



BACK RIVER PROJECT Incineration Management Plan

June 2020

BACK RIVER PROJECT

INCINERATION MANAGEMENT PLAN

Table of Contents

Table of Contents	i
List of Tables	ii
List of Appendices	ii
Revision Log	i
Acronyms.....	ii
Executive Summary	iii
1. Introduction	1-1
2. Scope and Objectives	2-1
2.1 Related Documents	2-2
3. Applicable Legislation and Guidelines	3-1
4. Planning and Implementation	4-1
4.1 Incinerator Selection.....	4-1
4.2 Incinerator Locations	4-1
5. Roles and Responsibilities.....	5-1
5.1 Training	5-1
6. Operation and Maintenance	6-1
6.1 Waste Stream Management.....	6-1
6.1.1 Waste Volumes.....	6-2
6.2 Incinerator Operation.....	6-2
6.2.1 Ash Disposal	6-2
6.2.2 Odour and Dust Control	6-3
6.2.3 Used Oil and Waste Fuel	6-3
6.3 Contingencies	6-3
7. Environmental Protection Measures.....	7-1
7.1 Waste Reduction and Mitigation Strategies	7-1
Reduce 7-1	
Re-Use 7-2	
Recycle 7-2	
7.2 Dioxans and Furans.....	7-2
7.3 Mercury.....	7-2

7.4	Prevention of Wildlife Attraction.....	7-2
8.	Monitoring	8-1
8.1	Incinerator Emissions Testing	8-1
8.2	Ash Testing	8-1
8.3	Waste Auditing	8-2
8.4	Quality Assurance/Quality control	8-2
9.	Record Keeping	9-3
10.	Environmental Reporting.....	10-1
11.	Adaptive Management	11-1
12.	Reclamation	12-1
13.	References.....	13-1

List of Tables

TABLE	PAGE
Table 3-1. Applicable Legislation to the Incineration Management Plan.....	3-1
Table 6.1-1. Waste Classification for Incineration	6-2
Table 7-1. Canada-Wide Standards for Waste Incineration Emissions.....	7-1
Table 8.2-1. Guidelines for Solid Waste/Process Residuals (Ash) Leachate Suitable for Landfill	8-1

List of Appendices

- Appendix A. Ketek CY-100-CA Incinerator
- Appendix B. Ketek CY-50-CA Incinerator

Revision Log

Date	Section	Page	Revision	Prepared by:
December 2013	All	All	Original document prepared in support of Final Environmental Impact Statement (FEIS)	Sabina Gold and Silver Corp. (Sabina)
October 2017	All	All	Minor revisions for submission as supporting document for Type A Water Licence Application=	Sabina
July 2019	All	All	Full update of document following issuance of NIRB Project Certificate No. 007 and NWB Water Licence 2AM-BPR-1831 and prior to initiation of Project Construction	Sabina
June 2020	All	All	Minor revisions, changes to address ECCC and KIA comments on 2020 Annual report for NIRB Project Certificate No. 007.	Sabina

Sabina Representative Responsible for this Plan Update:

Department:

Title:

Date:

Signature:

Merle Keefe

Environment & Sustainability

Manager, Environmental Permitting

Sabina Representative Responsible for Review and

Approval of this Update:

Department:

Title:

Date:

Signature:

Matthew Pickard

Environment & Sustainability

Vice President - Environment & Sustainability

Distribution List:

Organization/Department

NIRB

NWB

KIA

Acronyms

CCME	Canadian Council of Ministers of the Environment
EC	Environment Canada
GHG	Greenhouse Gas
GN	Government of Nunavut
IMP or Plan	Incineration Management Plan
MAD	Main Application Document
MLA	Marine Laydown Area
Project	Back River Project
Sabina	Sabina Gold & Silver Corp.
QA	Quality Assurance
QC	Quality Control
WIR	Winter Ice Road

Executive Summary

This Plan describes the waste management processes at the Back River Project relevant to on site incineration. This Plan ensures that 1) only appropriate burnable material enters the incinerator waste stream, 2) animal attractants are promptly incinerated or safely stored, 3) the incinerator is operated in a manner that reduces harmful emissions, 4) residual ash is handled and disposed of properly, and 5) that all compliance monitoring and reporting associated with incinerator operations occurs.

