79	6.0	5.25	6.0	10.75	5.0	6.25	7.25	13

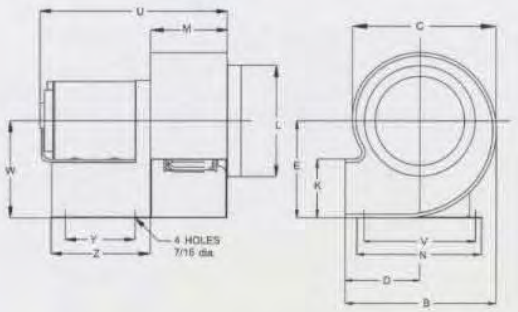
Specification Charts



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

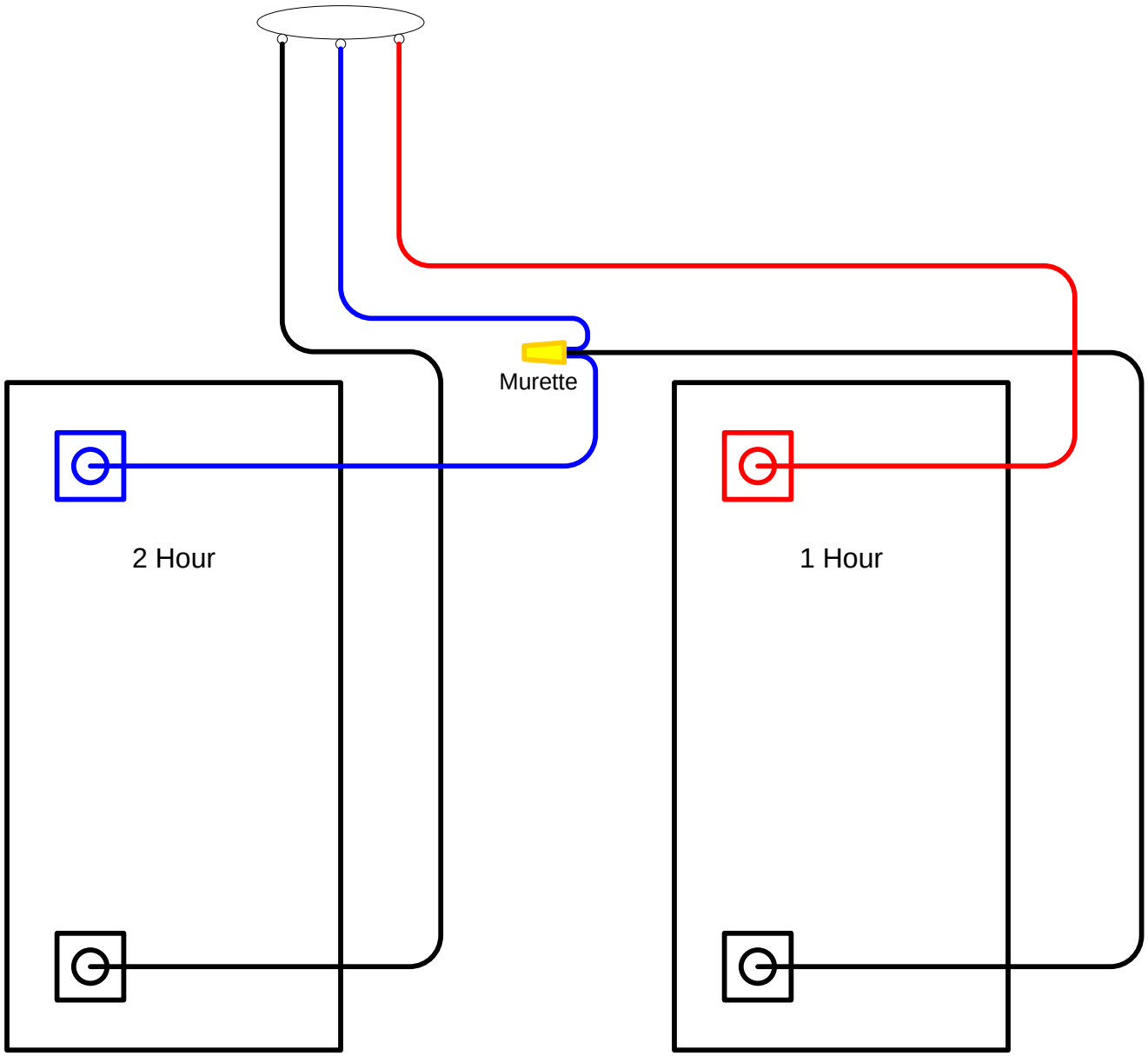


Description	A	B	C	D	E	K	L	M	N	P	R	S	U	Weight (lbs)
AMU 465	9.93	9.0	8.46	3.9	5.55	3.75	4.37	8.12	8.82	5.0	9.4	4.41	9.46	11.0



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

Cyclonator Timers
Wiring
CY-1020/1050 FA”D”
CY-2020/2050 FA”D”



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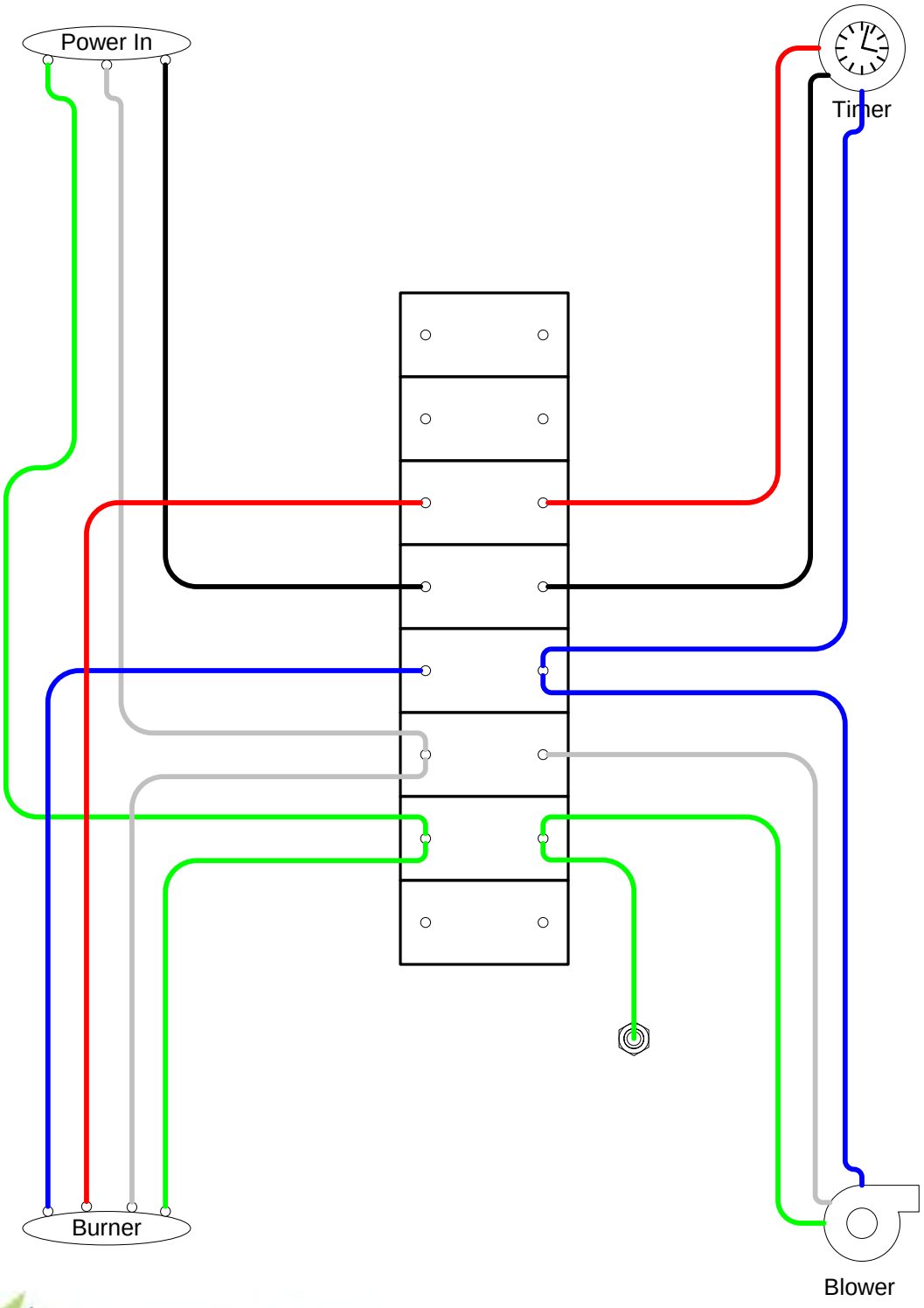
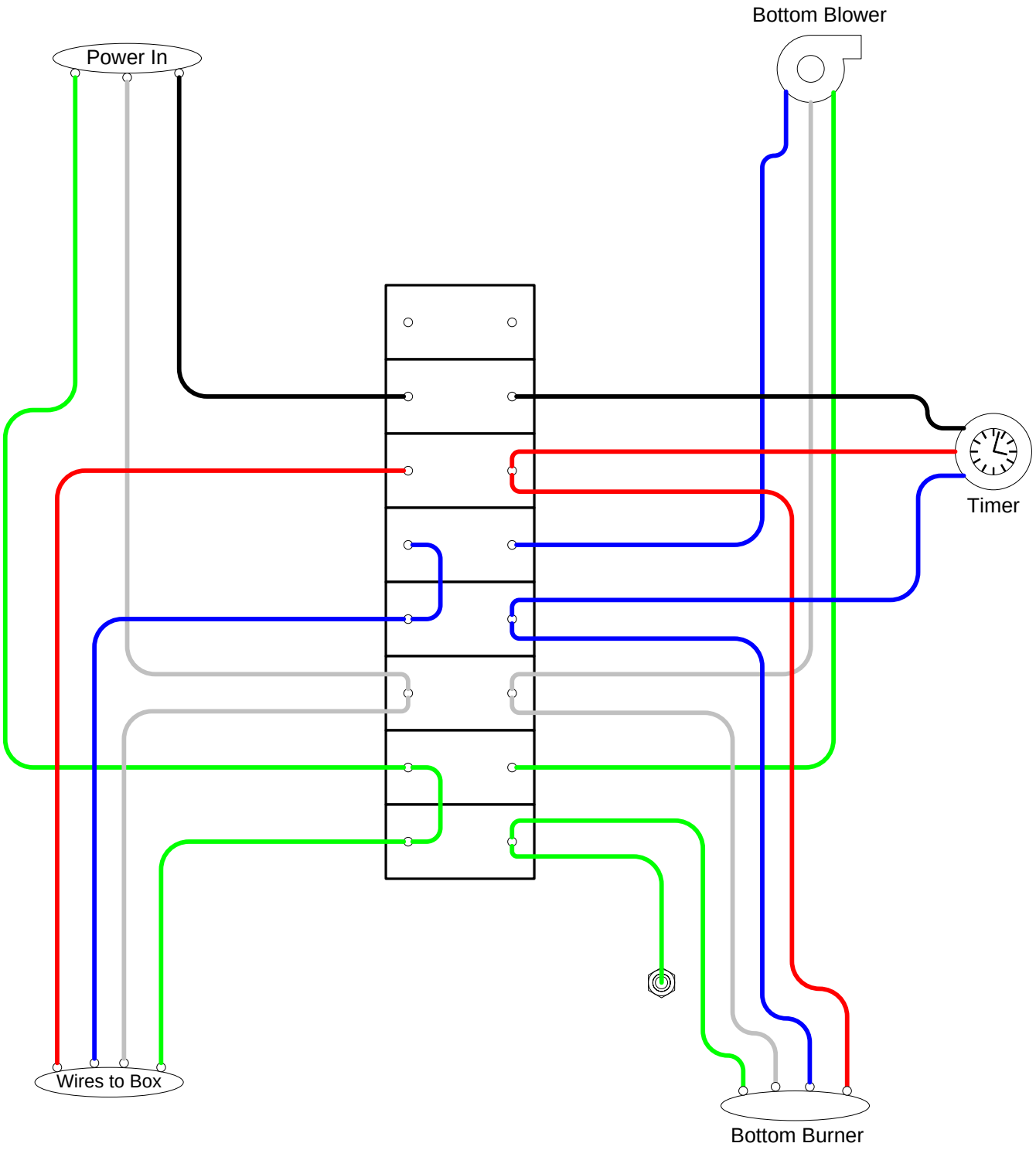
Burner Wiring (Beckett)
CY-1020/1050 FA”D”

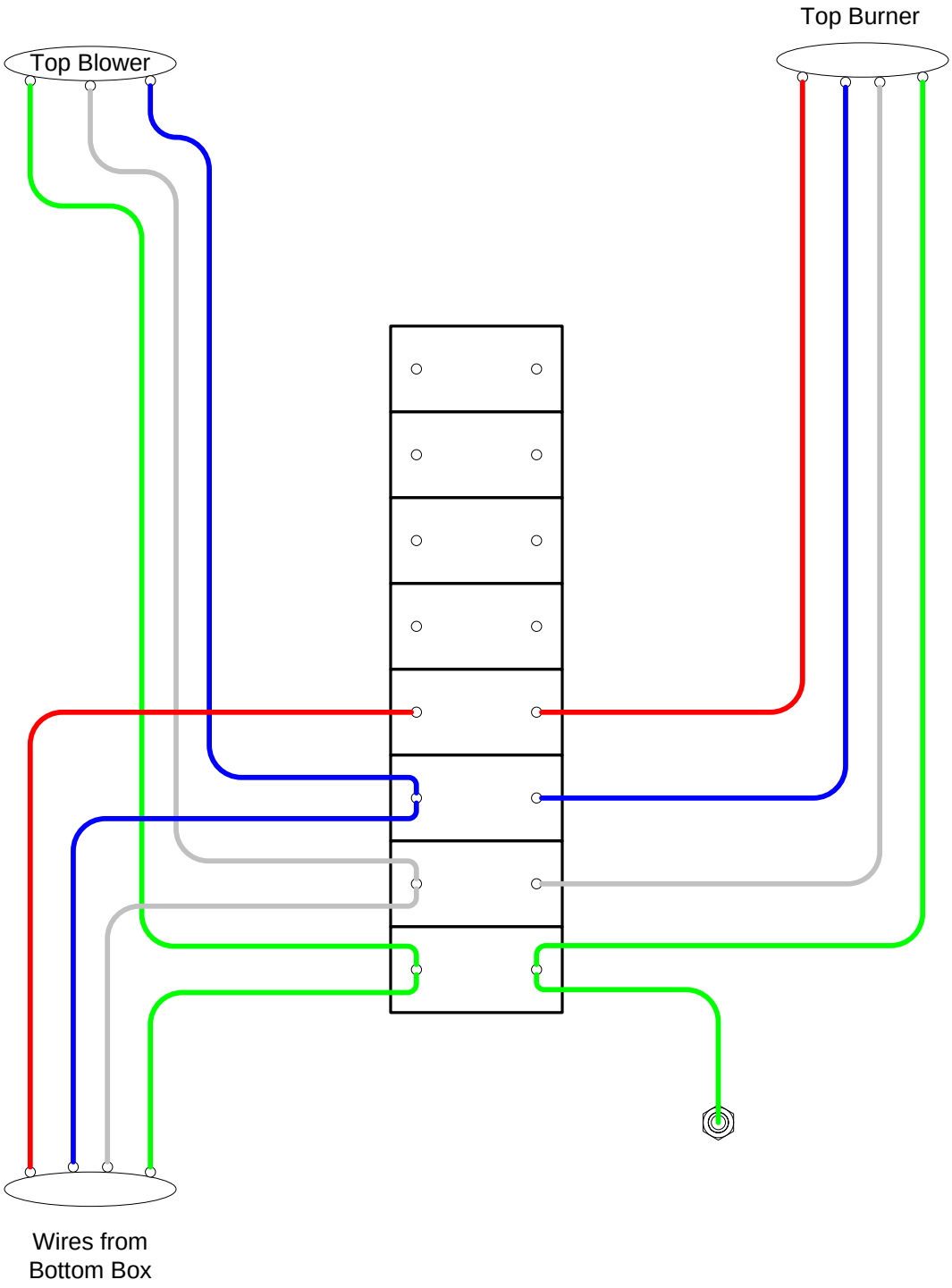


WESTLAND
ENVIRONMENTAL
SERVICES INC.

Wiring (Beckett)
CY-2020/2050 FA”D”
Bottom Box



Burner Wiring (Beckett)
CY-2020/2050 FA”D”
Top Box



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SERVICES INC.

Appendix B: Operating and Maintenance Manual CY-100-CA-D

KETEK GROUP

Results Driven.

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CY-100-CA

MANUAL

OPERATION & MAINTENANCE

LIST OF TABLES

LIST OF FIGURES

Thank you for selecting Ketek Group 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, ensuring its proper operation and continued use for a long time.

It also contains information on the combustion process. We think a good understanding of the basic principles make a knowledgeable, and hence a better, operator.

Table 1 outlines the contents of this manual. We encourage you to read Chapter 2. Chapters 4 and 5 contain the most important information.

TABLE 1 ORGANIZATION OF MANUAL

Chapter	Title / Description
2	Waste Incineration and General Guidelines for Waste Management
3	Roles and Responsibilities
4	Principles of waste incineration What incineration is, how it is affected by waste properties, including incinerator capacity and the design and operational features of the system.
5	System Description List of photographs of the components of the system and their functions
6	Operation and Maintenance How to operate and maintain the system, including discussion of safety

Incineration of waste is recognized as an effective and environmentally sound disposal method for a wide range of wastes, provided the incinerator is properly operated and maintained. However, waste segregation, recycling and reuse should be considered before waste is sent for incineration. Examine the waste to determine the opportunities that exist for:

- reducing the overall quantity of waste generated
- reusing materials, and
- recycling as much as possible before disposal

Incineration of waste can lead to the emission of pollutants. Polychlorinated dibenzodioxins and polychlorinated dibenzofurans (PCDDF), commonly known as dioxins and furans, can be generated if the incinerator is operated inefficiently and combustion is incomplete. Dioxins and furans are toxic, persistent, and bio-accumulative and therefore must be controlled. Mercury is another high priority potential contaminant released from incinerators. It is toxic and bioaccumulates in the environment. Mercury is not emitted unless the waste items incinerated contain mercury. The best method to control mercury is therefore waste segregation to eliminate mercury from the waste fed into the incinerator.

Waste management and segregation before incineration will help reduce waste and provide cleaner emissions, maintaining an environmentally sound way of disposing waste products.

3.1 Waste management in charge/site services

- Ensure that relevant waste handling training is provided to all waste management personnel at site and only properly trained individuals (Incinerator Operators) operate the incinerator.
- Ensure that the operator follows the requirements of the Incinerator Operational Plan, Equipment Operation Manual and other relevant guidelines.
- Ensure that all checklists and data logs are maintained and the records required by this guidance document are collected.
- Ensure adequate re-training is provided to the operators at regular interval.
- Ensure the safety of all personnel and the site.
- Carry out periodic inspections and record observations in supervision checklist appended in this document.

3.2 Incinerator Operator

- Ensure the safe operation of the incinerator and the associated work and storage area.
- Ensure the operation and maintenance of the incinerator is carried out in accordance with the Equipment Operation Manual.
- Ensure that only appropriate wastes are incinerated, and all inappropriate wastes, including plastics, aerosol cans, metallic containers or cans filled with waste oil, are removed and handled accordingly.
- Document and maintain the required logs and records as appended in the document (pre-operational checklist, operational checklist and waste incineration log).
- Notify the supervisor or waste management in charge of any incinerator upsets, malfunctions or required repairs.
- Wear proper Personal Protective Equipment at all times while working with the incinerator or waste.

3.3 Maintenance Personnel

- Carry out timely Inspections and maintain the records
- Carry out preventive maintenance at scheduled intervals; record and report any unusual observations on the equipment.
- Do not alter the electrical wiring or incinerator components.
- Consult Ketek for any clarifications or guidance related to maintenance of the equipment.
- Fill and record the inspection and maintenance checklist and follow the checklist for weekly, monthly and annual inspection and maintenance
- Make sure to lock out/tag out the unit as per the company's existing procedures if there is a problem.

4.1 Combustion

Combustion, burning, incineration, and thermal oxidation all denote the same process, which is the reaction of a combustible materials with oxygen at temperatures higher than the ignition temperature[1] of that matter. The reaction is exothermic, meaning it generates heat in the form of hot gas.
In the case of waste, it may also contain non-combustible matter which does not react with oxygen. In waste incineration, the non-combustible component ends up as ash and a small portion of it is also present in the hot gas in the form of particulate matter or dust.

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

4.2 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. In remote areas, where wildlife is present, scavenging and spreading of diseases can be prevented by incineration.

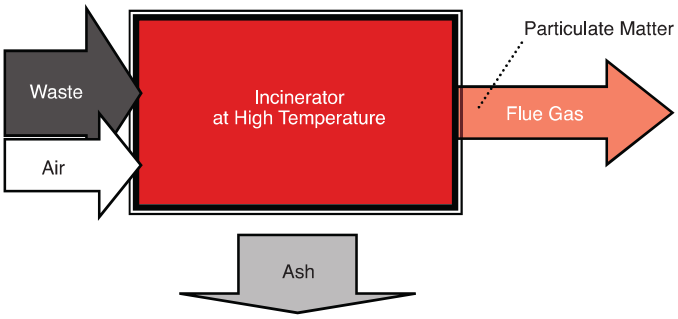


FIGURE 1 SCHEMATIC DIAGRAM OF INCINERATION PROCESS

In some cases, 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.

4.3 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, which requires a lot of energy.[3] That, in turn, lowers the temperature of the flue gas.

B. COMBUSTIBLES are those components that react with oxygen and release heat.[4] The higher the combustible content in the waste, the more air per kilogram of waste is needed for incineration.

This component can be further classified as:

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

C. NON-COMBUSTIBLE OR ASH is the component that does not react with oxygen.[5] As previously mentioned, this forms ash, and some of it is in the flue gas in the form of particulate matter or dust. If the waste has a high ash content, less waste can be incinerated before ash must be removed from the combustion chamber. Note also if the waste contains metals, such as lead and cadmium, these metals will be present in the ash.

4.4 Heating Value

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

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, and H (MJ) is the heat extracted from the heat exchanger. The heating value of the dry waste is H/M (MJ/kg).

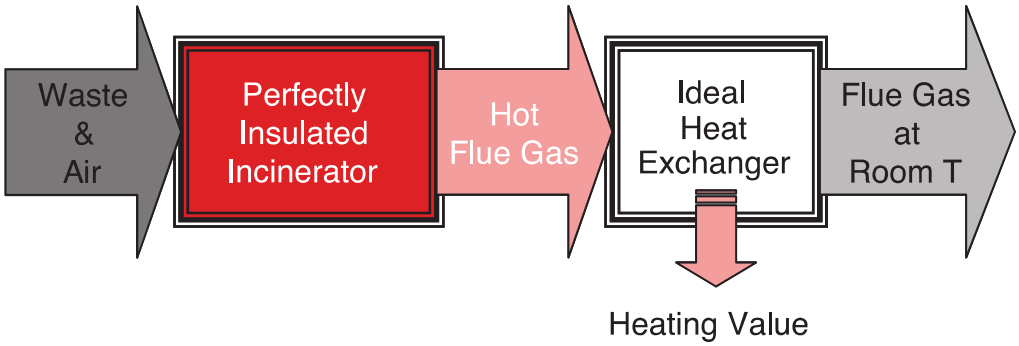


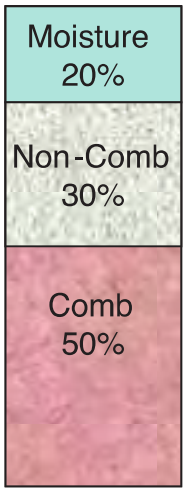
FIGURE 2 THE CONCEPT OF HEATING VALUE

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

4.5 Different Expressions for Heating Value

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

To be noted also is the basis on which the heating value is expressed, which can be (a) as fired, (b) dry basis or (c) ash free. The distinction is illustrated in Figure 3. An understanding of the different bases can be gained by noting that heating value is a property of 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".



* HV as measured:
15 MJ/kg "Dry Basis"

* HV of whole waste:
= (30 + 50)/100 * 15 = 12 MJ/kg "As Fired"

* HV of combustible component:
= (30 + 50)/50 * 15 = 24 MJ/kg "Ash Free"

FIGURE 3 DIFFERENT BASES FOR EXPRESSING HEATING VALUE (HV)

4.6 Examples of waste characteristics

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

FIGURE 3 DIFFERENT BASES FOR EXPRESSING HEATING VALUE (HV)

Type*	Description	Componets	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
1	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 waste, 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

4.7 Incinerator Capacity and Load Size

Incinerator capacity is dependent on waste composition. In general, the higher the heating value, the lower is the capacity in terms of kg/h that can be incinerated. This can be explained by noting that waste that has a higher heating value requires more air per unit mass than that required to incinerate a waste with a lower heating value. To put it another way, for the same amount of air, more mass of a waste with a lower heating value can be incinerated.