1. Introduction

The Back River Project (the Project) is a gold project owned by Sabina Gold & Silver Corp. (Sabina) within the West Kitikmeot region of southwestern Nunavut. It is situated approximately 400 kilometres (km) southwest of Cambridge Bay, 95 km southeast of the southern end of Bathurst Inlet, and 520 km northeast of Yellowknife, Northwest Territories. The Project is located predominantly within the Queen Maud Gulf Watershed (Nunavut Water Regulations, Schedule 4).

The Project is comprised of two main areas, Goose Property and the Marine Laydown Area (MLA) with interconnecting winter ice roads. The majority of annual resupply will be completed using the MLA situated along the western shore of southern Bathurst Inlet, which is connected seasonally to Goose via an approximately 160 km long winter ice road.

The Incineration Management Plan (IMP or Plan) outlines the approach for managing waste appropriate for incineration at both the MLA in southern Bathurst Inlet and at the Goose Property. These measures demonstrate how Sabina will avoid, minimize, mitigate and/or manage to an acceptable level, the potential adverse effects on the environment associated with waste incineration.

The Plan was prepared following the requirements of the Nunavut Impact Review Board (NIRB) to Sabina (NIRB 2013), Project Certificate No. 007, Water Licence 2AM-BRP1831, and in accordance with best management practices and in conformance with current Federal and Territorial statutory requirements.

This plan is a living document to be updated upon changes in related regulatory requirements, management reviews, incident investigations, changes to facility operation or maintenance, and environmental monitoring results, best practice updates or other Project specific protocols once construction starts through to Project closure activities. Any updates will be filed with the Annual Report submitted to the NIRB in accordance with Project Certificate No.007 and the Nunavut Water Board (NWB) in accordance with Water Licence 2AM-BRP1831.

The information presented herein is current as of June 2020. The Plan will be reviewed as needed for changes in operation and technology and as directed by regulators where appropriate.

2. Scope and Objectives

The IMP is one of the documents that forms part of Sabina's overall Waste Management Program for the Project. This plan addresses requirements of the Type A Water Licence 2AM-BRP1831 as well as Project Certificate No. 007 and applies to all Sabina projects in the Kitikmeot region.

This plan is divided into the following components:

- Applicable Legislation and Guidelines (Section 3);
- Planning and Implementation (Section 4);
- Roles and Responsibilities (Section 5);
- Operational and Maintenance (Section 6);
- Environmental Protection Measures (Section 7);
- Monitoring (Section 8);
- Record Keeping (Section 9);
- Environmental Reporting (Section 10);
- Adaptive Management (Section 11); and
- Reclamation (Section 12).

Incineration is an essential part of waste management at the Back River site. The incineration of acceptable solid waste from the accommodation complex, kitchen, lunch rooms, shops, warehouses, and offices minimizes accumulation of wildlife attractants and will divert waste transported off-site and from the on-site landfill once constructed. Sewage sludge from the planned sewage treatment plant at the Goose Property will also be incinerated, as is any Pacto waste generated (i.e. human waste from waterless toilets). Incineration has the advantage of eliminating waste that could potentially attract wildlife to the Project and landfill, thereby reducing possible interactions between humans and wildlife.

Waste products are safely managed from the time they are produced to their final disposal. Reduce, reuse, and recycle initiatives, as well as a waste segregation program are used to minimize the quantity of waste incinerated or directed to the landfill. Waste that is deemed unsuitable for incineration, including hazardous materials, will be handled appropriately as per the Landfill and Waste Management Plan and Hazardous Materials Management Plan.

By implementation of the waste management program and selection of appropriately designed incinerators incineration practices will comply with air quality requirements for the protection of the environment and human health.

The objectives of incineration management through all phases of the Project are to:

1. Characterize the quantity and composition of the waste products to be generated at the Back River site, and effectively separate wastes acceptable for incineration from waste that is not;
2. Select appropriate batch waste incinerators based on the characteristics and quantity of waste;

3. Locate incinerators at appropriate sites and set back an appropriate distance from other infrastructure;
4. Operate incinerators to achieve optimal combustion and avoid the formation of dioxins, furans, and mercury in the combustion process;
5. Implement incinerator operational practices and to document frequency and incinerator operating parameters, including the safe handling and disposal of incinerator residues; and
6. Demonstrate compliance with applicable Federal and Territorial regulations for environmental protection.

2.1 RELATED DOCUMENTS

This Plan is intended for use in conjunction with the following Plans:

- Air Quality Monitoring and Management Plan;
- Environmental Management and Protection Plan;
- Landfill and Waste Management Plan;
- Hazardous Materials Management Plan;
- Risk Management and Emergency Response Plan;
- Spill Contingency Plan; and
- Fuel Management Plan.

3. Applicable Legislation and Guidelines

Federal and Territorial legislation that is applicable to solid waste incineration management in Nunavut is presented in Table 3-1.

Provincial and/or territorial regulations that pertain to emissions from incinerators are not available for Nunavut or the Northwest Territories. Therefore, performance limits for Project incinerators will be in accordance with the emission guidelines set out by the Canadian Council of Ministers of the Environment (CCME): Canada-Wide Standard for Dioxins and Furans (CCME 2001), and Canada-Wide Standards for Mercury Emissions (CCME 2000).

Ash produced from the incineration process will be disposed of in accordance with the Nunavut Environmental Guideline for Industrial Waste Discharges (GN 2011b).

Table 3-1. Applicable Legislation to the Incineration Management Plan

Acts	Regulations	Guidelines
Federal		
<i>Canadian Environmental Protection Act</i> (CEPA 1999 c.33)	Schedule 1: List of Toxic Substances Interprovincial Movement of Hazardous Waste and Hazardous Recyclable Material Regulations (SOR/2002-301)	Environment Canada (EC) Technical Document for Batch Waste Incineration (EC 2010) Canada-Wide Standards for Dioxins and Furans (CCME 2001) Canada-Wide Standards for Mercury (CCME 2000)
<i>Hazardous Products Act</i>	Controlled Products Regulations	Workplace Hazardous Materials Information System (WHMIS 2015)
Territorial – Nunavut		
<i>Nunavut Environmental Protection Act</i>		Environmental Guideline for Industrial Waste Discharges into Municipal Solid Waste and Sewage Treatment Facilities (GN 2011b) Environmental Guidelines for the Burning and Incineration of Solid Waste (GN 2012a) Environmental Guidelines for Ambient Air Quality (GN 2011a) Environmental Guideline for Mercury-Containing Products and Waste Mercury (GN 2010) Environmental Guideline for Used Oil and Waste Fuel (GN 2012b)

Additionally, the NIRB Project Certificate No. 007 condition 4 states that *“The Proponent shall develop and implement an Incineration Management Plan that demonstrates consideration for the recommendations provided in Environment and Climate Change Canada’s Technical Document for Batch Waste Incineration (2010).”* Additional commentary related to Condition 4 indicates that:

“The initial Incineration Management Plan must be submitted to the Nunavut Impact Review Board at least 60 days prior to the commencement of construction and must be tested within the first year of operations.

Subsequently, unless otherwise directed by Environment and Climate Change Canada, every (3) three years the Proponent shall provide the Nunavut Impact Review Board with confirmation of any changes to the Proponent’s Incineration Management Plan in the Proponent’s annual report to the Nunavut Impact Review Board.”

The Incineration Management Plan is also a plan applicable to NWB Water Licence 2AM-BRP1831, which requires reporting of incinerator test results and materials burned.