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, insufficient amount of the air would generate black smoke.

Unfortunately, waste composition is not always known. Nevertheless, there may be indications 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 (bituminous)	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
Plastic + Colour	98	0	0	2	0
PVC	93	0	7	0	0.08

Notes:

FC = Fixed Carbon
FCN = Ratio of Fixed Carbon to Volatile
RDF = Refuse Derived Fuel
PDF= Paper Derived Fuel
TDF = Tire Derived Fuel
PE= Polyethylene
PP= Polypropylene
PS = Polystyrene
PVC = Polyvinylchloride

5.1 Overview

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 Secondary Chamber is delivered via the flame-port by the flame-port blower. Auxiliary burners are provided for start-up and to maintain the minimum temperatures set in the two chambers.

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

The Secondary Chamber combined with high temperatures maintained by the auxiliary burner, and the turbulence created from the delivery of air (oxygen) by the flame-port air blower, ensures that black smoke is not generated (provided the size of the waste load is not too large).

Waste is charged manually and intermittently via the waste charging door (1), and ash is removed manually and batch-wise after operation. The waste charging 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 oxygen.

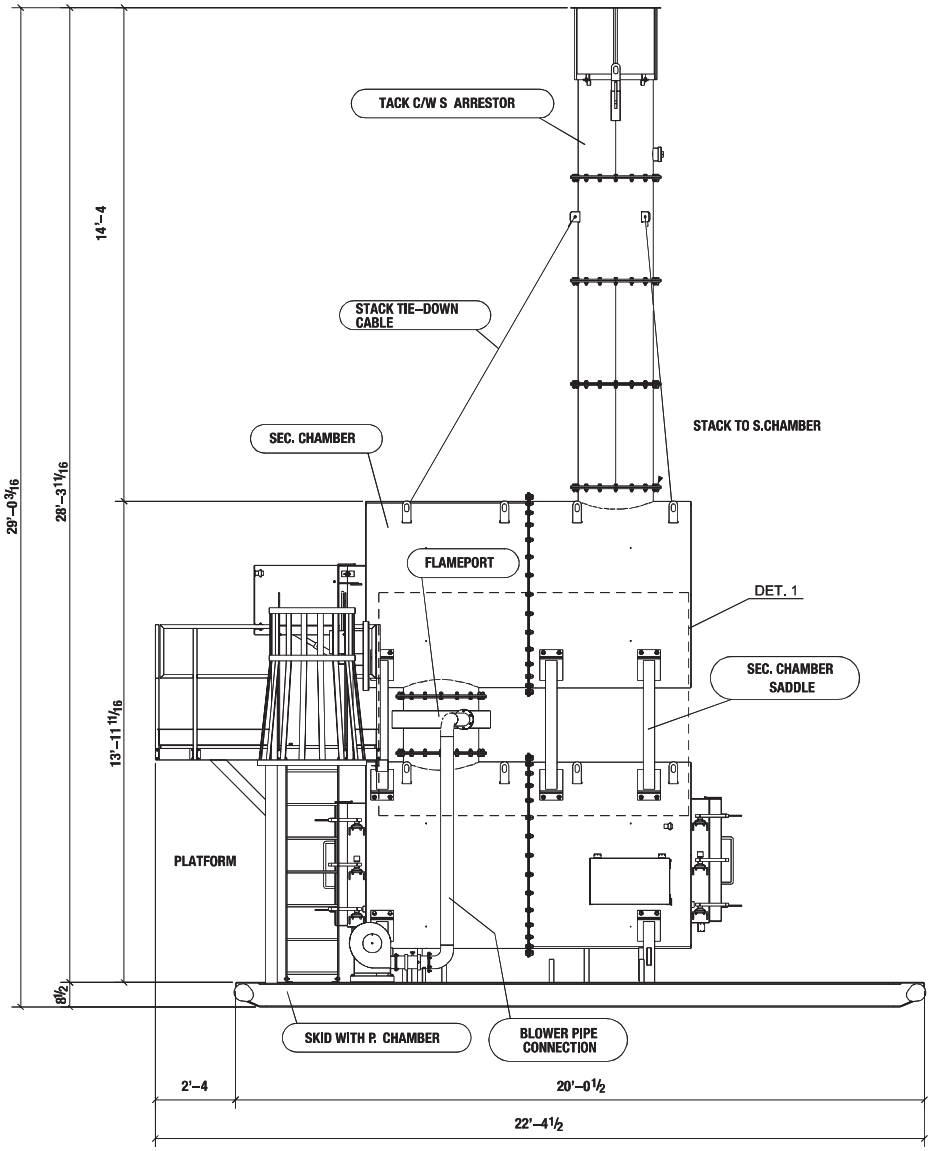


FIGURE 4 SCHEMATIC OF THE INCINERATION SYSTEM

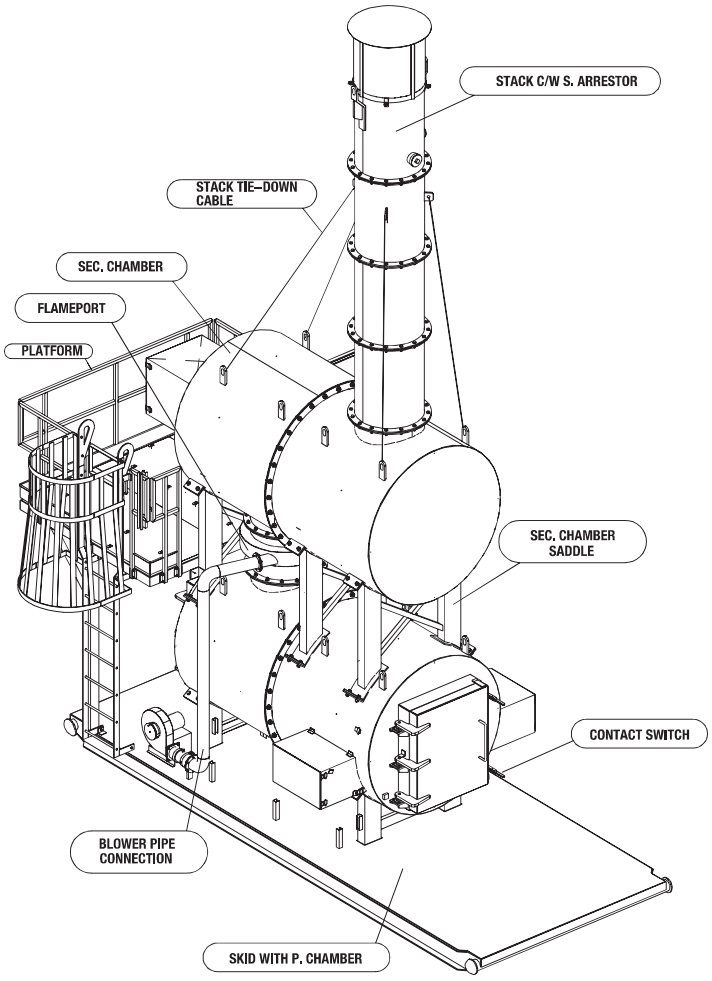


FIGURE 5 OVERALL VIEW SHOWING THE SECTIONS

5.3 Primary Chamber Section

TABLE 5 COMPONENTS IN THE PRIMARY CHAMBER SECTION {FIGURE 6 & FIGURE 7)

Code	Component	Description	Function
PC	Primary Chamber	Built in-house. Inside Vol: 2.74 m3 Refractory + Insulation	Pyrolysis and gasification Combustion of fixed carbon
PC_B	Auxiliary Burner	Becket2 x WIC-201; 770,000 BTU/h (Each); 5.5 USG/h (Each)	Start-up and maintains a minimum temperature
PC_T	Thermocouple	Stainless Steel	Used by PC Temp. Controller to regulate burner
PC_D	Charging Door & Ash Door	Built in-house. Feed Door: 90cm (Height) x 70 cm (Width) Ash Door: 86 cm (Height) x 70 cm (Width)	Load waste and ash removal
PC_S	Contact Switch	Square D ZCKJ1H7 (2)	Turn off PC burner when Feed door/Ash door is opened

5.4 Secondary Chamber Section

TABLE 6 COMPONENTS IN THE SECONDARY CHAMBER SECTION {FIGURE 6 & FIGURE 7)

Code	Component	Description	Function
SC	Secondary Chamber	Built in-house. Inside Vol: 2.87m3 Refractory Insulation	Complete combustion of gases and soot generated in Primary Chamber
SC_B	Auxiliary Burner	Becket WIC-301; 1,600,000 BTU/h; 13.0 USG/h	Start-up and maintain minimum set temperature
SC_T	Thermocouple	Ceramic	Measure temperature in Secondary Chamber
FP_P	Flame-port Plenum	Turbulent vortex flow built inhouse.	Mixing of combustible gases and flame-port air
FP_B	Flame-port Blower	4C 108 Dayton; 1 HP; 3600 rpm	Combustion air supply to flame-port plenum
FP_T	Flame-port Throttle	Butterfly valve	Controls flame-port airflow
ST	Stack	Refractory+ Insulation, built in-house.	Dispersal of flue gas

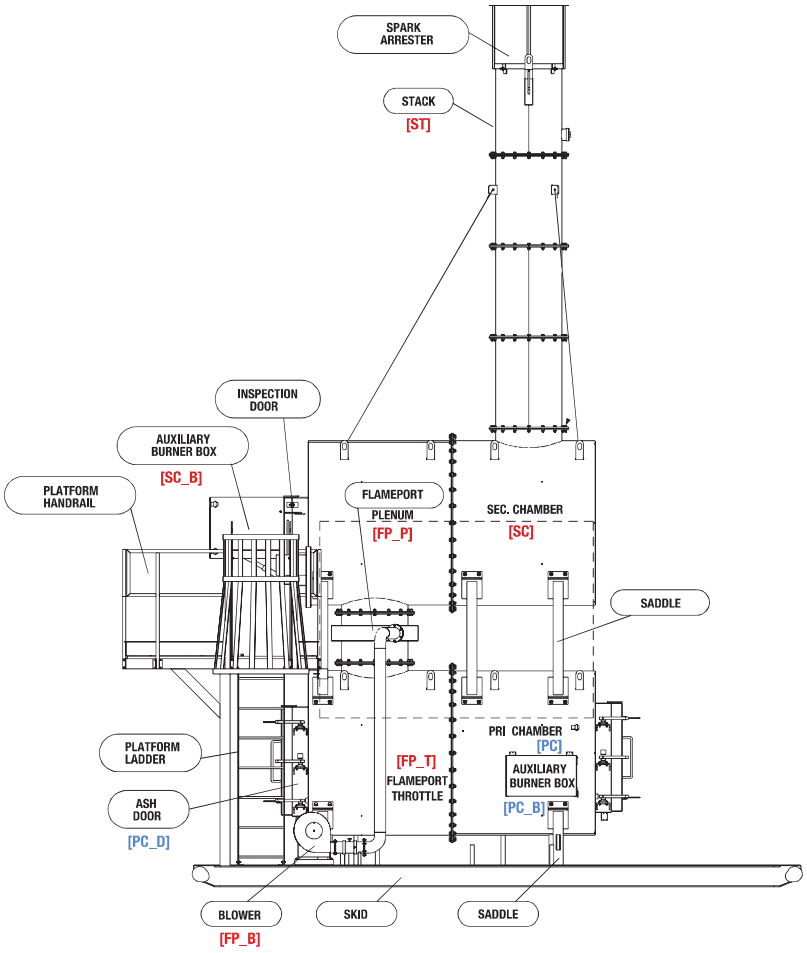


FIGURE 6 COMPONENTS IN THE PRIMARY AND SECONDARY CHAMBER SECTIONS (1)

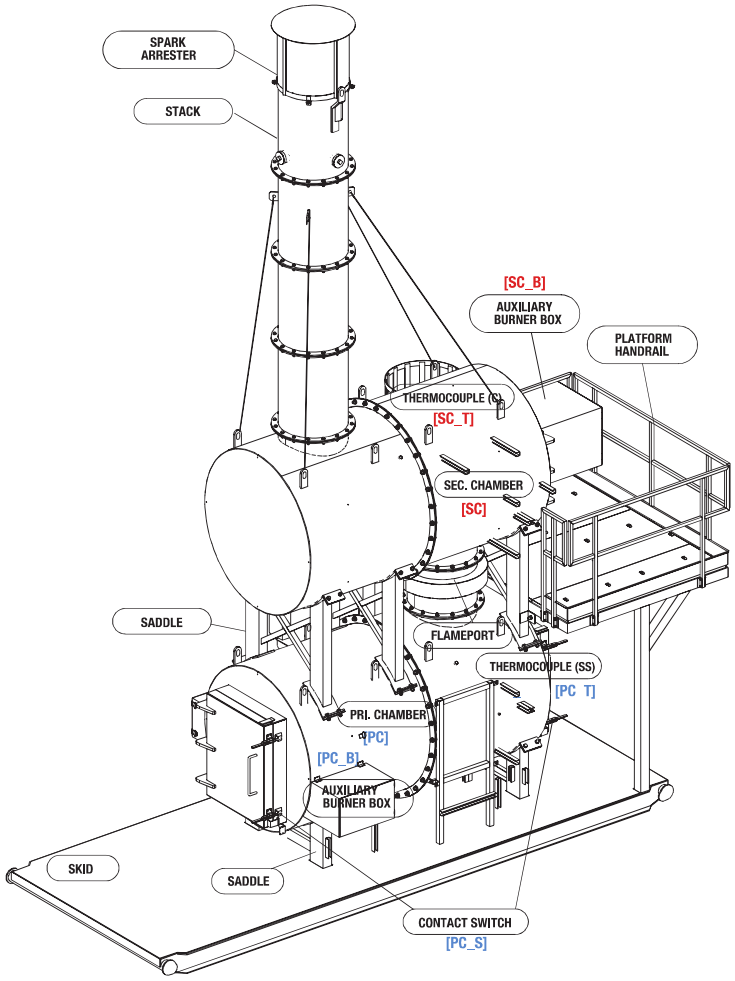


FIGURE 7 COMPONENTS IN THE PRIMARY AND SECONDARY CHAMBER SECTIONS (2)

5.5 Control Panel Section

The components are listed in Table 7.
Figure 8 Overview of Control Panel, Showing the Main Sections shows a photograph of the whole control panel, which has been divided into sub-sections marked A, B, C, and D.

TABLE 7 COMPONENTS IN THE CONTROL PANEL SECTION

Code	Label	Function
Sub-Section A: Indicator LEDs (ON-OFF)		
C3, C5 C8	Primary Blower Secondary Blower	GREEN PC_BL GREEN SC_BL
C6	Flameport Blower	GREEN FP_B
C2, C4 C7	Primary Burner Secondary Burner	RED PC_B RED SC_B
Sub-Section B: Burn Timer		
T1	Burn Timer	Set burn-cycle duration to the specified time. (Start switch restarts timer)
Sub-Section B and C: Main Controller and Controllers for Burners and Blowers		
PB1 PB2 R1	Start Switch Energy Stop Contact Switch	Initiate Pre-Purge, Burn, Burn-Down, Cool-Down Automatic Cycles. Emergency Use Only. For Normal Stop, Set Burn Time to 0. Safety Apparatus, Will Turn ON/OFF Primary Chamber Burner When Feed Door is OPEN/CLOSED.
Sub-Section D: Omron Temperature Controllers and Indicators		
TC1 TC2 TC3	Primary Chamber T.C. Secondary T.C. Secondary Trigger T.C.	Temperature Displays and Control of Minimum Temperatures in Primary and Secondary Chambers by Setting Adjustable Set Points (OMRON E5CN). Primary Burner Enabled When Secondary Trigger Reaches its Specific Temperature Set Point.
Sub-Section E: Touchscreen Digital Display		
	Primary Blower Secondary Blower Flameport Blower	Blower symbol - GREEN "OFF" Blower symbol - BLUE "ON"
	Primary Burner Secondary Burner	Burner Symbol - NO FLAME "OFF" Burner Symbol - FLAME SYMBOL "ON"
	Digital Magnetic Guage	Displays pressure of Primary Chamber Should be Negative Pressure between 0 and -0.5 inches
	Feed Door / Ash Door	Displays if door is open or closed.

Notes:
This panel has been configured with Burner Protection which ensures that if the primary and/or secondary chamber is hot, the corresponding burner-blower will run even if the cool-down period has elapsed, or if there has been a power disruption.

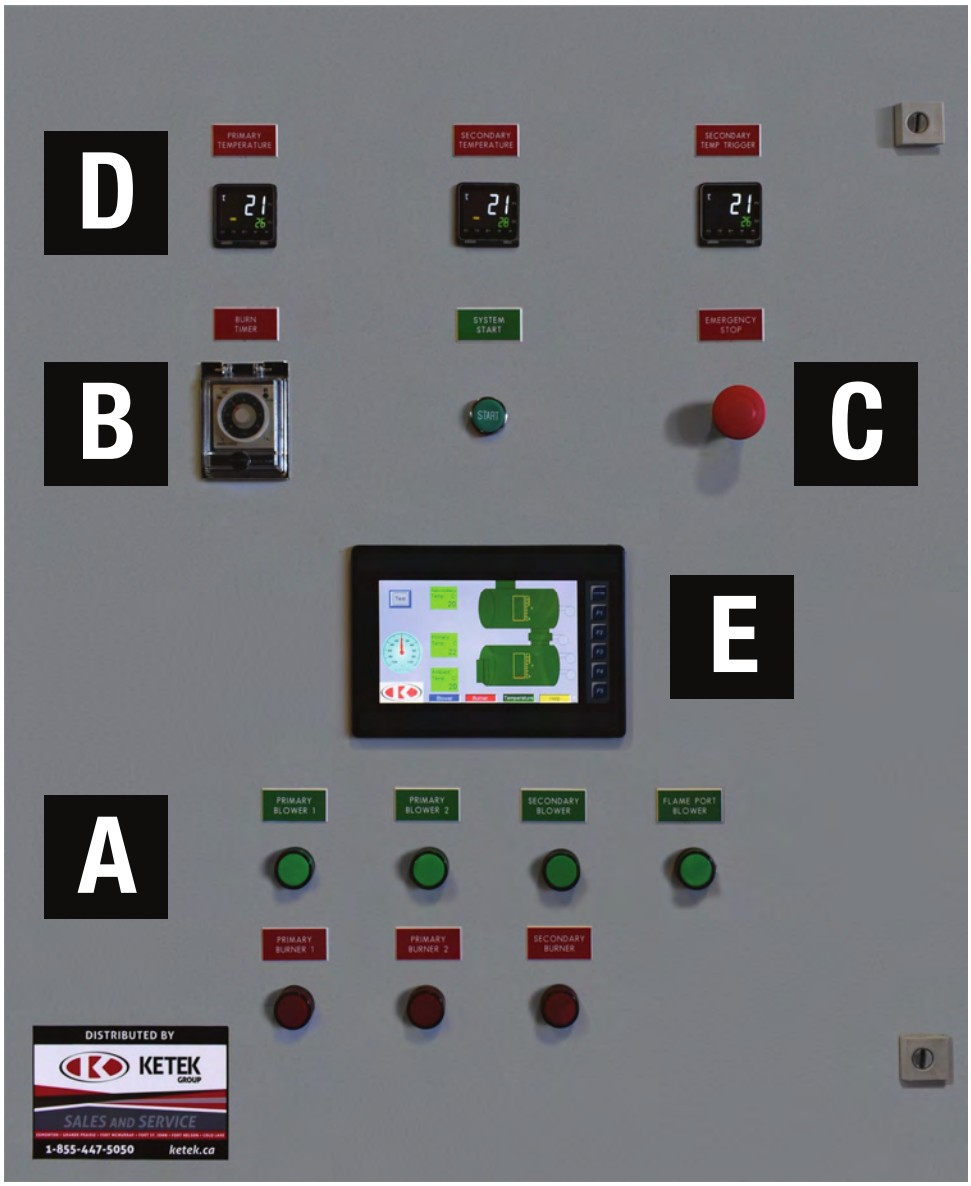


FIGURE 8 OVERVIEW OF CONTROL PANEL, SHOWING THE MAIN SECTIONS

The operation of the incinerator can be described by distinct sequential steps as shown in Figure 9. There are additional necessary steps which involve safety, routine inspection and waste batch preparation, which will be first described.

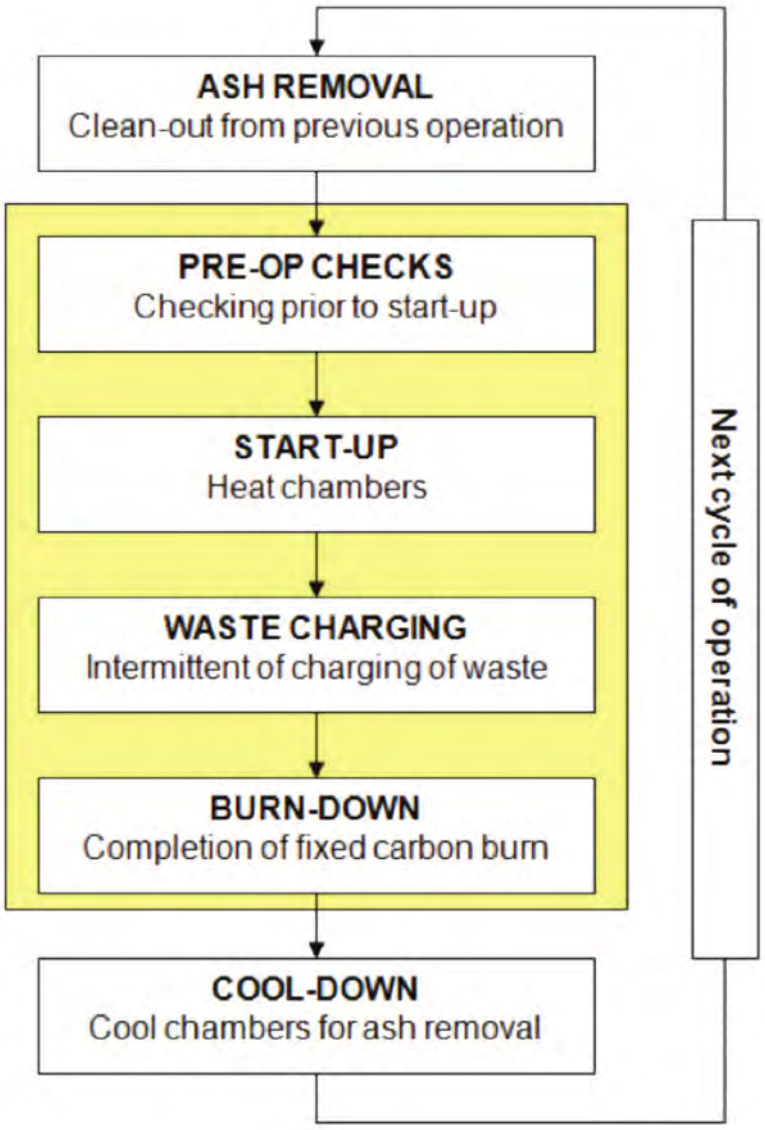


FIGURE 9 STEPS IN THE OPERATION OF THE INCINERATOR

6.1 Safety equipment

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 are listed below:

- Ash removal and handling: NIOSH N95 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 / ash doors while combustion is taking place).
- Wearing appropriate PPE for charging waste and raking the primary chamber, AND minimizing the time for those tasks.

6.2 Routine inspection and maintenance

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

6.3 Waste batch preparation

The following cautionary notes should be followed:

- NO explosives, aerosol cans or 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 for health/safety reasons.