4. Planning and Implementation

4.1 INCINERATOR SELECTION

The Project will select and operate incinerators based on Environment Canada's Technical Document for Batch Waste Incineration (EC 2010). Typical modern, controlled-air, batch, dual chamber incinerators are designed using the principles of pyrolysis (starved-air burning condition) in the primary chamber and complete oxidation (high temperature, excess oxygen, and sufficient combustion time) in the secondary chamber. The incineration system will be a two-stage process. In the first stage, waste will be converted to gas in the primary chamber at approximately 650 to 850 degrees Celsius (°C). This process will be self-fueling until the volume is reduced by 90%. Gasses from the primary chamber will enter the secondary chamber of oxygen-rich and turbulent conditions, which is typically at a higher temperature of approximately 1000°C. Combustion will be complete after a retention time of about two seconds. The temperature of combustion gases exiting the stack is anticipated to exceed 700°C and to flash cool in the ambient air, thereby leaving little opportunity for the de novo synthesis of dioxins/furans. Heat capture will not be used on the exhaust gases.

Critical process parameters, such as temperature, air flow, and burner output will be computer-controlled to maintain optimal combustion conditions.

A controlled-air, batch, dual chamber Ketek CY-100-CA-D incinerator has been purchased for use at the Goose Property and will be installed and commissioned during Project construction. The existing incinerator at Goose, a Ketek CY-50-CA, will continue to be used at Goose until that time, at which point it will be transferred to the MLA to upgrade from the existing Firelake MFG Model # A850X-20 incinerator. Both the CY-100 and the CY-50-CA incinerators meet the selection criteria described above. Operational manuals for the Ketek incinerators are provided in Appendix A and B of this Plan.

4.2 INCINERATOR LOCATIONS

The incinerators at both the Goose Property and the MLA will continue to be located more than 31 meters from any waterbody and are equipped with sufficient secure storage and workspace to allow waste drop off and sorting in one location and to prevent wildlife access to food scraps.

5. Roles and Responsibilities

The Construction Manager is ultimately responsible for the success and implementation of this plan including overall operator training, operation, adaptive management, operational record keeping and execution of stack testing.

The Manager, Environmental Permitting is responsible for the development and revision of this Plan, waste management audits, coordination of stack tests and compliance reporting.

Other relevant personnel designated by the Construction Manager or Environmental Permitting Manager which may be responsible for incineration management will be required to complete and maintain compliance with appropriate training requirements as defined in this plan, Sabina's Standard Operating Procedures, current Best Management Practices, and applicable Health and Safety Laws and Regulations.

5.1 TRAINING

Incinerator operators complete a training program prior to commencement of incinerator operation. This training includes recommendations presented in Environment Canada's Technical Document for Batch Waste Incineration (2010) and has been developed in conjunction with the training manual provided by the incinerator supplier.

The training program educates operators in the following areas:

- hazard recognition and safety protocols;
- identification of waste types and understanding of how waste composition affects operation;
- incinerator start-up and operating procedures, including identification of adjustments to increase operating efficiency;
- incinerator clean-out and maintenance procedures; and
- record keeping and reporting requirements.

Initial operator training on a new incinerator is provided by a qualified technician experienced in the operation of controlled-air, batch, dual chamber incinerators in compliance with regulatory guidelines. The incineration process of this incinerator is automated and requires minimal attendance during operation. A computerized incinerator will typically require one operator to interact with the equipment for approximately 1 to 1.5 hours per day, largely for ash removal, loading, and start-up. Each incinerator will be designed, installed, and operated so that the operators are not exposed to high temperatures during loading or ash removal in accordance with the complete cool down after each burn cycle.