6.4 Ash removal

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

- Make sure combustion chamber is sufficiently cool (DO NOT spray water into the combustion chamber) While removing ash, avoid damaging the burner tip Use non-combustible container
- Minimize dust generation
- Light water spraying on ash in the container is OK to minimize dust generation Ash to be removed daily (after sufficient cool down period)
- Dispose of ash as specified in the guidelines or regulations

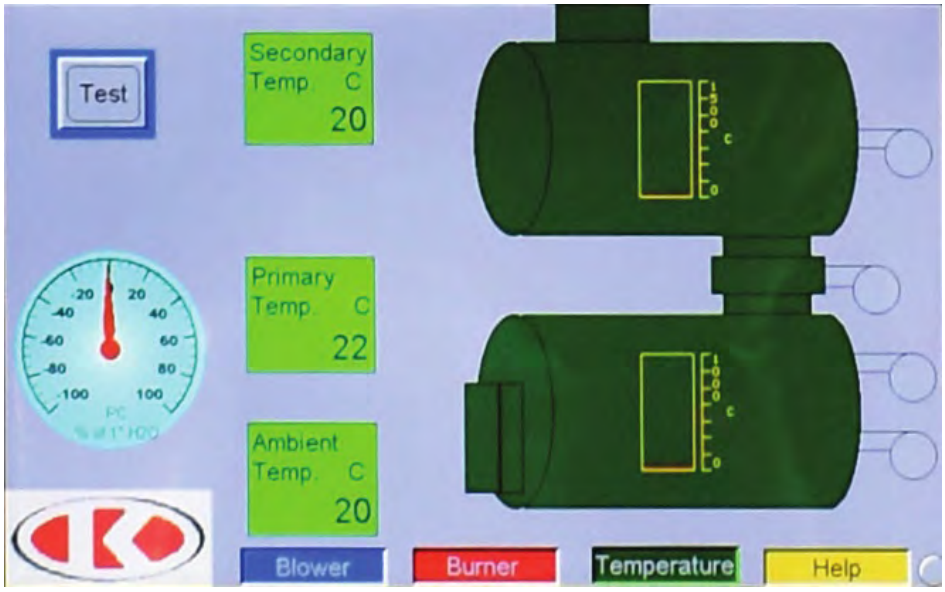
6.5 Pre-operational checks

- When diesel or propane is used, check fuel tank to make sure there is enough fuel (see Figure 14 for estimates of fuel consumption, depending on burner size and length of operation). Conduct inspection around incinerator, make sure there is no debris or fire hazards; area should be clean
- Open fuel valve
- Check fuel lines for leaks and check all connections
- Check for any physical damage on incinerator including stack and spark arrestor Inspect thermocouples, feed door/ash door seals, and blower inlets
- Re-check that the combustion chamber is empty Check power connection
- When diesel is used, bleed the diesel lines to the burners if necessary

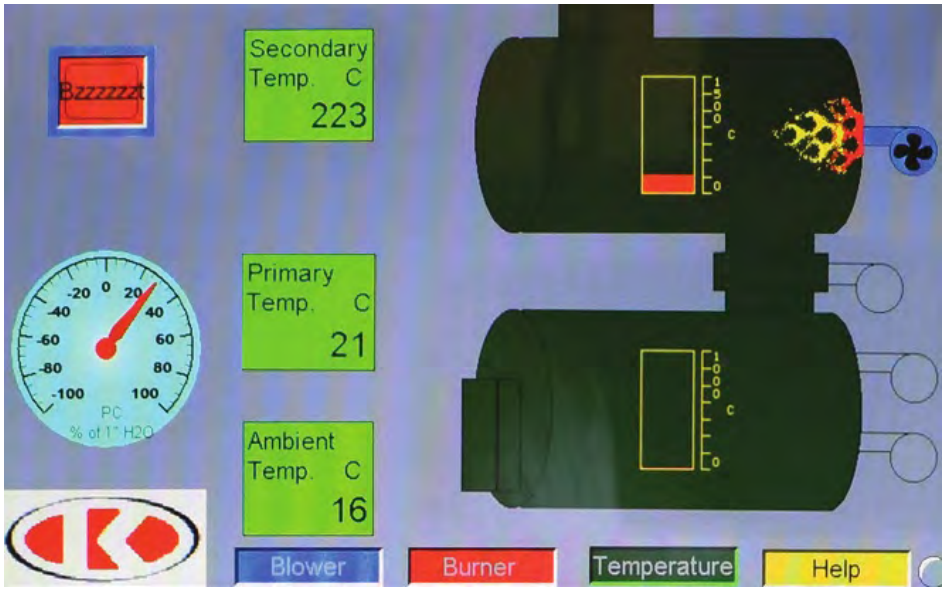
6.6 Operational Procedure

1. The first step in managing waste is to understand the quantity and composition of the waste that is generated. A waste audit should be completed. (Ketek Group can provide a waste audit, which can provide the following:
- Determine the quantity of waste from each type of operation
- Characterize the waste stream to determine what opportunities exist for:
- Reducing the quantity of waste generated,
- Reusing materials and recycling as much as possible before considering disposal.
2. Before operation of an incinerator, the area surrounding the incinerator shall be free of any debris and tripping hazards. Maintaining proper housekeeping for the incinerator is important and will reduce safety hazards such as slips, trips and falls.
3. A pre-operational checklist should be completed prior to operation of the incinerator. (Ketek can prepare a pre-operational checklist for you). Make sure all ash is removed from the previous burn. Record the weight of ash on checklist.
4. The operational checklist should be continually filled out with the required information throughout the day and during operation of the incinerator.
5. The incinerator should be loaded to the limited charging capacity (both in terms of waste quantity and the calorific value of waste charge). The incinerator should be charged with the appropriate mix and quantity of waste, the operator should close the door, ensure all interlocks are engaged, and start the burn cycle.

6. Turn the timer to 12 hours and press the green "Start" button.



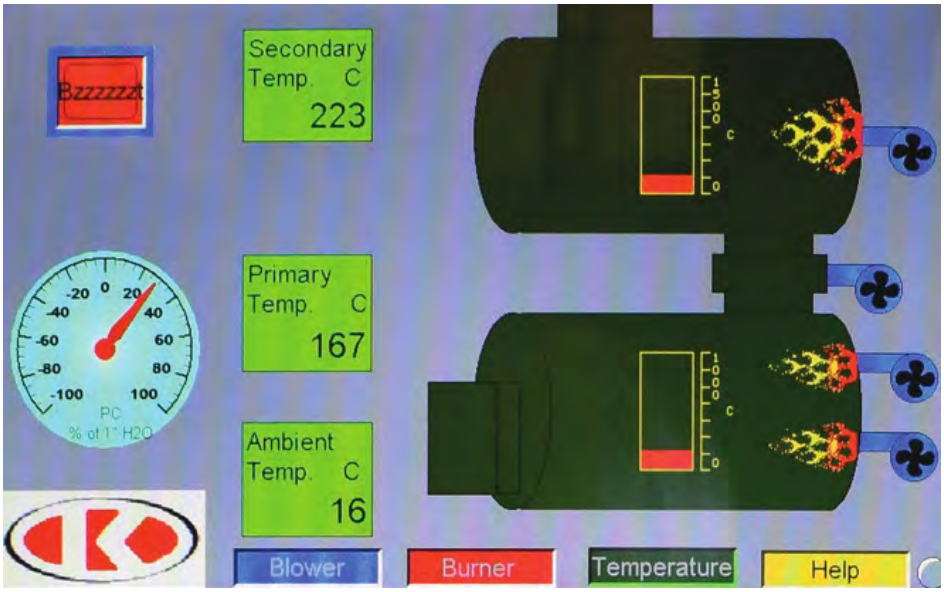
7. Proceed with inspecting of the incinerator and make certain that all burner blowers (two burners in Primary Chamber and one in Secondary Chamber) are functioning correctly.
8. After five minutes, primary burner motor will shut off and the secondary burner (flame) should be running. You will see the temperature increase on the temperature display "Secondary Chamber T.C."



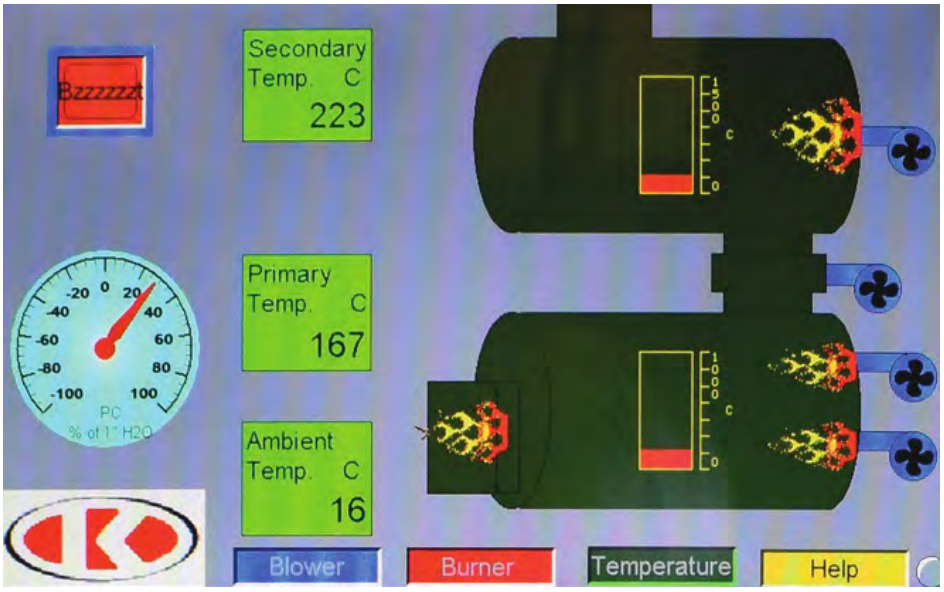
9. The secondary burner heats up to the specified temperature in "Secondary Temperature

Trigger."

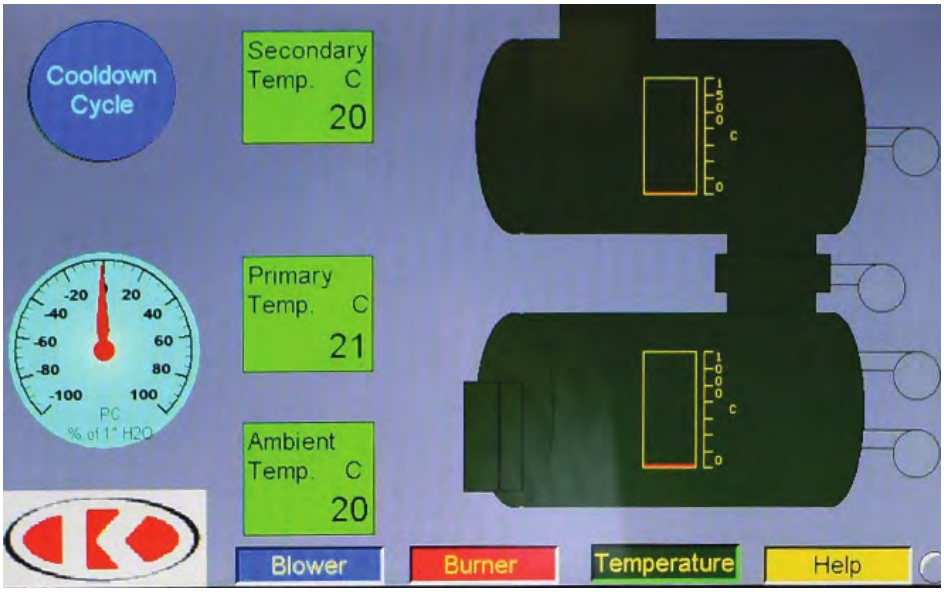
10. At this point, primary burners (flame and blowers) and flame port blower will come on and you will see the temperature increasing on the temperature display "Primary Chamber T.C."



11. The temperature will keep increasing until it goes up to the set point and after that burners will continually function on/off to maintain the specified temperature set on the incinerator control system.
12. After about 2-3 hours into the burning process, open the door and check the status of the waste and rake if necessary. Always rake from the ash door side.



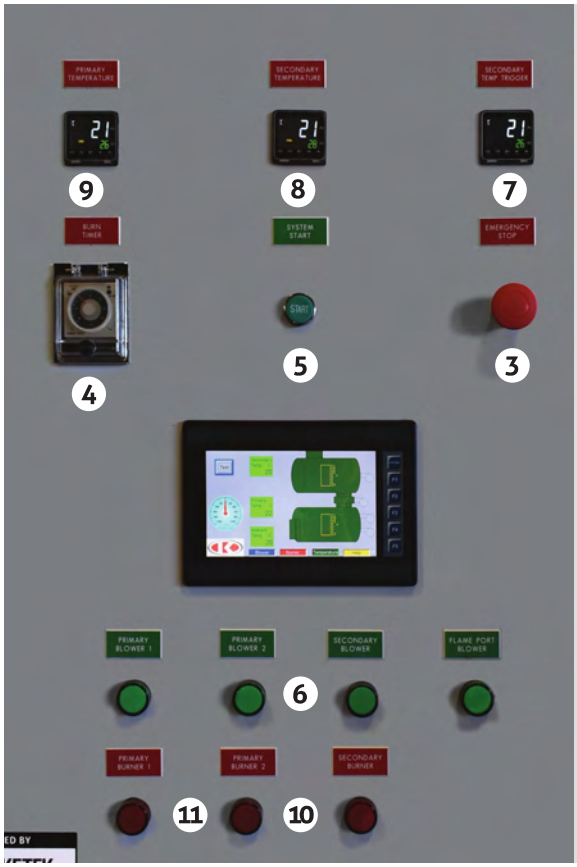
13. Approximately one hour after the rake, check the waste status again. If not burned, rake it and close the door. If waste seems burned and you do not need to burn another batch, then manually run the burn timer to zero. If you need to burn more batches, lower the set point on "Burn Timer" to 0 by pressing the "▲" down arrow. Give about 30-60 minutes for the Primary Chamber to cool down.
14. Load the next batch in the Primary Chamber and turn the timer to 12 hours.
15. Repeat steps 11 to 13 for other batches of the day.
16. For the final batch of the day turn the timer to about 5-6 hours. Rake in between if required.
17. After the timer runs out, the primary burners will no longer produce flames, but the blowers will continue to run. At this time the secondary chamber burner will still keep running for another half hour.



18. After secondary burners shut down, all the blowers will keep running for another 5-6 hours to give enough time for the incinerator to cool down and prevent any damage to the burners. If after the cool down process the temperature in the chambers is still above 250°C, the blowers will continue to run until the temperature drops below the 250°C value.
19. The pre-operational checklist should be given to the supervisor for documentation and any further procedures. Pre-Operational Checklist should be filed and kept for record.
20. The touchscreen digital display records the incineration operations. It comes standard with 32 Gb of memory. The PLC records operations such as blower operation, burner and door feed, and incinerator chamber temperature. To go back to the home screen please push the Ketek symbol, located bottom left of screen.

Note:

a. Do not operate the incinerator if something is not functioning properly. Immediately tell your supervisors.
b. Do not overload the incinerator
c. It is important that waste should neither be open-burned nor burned in a barrel
d. Wear all required PPE (gloves, face-shield, dust mask, flame retardant coveralls, etc.)
e. If flame detection control locks out, try resetting it by pressing red button on the burner control. If it keeps resetting, let your supervisor know immediately.
f. Always ask if unsure about something.



1. Perform Pre-Op Checks
2. Load first waste charge
3. Ensure Emergency Stop is pulled out
4. Set burner timer
5. Press "Start"
6. Observe blowers in pre-purge.
   Can be seen as Touchscreen display.
7. Set Trigger TC to 650°C
8. Set Secondary TC to - 1100°C
9. Set Primary TC to - 600°C
10. Observe secondary burner.
    Can be seen as Touchscreen display.
11. Once Trig Temp is reached, observe all blowers and Primary Chamber.
12. Automatic operation until burn timer expires. Burn Down and Cool-Down cycles follow automatically.

FIGURE 10 OPERATING SEQUENCE

Note: Temperatures in Steps 8 and 9 may be governed by regulations:
If so, SET TEMPERATURE TO THE REGULATORY VALUES

6.7 Waste charging:

For Batch feeding (recommended) see Figure 11.

1. After de-ashing the cooled-down incinerator, load waste on the hearth. Refer to training notes and operating experience.
2. Ensure Burn Timer is set to 4-5 hours, depending on load size. Pressing "Start" button begins a new cycle.
3. Primary burners will start once Secondary Chamber is at trigger temperature (TC3 set-point typically at 650°G)
4. After three hours, open door, check state of ash, rake if needed.

FIGURE 11. PROCEDURE FOR BATCH WASTE CHARGING

Additional Notes to Figure 11:
** The main danger is from exposure to heat radiation, and from waste 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. Check burning conditions from charge door. Rake if necessary.

6.8 Waste Incineration Records

To demonstrate appropriate operation and maintenance of the incinerator, we recommend that the facility maintain records containing at least the following information (or as per permits/regulations):

- A list of all staff who have been trained to operate the incinerator; type of training conducted and by whom; dates of training; dates of refresher courses.
- All preventative maintenance activities undertaken on the equipment.
- Records of operation of the incinerator.
- Records of quantities of waste incinerated.
- Summarized annual auxiliary fuel usage.
- A list of all shipments/disposal of incinerator residues, including the weight transported and disposed of by type if necessary, and the location of the disposal site.
- Results of any stack emission monitoring and ash sampling information.

All raw data records from the operation of the incinerator will be retained for inspection by the appropriate authorities for a period of three years (or any other time period as deemed necessary).

6.9 Burn-Down and Cool-Down: see Figure 12

For Batch feeding (recommended) see Figure 11.

1. Automatic Burn-Down cycle begins after burner timer expires. Primary burners shut down immediately.
2. Automatic Cool-Down cycle follows. Secondary burner shuts down.
3. Blowers automatically shut down once chambers have cooled to 250°C. Cycle is complete.

FIGURE 12. PROCEDURE FOR BURN DOWN.

6.10 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 PC_T and SC_T	Check that the readings of temperature controllers are close to the estimated temperatures of the Primary and Secondary Chambers
	Contact switches PC S	Free movement, no obstruction
	Gasket/seal waste feed door PC_D	Wear and tear; proper sealing
	Refractory in primary chamber PC	No large (not expansion) cracks; pieces falling out. Repair if necessary.
Weekly	Blowers PC_B, SC_B, FP_B	Inspect clean in-takes, clean if necessary
Monthly	External surfaces of PC and secondary chamber SC	"Spotty" discoloration may indicate damage to refractory and/or insulation
Annual	Refractory in SC	No large (not expansion) cracks; repair if necessary

6.1.1 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 corrected them yourself.

TABLE 9 TROUBLESHOOTING GUIDELINES

Phase	Observation	Points/Items to look at.
Start UP	Incinerator won't start	□ Make sure there is power. □ Check emergency stop is not engaged. □ Timer is set to an actual value and mode. □ Make sure there is power on all phases/legs coming into the incinerator.
Pre-Purge Phase	Skipping or not starting the Pre-purge.	□ Check that pre-purge timer works correctly. □ Check emergency stop is not engaged. □ Make sure there is power on all phases/legs coming into the incinerator.
	Auxilia burner blower(s) won't run in pre-purge cycle.	□ Check Breakers. □ Check burner blower contacts are energized. □ Check that overload switch on the motor is not tripped. □ Check there is power at the burner on the wire supplying power to the motor (Use Multi meter) □ Check for a seized motor by manually spinning the blower wheel. (Make sure power is off and locked out)
Pre-heat Phase	Secondary burner wont ignite	□ Check Breakers. □ Check there is power at the Genisys Control. □ Check that Genisys control is not locked out.
	Burner keeps Locking out after manual reset.	□ Check all fuel valves are on. □ Check Burner contacts are energized. □ Check there is sufficient fuel in the tank. □ Bleed the pump at the 3/8" bleed screw and make sure there is fuel flow and no air bubbles are present. If diesel is gelled (due to cold weather) it will not let the burner operate efficiently. □ If there is no fuel coming out of the pump and the motor is running then it could be a damaged coupling or seized pump. □ If bubbles do not disappear after a while then there is a possible minute leak in the supply line. Make sure all the fittings and joints are tight. □ Check that CAD cell is clean. □ Try and hear the spark at the electrodes.
Burn Phase	Primary burner(s) won't ignite.	□ Check Door Switch(s) are engaged. □ Check Fuses. □ Check there is power at the Genisys Control. □ Check that Genisys control is not locked out.

	Burner keeps Locking out after manual reset.	□ Check all fuel valves are on. □ Check Burner contacts are energized. □ Check there is sufficient fuel in the tank. □ Bleed the pump at the 3/8" bleed screw and make sure there is fuel flow and no air bubbles are present. If diesel is gelled it will not let the burner operate efficiently. □ If there is no feel coming out of the pump and the motor is running then it could be damaged coupling or seized pump. □ If bubbles do not dissapear after a while then there is a possible minute leak in the supply line. Make sure all the fittings and joints are tight. □ Check that CAD cell is clean. □ Try and hear the spark at the electrodes.
	Flame port Blower won't start	□ Check Breakers. □ Check blower contacts are energized. □ Check there is power at the electrical box on the wire supplying power to the motor (Use Multimeter) □ Check for a seized motor by manually spinning the blower wheel. (Make sure power is off and locked out)
General	Auxiliary burner(s) ignite for a while and then stop while system is still calling for them to be on.	□ Bleed the pump at the 3/8" bleed screw and make sure there is fuel flow and no air bubbles are present. □ If bubbles do not disappear after a while then there is a possible minute leak in the supply line. Make sure all the fittings and joints are tight.
	Omron Temperature controller showing "S.err"	□ Make sure wire connections are tight at the thermocouple and on the controller inside the panel. □ Check thermocouple is not damaged. To do this follow steps below: □ If you connect red and yellow wire together at the thermocouple and the error goes away, then go ahead change the thermocouple. □ If error does not go away after connecting the wires together then most probably the wire is damaged or a small chance of a faulty controller.
	Liquid dripping from the door.	□ Check that the door seals are not damaged. □ Check there are no depesits on the door or the door frame. Scrape off any deposits. It is a good practice to do it once a week.

For further troubleshooting of burners or blowers please refer to equipment specific manuals (attached at the end of this manual).

Before conducting any work, make sure all power is locked/tagged out and that any site specific safety procedures are followed before any maintenance occurs.

6.12 Auxiliary Fuel Consumption Rate

Figure 13 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 USG where Y is the fuel consumption rate for X million Btu/h rating, as shown in the graph.

FIGURE 13 CONSUMPTION RATES OF PROPANE AND DIESEL

APPENDIX A

1. SUGGESTED SPARE PARTS LIST
2. BURNER WIC 201
3. BURNER WIC 301
4. BLOWER DAYTON 4C 108
5. INSPECTION CHECKLIST
6. WIRING DIAGRAM

7.1 Suggested Spare Parts List

CY-100-CA-D RECOMMENDED SPARE PARTS LIST

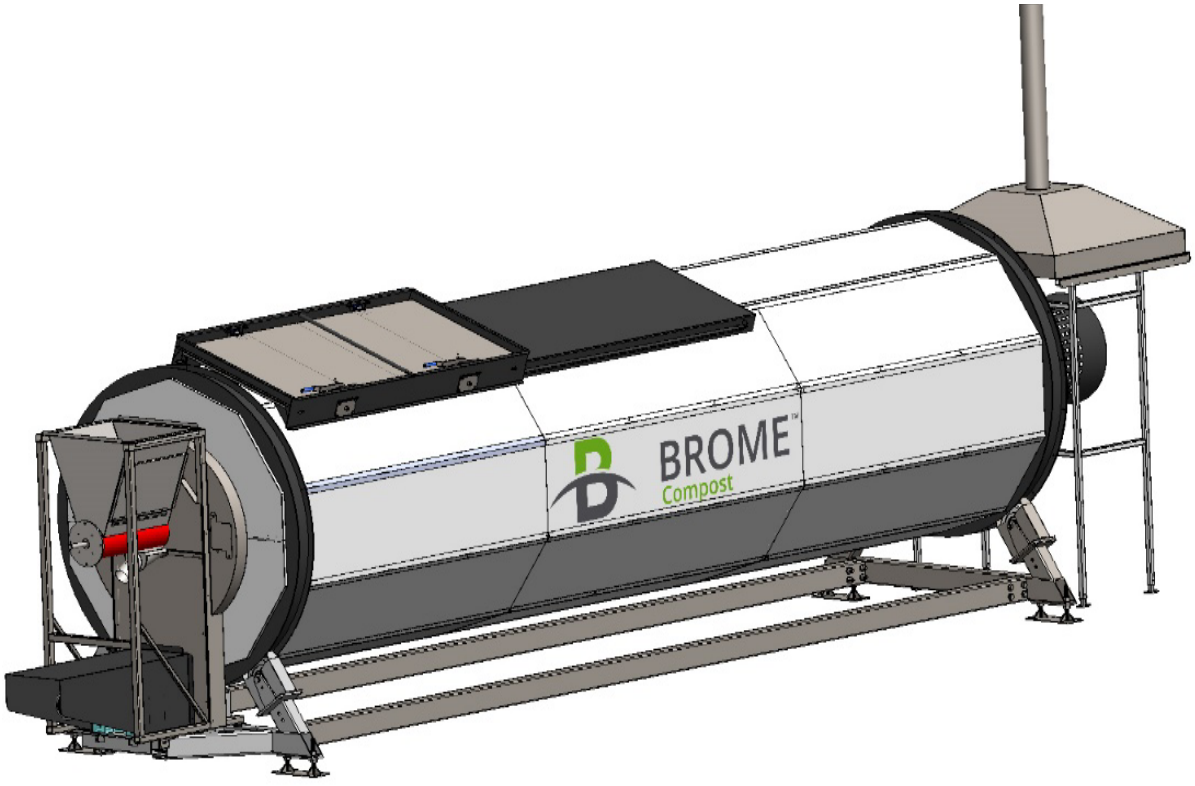
Description	Qty	KETEK Part No.
Gun Burner Beckett, WIC 201 16" (5.5GPH)	2	129230
Gun Burner Beckett, WIC 301 10-1/4" (7.0GPH)	1	129240
Dayton 4C-108 Flameport Blower	1	129305
Air Tube Combination for WIC 201 6 5/8	2	129420
Air Tube Combination for WIC 301 10-1/4"	1	129455
Motor for WIC 201	2	129480
Motor for WIC 301	1	129520
Coupling, Flex for WIC 201	4	129400
Coupling, Flex for WIC 301	2	129510
Fuel Pump A2YA-7916 Suntec	2	129320
Fuel Pump B2TA-8851 Suntec	1	129321
Blower Wheel for WIC 201	2	129410
Blower Wheel for WIC 301	1	129411
Transformer, Ignition "S" for WIC 201	2	129360
Transformer, Ignition "S" for WIC 301	1	129530
Nozzle (5.5 GPH 60° B)	2	144700
Cad Detector Call (If Applicable)	4	120730
Beckett Genysis Control (If Applicable)	2	177800
Timer, H3CR-A 11pin	1	152760
Omron Temperature Controller	1	131850
Panel Fuse Package	8	No item #
Thermocouple Ceramic (Secondary Chamber) – 12.75"	2	130140
Thermocouple Ceramic (Primary Chamber) – 12.75"	2	163670
Proximity Switch Door	1	132600
Limit Switch Assembly	1	130090
Gasket, Ceramic Fibre ¼" x 2" (price per foot)	100 ft.	132610
Gasket Cement, HT Silicone Tube	4	132620
Spark Arrester, Stainless Steel (Crating Not Included in Price)	1	130341
Filter Adapter (For Fuel Tank)	1	147840
Filter, Fuel LFF2 (For Fuel Tank)	2	133460

Appendix C: Brome Composter Instruction Manual

V7

BROME Compost inc.