6. Operation and Maintenance

This section provides general guidance and standard operating procedures for the operation of the incinerator. The incinerator operator is to refer to the operational manual provided by the manufacturer for specific instructions and optimal operating conditions for each incinerator. If there is a disagreement between the information provided below and the operational manual, the operational manual is to be followed. Any needed additional incinerator operating procedures will be developed in consultation with the supplier/manufacturer prior to use of a new incinerator. The Standard Operating Procedures shall include the following general procedures:

- Waste sorting on the basis of origin and heating value. Food waste and waste that has been in contact with food will have priority for incineration.
- Waste mixing to ensure a calorific value within incinerator specifications and to achieve good combustion inside the primary chamber.
- The operator will observe the start of the burn cycle to ensure incinerators are operating correctly, and the primary and secondary chambers operate in the temperature ranges specified by the manufacturer.
- Incinerator doors will only be opened after the burn cycle is complete and the unit is fully cooled except if required otherwise in the operator's manual (i.e. see raking requirements specific to the CY-100-CA).

Ash disposal procedures are provided in Section 6.2.1.

Operation of the incinerators will be conducted in accordance with Environment Canada's Technical Document for Batch Waste Incineration (EC 2010). Additional acts, regulations, and guidelines applicable to the operation of the incinerators are listed in Section 3.

Key operational control procedures that will help maintain good operation of the incinerator are provided in the following sections.

6.1 WASTE STREAM MANAGEMENT

Only authorized waste may be incinerated. Table 6.1-1 provides a list of waste that is considered acceptable for incineration and examples of waste that is considered unacceptable. To facilitate the initial sorting of material, waste will be collected in transparent bags so that the contents are readily visible. Verification of correct sorting and mixing procedures will be ensured by periodic spot checks and Quality Assurance (QA)/Quality Control (QC) management by a trained staff member.

Table 6.1-1. Waste Classification for Incineration

Acceptable Wastes for Incineration	Unacceptable Wastes for Incineration
<ul style="list-style-type: none"> • organic matter including food; • food containers and packaging, including plastics that are contaminated by food; • untreated wood including lumber and plywood; • medical waste from the Health Care Station; • paper, cardboard; • painted wood except wood painted with lead or PCB-amended paint • hydrocarbon spill absorbents; • plastic and Styrofoam, except plastic containing chlorine; • dead animals; • used oils and waste fuel; • Pacto waste; and • dewatered sewage sludge from the Goose Site Sewage Treatment Plant. 	<ul style="list-style-type: none"> • chlorinated plastics; • inert materials, such as concrete, bricks, ceramics, ash; • machinery parts or large metal goods (i.e., appliances); • radioactive materials, such as smoke detectors; • potentially explosive materials, such as propane tanks, other pressurized vessels, unused or ineffective explosives; • hazardous materials such as organic chemicals (pesticides), other toxic substances (arsenic, cyanide); • electronics and/or batteries; • asbestos; • dry wall; vehicles and machinery; • fluorescent light bulbs; • whole tires; • paints and solvents; any materials containing mercury; and • any other wastes not considered 'acceptable'.

6.1.1 Waste Volumes

Quantity of waste incinerated will be recorded by batch in kg and as an estimate of volume in cubic meters.

6.2 INCINERATOR OPERATION

Each day, the Primary Chamber should be loaded to design capacity or, at a minimum, to half capacity with waste types and quantities conducive to a clean burn. If waste quantities are not sufficient to operate the machine daily, the waste may temporarily be stored in a secure area, such as a seacan, to prevent wildlife access. A front-end loader may be used to manually load feed waste.

Pre operational inspections, loading, operation and unloading should occur as outlined in the applicable operators manual. The operator is required to remain present to supervise the beginning of the process (start-up) to ensure that the primary and secondary chambers reach and operate in the temperature ranges specified by the manufacturer. The entire process is controlled by computer in the Main Control Panel. The Operator can see the status of all the critical components and parameters, such as temperature, air flow, and burner output in addition to any malfunction alarms.

6.2.1 Ash Disposal

Incinerator ash should be handled and disposed of appropriately, following these steps:

- Ash is removed from each incinerator before a new burn cycle is initiated.
- Incinerator ash is packaged in labelled drums or sacks and the whole container landfilled, minimizing wind-blown effects.