Brome Composter Instruction Manual



Operator Manual

Before using this composter, please be sure to carefully read the following instructions and become familiar with its operation in order to prevent problems and accidents.

INTRODUCTION

Composting is the ideal solution for the disposal of organic waste, especially when the alternative is sending it to landfill sites. Composting on-site greatly reduces greenhouse gas emissions and atmospheric pollutants related to the transport of organic residual matter to landfills or to industrial composting sites.

Brome Composters are easy to install and use. They have low operating costs and low maintenance requirements, making on-site composting accessible to many types of industries, commercial business and institutions (ICI), as well as farms and municipalities.

Brome Composters are designed to convert many types of organic waste including food scraps, animal products, green waste, animal carcasses, sceptic mud, etc., into high-quality compost in a short period of time and with little handling. Brome Composters are available in a variety of different models, which can easily be adapted to the user's needs.

Models :

Composter 400 Series	Brome 406 Brome 410 Brome 416 Brome 424 Brome 430
Composter 500 Series	Brome 506 Brome 510 Brome 516 Brome 524 Brome 530
Composter 600 Series	Brome 608 Brome 616 Brome 624 Brome 630

Model: (capacities can vary depending on the type of material, the required residency time, and whether the input is pre-treated).

The composter is an insulated cylinder that self-rotates according to the user's pre-set time intervals. These rotations mix the contents while at the same time providing aeration, allowing the bacteria to breathe and break down the organic waste (O.W.) into compost more rapidly than other composting methods. The decomposition process produces heat. The cylinder is insulated with a 1½" insulating material (R 7.5) to preserve heat inside the cylinder during the winter months. The compost is discharged at the cylinder's extremity through an opening that also serves as an air inlet.[1] The rotation intervals and the amount of matter added regulate the amount of finished compost being discharged.

This composter is designed to work year-round, indoors or outdoors, and can compost a wide variety of O.W. In certain extreme conditions, adaptation may be required during the installation process.

Figure 1 -- Interior view of the cylinder

[1] Composters are pre-perforated to accommodate an optional ventilation system. Valves can also be installed as an option (passive ventilation).

Safety

Before operating this equipment, make sure that each employee understands and follows the safety, operation and maintenance rules described in this document.

No modifications should be made to this equipment without authorization from Brome Compost. Equipment modification will automatically invalidate the warranty offered by the manufacturer and could cause serious injuries.

Table of Content

Section 1-- Safety

1.1 Safety instructions

- Never go into the cylinder unless you are trained to work in confined spaces and have authorization from your immediate superior; always follow the appropriate lockout procedure;
- Make sure all the warning labels are in place and visible
- Repairs and maintenance on the equipment must be made by qualified personnel only;
- Respect all established safety standards while performing maintenance on the equipment;
- Make a visual inspection of the equipment as often as possible
- It is recommended to use replacement parts from the manufacturer
- It is recommended to restrict access to the equipment by installing a fence or other barrier
- We recommend that the doors be locked when there is no surveillance or operator present

1.2 Operating the Equipment Safely

Before operating the composter, please note that a support service is offered for the installation, the initial start-up, and the training of personnel designated for the equipment's operation and maintenance.

Start-up support is available once the installation is completed. A remote monitoring service, as well as an interactive data tracking system are available upon request. Please contact Brome Compost for more information on this subject.

1.3 Performing Maintenance Safely

- Always ensure that the electrical current is switched off and that the lockout procedure is done properly when performing maintenance on the composter. If you must go inside the composter, be sure to have adequate ventilation and to respect the regulations governing work in enclosed spaces.
- If you need to rotate the cylinder during maintenance, please remove toolboxes, stepping stools, ladders, etc. and ensure that there are absolutely NO OBSTACLES within the rotational axis in front, in back, and on each side of the composter.

1.4 Precautions Against the Risk of Electrocution and Physical Damage

- Always cut the electrical current if you need to open the control panel
- Never go beneath the composter
- Always ensure the doors are closed and locked before operating the composter
- Pay close attention to the turning of the wheels
- Never climb on the composter
- ***Screw option : never clear or clean matter without first cutting the electrical current and locking the composter.***

Feeder Mechanism : Feeding Screw

Never place hands or tools inside the composter's feed shaft without first cutting the electrical current and always respect the recommended lockout and safety procedures.

If the screw mechanism becomes jammed, you should under no circumstances try to remove matter with your hands or with a tool without first having followed the safety lockout procedure.

1) Operate the screw for only a few seconds in reverse to unblock it. Stop the screw and start it again in the right direction

2) If this does not work, follow the lockout procedure;

3) Remove the screw or the lock from the access door and remove the blocked matter carefully with an appropriate tool in order to avoid injuries;

4) Once the matter is removed, close the access door, put the screw or lock back in its proper position and restart the composter and the screw according to the proper procedure;

Section 2 – Important Information for Delivery

Composter Model	Weight (empty) (Kg)	Weight (in operation) (kg)	Working Volume (m3)
Brome 406	599	1291	1.8
Brome 410	1796	2950	2.3
Brome 416	2199	4041	3.7
Brome 424	2595	5364	5.4
Brome 430	3193	6656	6.9
Brome 506	3492	4443	1.9
Brome 510	2023	3609	3.1
Brome 516	2381	4918	5.0
Brome 524	2821	3201	7.5
Brome 530	3401	8159	9.5
Brome 608	798	3113	4.6
Brome 616	3493	8121	9.2
Brome 624	5189	12132	13.8
Brome 630	5988	15245	18.3

2.1 Transport and Unloading

- Transport of the composter from the manufacturer to the installation site is the responsibility of the client.

- The unloading, on-site transport and installation of the composter are the responsibility of the client. The client is responsible for providing the machinery needed to unload the composter and a foundation on which to place it according to the technical data sheet provided by *Brome Compost*.

Place the strap firmly around the grooves by passing through the composter's support beams

Lift the composter with the appropriate lifting equipment (ensure that the composter is empty first).

Section 3 -- Installation

3.1 Site selection and preparation

The client is responsible for choosing the layout for the composting site and providing the correct type of surface required for the equipment, as specified in the information provided by Brome Compost. The composter must be installed on a level surface. The surface or structure must be strong enough to support the composter with its full load and ensure it stays level at all times. For example, a concrete slab or steel plate can serve as a foundation depending on the type of soil underneath it.

When the composter is used with mechanized loading equipment (e.g. a bin lift), we recommend securing the composter to the ground with an appropriate anchor depending on the type of surface it is resting on.

Respect all current regulations regarding the installation of a composting site.

3.2 Precautions for Outdoor Installation

- Install the composter as far from houses as possible;
- Avoid placing the composter near an air intake, a ventilation system, windows and doors;
- Avoid placing the composter in busy areas;
- Unless the composter is equipped with a cover (available as an option), we recommend the installation of a fence around the equipment.

3.3 Precautions for Indoor Installation

- Plan a ventilation shaft or a sanitary drain that exits the building for the elimination of composting gas and odours;
- Do not place the air exit near an air intake, a door or a window;
- Take care to place the system in a separate room to avoid any contact with human food preparation or food storage areas in order to minimize contamination risks;
- Make sure the building's foundation can support the weight of the composter when it's both empty and full;
- Allow sufficient space around the composter to ensure ease of movement related to composting operations (addition of matter, collecting compost at the exit, etc.).

3.4 Electrical Installations

- The client is responsible for the electrical installations for the equipment.
- It is possible, however, to deliver the equipment with an electrical connection as specified by the client.
- Please contact Brome Compost to schedule your electrical installation before the delivery of the equipment.

Section 4 – Operating Procedures

4.1 Sanitary Precautions When Composting

Composting is considered a safe activity for operators and compost users when certain basic rules are respected and followed. It is the owner's duty to give all necessary information to operators to ensure composting activities are conducted safely. Brome Compost is a manufacturer and is not responsible for the client's use of the equipment.

4.2 Verifying the Installation and Assembly Before Start-up

Verify that the surrounding area is free of all equipment, tools, etc. and that the safety guards are installed before the initial start-up.

4.3 Initial Start-up

Before adding matter:

1- Ensure that the emergency stop button is in the OFF position;
2- Wear personal safety equipment such as a mask, safety goggles, gloves;
3- Ensure that the doors are open facing the operator
4- If necessary, use a platform to ensure a safe and ergonomic operation
5- Verify that the composter is free from all possible collisions with equipment or work tools when it is rotating.

Always make sure the emergency stop button is pulled (composter is working) after each use.

Figure 2 -- Brome Composter Control Panel

Adding Matter into the Composter
Step 1:

Push the emergency stop button before working on the composter. This will prevent the rotation of the composter while you are working around the machine and when the door is open.

Step 2: Open the composter door.

Sliding door:

Unlock the door padlocks (on both handles) if you have this option. Pull the door locks at the same time as you pull on the handles. Pull on both handles alternately for ease of opening. When the handles are completely free, slide the door to the right.

Out-swing doors:

Unlock the door padlock (on the handle) if you have this option. Pull the handle slightly up and then towards you. Open both doors by pulling them towards you.

Step 3: Closing the door and starting the composter.

Close the door and lock the padlocks, if you have this option.

Start the composter by pulling the emergency stop button. A green light on the control panel will indicate that the composter is in operation.

Check the Organic Matter Before Adding It Into the Composter:

Before adding organic matter to the composter, check the contents to be sure there is no foreign or contaminating matter (i.e. plastic, metal, glass, etc.). If you see foreign material, take out as much of it as you can before you add the bin contents into the composter.

** **If you notice that most of the contents of the bin have a bad smell, throw it out.** **

4.4 Monitoring the Temperature in the Composter

Temperature is the best indicator of the composting process and it is crucial to monitor it daily. The best temperature range for aerobic composting is between 45°C and 70°C2.

• To read the temperature, check the thermometer(s) on the cylinder.

Using a portable thermometer is recommended for taking temperature readings at various locations through the door opening, especially during the initial start-up phase.

Figure 3 -- Composter Thermometer

4.5 Odours

Odour control is important to maintaining a good image of your composting installation and to avoid disagreements with your neighbours. By following good maintenance habits, you will prevent odour problems.

A good maintenance plan consists of:

1. Sweeping the floor and cleaning up splotches of O.W. on and around the composter;
2. Removing any waste that has fallen on the floor;
3. Carefully monitoring the composting process (make regular logbook entries, respect the procedures and recipes, etc.);[3]
4. Install an odour dispersion or treatment system if there is a possibility that odours may eventually bother neighbours in close proximity to your installation (available as an option).

[2] Check the standards in effect.

[3] An online calculator for composting recipes and monitoring is available as an option.

4.6 How to Set Rotation Intervals

The Brome composter can be set to rotate at different intervals by adjusting the programmable timer located in the control panel.

1. Locate the timer on the control panel:

- The clock can be set for different units of time (hours, seconds and minutes) to meet the needs of the user;
- Turn the screw located at the lower left on the clock (see red circle on the photo) to change the time intervals;
- Turn the screw located at the top right on the clock (see the red circle on the photo) to change the time units (hours, minutes).

Figure 4-- Rotation Programmed Every Hour

2. Turn the plastic wheel to change the hand position.

During normal use, the composter's rotation intervals should be around an hour. During special operations, it can be programmed differently.

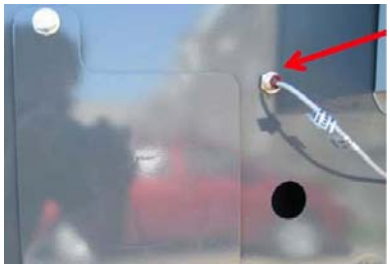
3. When you are finished setting the adjustments, close the panel.

4.7 How to Set the Door Position

The rotations can be stopped at a specific spot so that the door's position is always the same.

1. Press the red emergency stop button on the composter before you work on or near it.

2. Unscrew the panel located to the side of the control box.



3. When you look inside the composter, on the right-hand side, you will see a red magnet. The magnet stops the composter after a full rotation when it passes in front of the sensor. Remove the magnet and put it aside.

4. Pull the emergency stop button and set the composter on manual mode. Turn the composter to set the door at the desired position. Push the emergency stop button.

5. Put the magnet in front of the sensor. Pull the emergency stop button and allow one rotation on automatic mode to test the door stop position (set the clock at 0 to make a rotation on automatic mode).

6. After one rotation, the door should stop at the same position from which it started (if you still hear the alarm, put the composter back on manual mode to prevent a second rotation).

7. If the position is correct, you can screw the panel back on, set the clock back to its original position and return the composter to automatic mode.

Section 5 -- Maintenance

5.1 Performing Maintenance Safely (in Enclosed Spaces)

Work Procedures for Enclosed Spaces

Never enter the cylinder without having the proper training for work in closed spaces and without your organisation's authorisation. Always use the appropriate lockout procedure.

Generally speaking, an enclosed space refers to a partially or completely closed site that:

- Is not adapted nor destined for prolonged human occupation
- Has limited or restricted access and exit routes, or has a configuration that complicates first aid, rescue and evacuation procedures, as well as other emergency intervention practices
- Presents a potential risk to the health and security of persons entering the space, due to one or more of the following factors:
    - Its conception, its construction, its location and its atmosphere
    - The matter or substances that it contains
    - The nature of the work to be done
    - Risks related to the mechanisms and procedures used, as well as dangers to personal security

Please visit the following Government of Canada website for more information on enclosed spaces:
https://www.cchst.ca/oshanswers/hsprograms/confinedspace_intro.html

Securing the Composter and/or the Screw Feeder (Dispenser)

For your safety, it is vital to lock the composter in position during all maintenance procedures, whether it be according to the established schedule or when a malfunction occurs.

Composter:

It is important to cut contact and lock the control panel while performing your maintenance routine in order to prevent someone else from accidentally starting or turning the composter. If you are inside the composter, make sure that another person is there to monitor you or make sure that you clearly indicate your presence.

Feeding Screw (Dispenser):

Never attempt to clean, unblock or perform maintenance on the feeding screw with your hands unless the power is cut and the screw is locked in position. Serious injuries could result. In addition, the lateral panel should always be blocked so that it cannot open when in operation.

5.2 Checking the Condition of the Composter

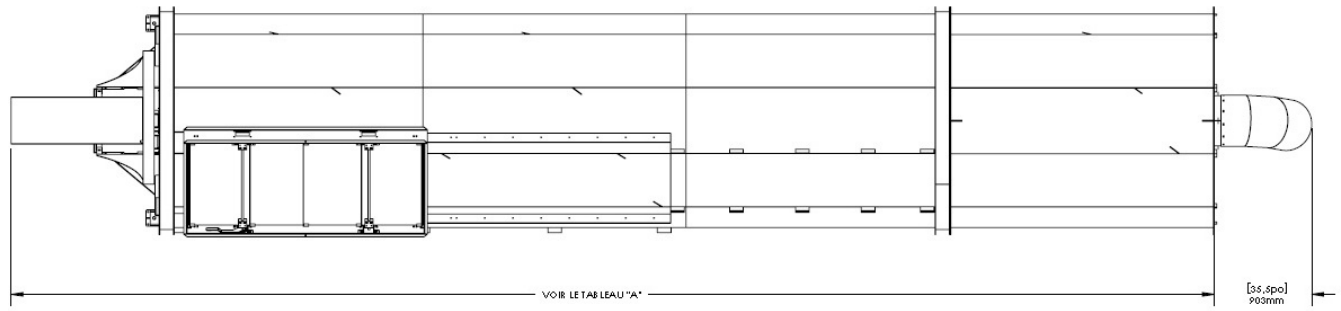
The Brome Composter is designed to function with only minimal maintenance. To ensure the composter's optimal operation, you must:

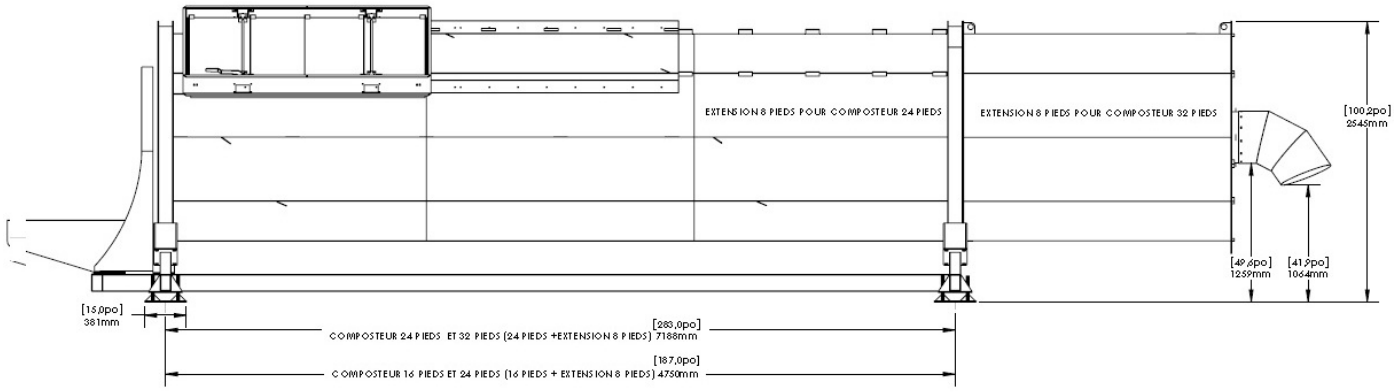
- Regularly inspect the inside of the cylinder to identify any damage that could cause premature deterioration. Remove the output end cap occasionally to allow an unobstructed inspection of the interior surfaces of the cylinder.
- Inspect and clean the area surrounding the cylinder. If material accumulates around the exterior, it can hinder the cylinder's rotational movements, contribute to the development of fly larvae, attract animals and create odours.
- Regularly inspect the opening through which the finished compost exits the cylinder (exit outlet) and clean it, if necessary.
- Do not operate the composter during prolonged periods of inactivity during the wintertime (in freezing conditions), and when if the material inside is frozen. This could damage the equipment.

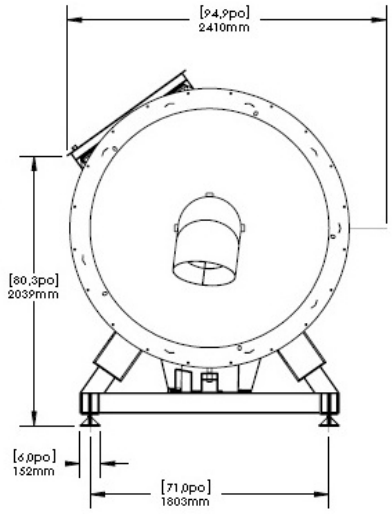
5.3 Maintenance Schedule

	Component	Check	Frequency
1	Door	Rubber Seal	Weekly
	Door	Easy to open	Each use
3	Compost exit outlet	Compost height	Each use
4	Ventilation	Working well	Weekly
5	Composter level	Keep it leveled	Twice a year
6	Control panel	➢ Waterproof ➢ Broken buttons	Monthly
7	Sifter	Holes are free of waste	Weekly
8	Interior of composter	Visual inspection	Annually
9	Mechanical components (motor, gear box, panel)	See manufacturer recommendations	As recommended
10	Wheel (Rotating and guide wheels)	➢ Visual inspection ➢ Rolling smoothy ➢ Check bearings	Each use

Section 6 – Brome Composter Dimensions





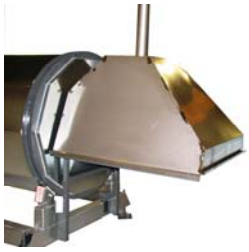


7 Equipment options / accessories

Brome Compost offers a wide range of accessories to facilitate on-site composting. Contact us for more information or if you have questions regarding the different options we offer.

Loading Ramp

Dumping Bin



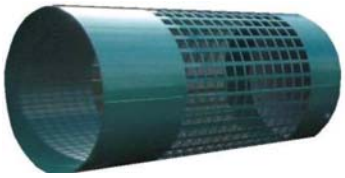
Ventilation option (With full air extraction)

Valve for passive ventilation

Universal Bin Lifter

Protected safety cage

Extension



Sifter

Out-swinging doors

Sliding door

Stainless steel finish

For more information, contact: Brome Compost

450 574-2000

Always inform your immediate superior of any incidents and/or damage to the equipment.

Section 8 – Problem Solving

8.1 Broken Chain

- Are the four wheels in good working condition? Perform a visual inspection of the rotating and guide wheels, and their bearings. A visual inspection should suffice.
- Are the two guide wheels located under the front part of the composter in good condition? Are they misaligned or rubbing against the groove thread?
- Is the composter rotating well on all four wheels when in operation?
- Is the composter level? 50%, 60%, 70% or more?
- Is the chain tensioner in good working condition? This prevents the chain from jumping off the sprocket.
- Are the two groove threads allowing the four wheels to turn correctly or are they problematic?
- Are the motor sprocket, the chain tensioner and the large composter sprocket all aligned?
- What is the internal temperature of the cylinder?
- According to you, are the humidity levels of the matter in the cylinder high, low or normal?
- To what height is the composter filled?
- Is the composter turning clock-wise when you look at the cylinder from the head / motor end?
- Is the overload mode on the control panel activated and causing the composter to restart?
- Could some material have become stuck in the chain or sprocket and damage either one?
- Are all the sprockets correctly aligned?

Section 9 – Warranty

The Brome Composter is guaranteed against manufacturing defects for one (1) year after the invoicing date. The warranty includes reimbursement, replacement, correction and/or the repairing of the defect. Brome Compost will repair or replace equipment that displays a defect during normal usage at our discretion. This warranty covers parts and labour.

Mechanical parts (the control panel and the motor/gear box) are guaranteed against manufacturing defects, according to the current guarantees of the supplier of these parts. This guarantee includes replacement, correction and/or the repairing of the defect. It covers parts and labour.

In case of damage, the supplier's/manufacturer's corroboration and assessment will aid in determining the decision to repair or replace a defective part.

All travel and/or delivery expenses, brokerage and customs fees are at the expense of the client.

Any damage due to environmental conditions are not covered by the warranty for the modular composter and its mechanical parts.

Any modification to the modular composter and its components made by a third party not authorised by Brome Compost will result in the automatic cancellation of the warranty.

Components	**Warranty**	**Conditions**	**Duration**
Modular Composter	Manufacturing defaults	Remplacement, correction and/or repairing of the defect.	! year after the invoicing date
Mechanical Parts	According to the manufacturer	Remplacement, correction and/or repairing of the defect.	According to the manufacturer

Brome Compost rejects all other damages sought due to defects or breakage of its equipment such as profit loss, travel, transport and labour costs.

Only this warranty applies to Brome Compost's equipment. No other person is authorised to interpret this warranty.

Operating the composter when the condition of the organic matter is such that it has a higher than 63% humidity level may result in mechanical and/or operating problems, as well as a premature deterioration of the system, which may limit the warranty.

9.1 Limitation of Liability

Please note that *Brome Compost inc.* is not responsible for problems that may present themselves due to the nature of the biological process involved in composting activities and releases itself from all such liability. We cannot guarantee that no problems will arise during the operation of the composter, as this is contingent upon the nature and variety of the organic matter to be processed, the operator's experience as well as the influence of weather conditions.

The equipment is under guarantee for normal use. A mechanical breakdown or premature wear of the equipment caused by abusive use will invalidate the manufacturer's warranty.

Brome Compost inc. reserves the right to make changes to the conception and manufacturing of their line of equipment at any time without obligation to change or modify the products already sold.