- The concentration of trace metals will be tested as per the Government of Nunavut's Environmental Guidelines for Industrial Waste Discharges (GN 2011b).
- Ash exceeding the above standard will be handled as per the Hazardous Materials Management Plan.
- Ash generated at Goose Property and MLA and meeting the standard will be disposed in the on-site landfill at Goose or be back-hauled off site for disposal.
- Containers of ash will be labelled in a manner to ensure ash sampling results can be traced back to specific containers/incineration batch(es) of concern, in case results indicate landfilling is not appropriate.

6.2.2 Odour and Dust Control

Current state of the art incinerators are designed with a non-turbulent atmosphere in the primary burn chamber which reduces the formation of particulate matter. Additional dust or odour control is therefore not anticipated. Ash residues generated in the primary chamber will be manually removed and packaged in a drum or sack before being disposed of in the on-site landfill, thus eliminating wind-blown effects.

6.2.3 Used Oil and Waste Fuel

The incinerator will be capable of efficiently and safely burning oil and waste fuel. Sabina will manage used oil and waste fuel according to the Environmental Guideline for Used Oil and Waste Fuel (GN 2012b). The regulations stipulate the maximum level of contaminants in used oil that is allowed for incineration. Specifics of the used oil and waste fuel regulations are referenced in the Fuel Management Plan.

6.3 CONTINGENCIES

In the event of an incinerator breakdown, the operator should consult the manufacturer-provided operations manual to try and diagnose the cause. A local technician should be contacted for assistance if needed. The operator should assess the likely downtime of the incinerator and alternative disposal and/or secure waste storage methods should be implemented until the incinerator is repaired. Contingency or alternative waste storage procedures to be implemental until the incinerator is repaired, which are dependent on the length of incinerator down time may include:

- short-term shutdown of incinerator will be mitigated through temporary storage in sealed, wildlife-proof containers;
- long-term shutdown of incinerator will require backhauling to an operational on-site incinerator or off-site disposal by a waste services provider; and
- food waste would be prioritized for storage in both instances with alternative disposal methods for other material considered.

Long-term storage due to the presence of putrescibles in the domestic waste is impractical due to the potential of attracting wildlife. In the event of long-term shutdown generation of organic wastes would be minimized as much as feasibly possible.

Spills associated with the incinerator or waste disposal steams will trigger the implementation of the Spill Contingency Plan. Any accidents and malfunctions will trigger the implementation of the Risk Management and Emergency Response Plan.

7. Environmental Protection Measures

Sabina has an ongoing commitment to implementing environmental protection measures in all aspects of its operations and is committed to reducing incinerator emissions using technologically advanced, best available, and economically feasible procedures.

Sabina is committed to reducing waste volumes to be incinerated, while managing and minimizing dioxin, furan, and mercury emissions. Sabina also implements appropriate material handling procedures for the disposal of ash material generated by incineration.

A summary of the Canada-Wide Standards, as prepared by CCME, for dioxins, furans and mercury emission limits is presented in Table 7-1.

Table 7-1. Canada-Wide Standards for Waste Incineration Emissions

Waste Incineration Compound	Sector	Emission Limit (Max)
Dioxins and Furans ¹	Municipal Solid Waste ³ Sewage Sludge Incineration	80 picograms of International Toxic Equivalents (I-TEQ) per cubic metre (pg/m ³)
Mercury ²	Municipal Solid Waste Sewage Sludge Incineration	20 micrograms per cubic metre (µg/m ³) 70 micrograms per cubic metre (µg/m ³)

¹ CCME 2001

² CCME 2000

³ According to the Canada-Wide Standards (CWS), "municipal solid waste" includes any waste that might be disposed of in a non-secure landfill site if not incinerated (i.e., non-hazardous wastes regardless of origin), but does not include "clean" wood waste.

These emission limits apply to waste incineration at new facilities across Canada. Compliance with these standards will be achieved through the installation and use of state of the art technologies and a detailed and conscientious waste management program. The permanent incinerators at the Project are expected to achieve full compliance immediately upon attaining normal full-scale operation. Should elevated concentrations be found adaptive management strategies would be implemented (see Section 11).

7.1 WASTE REDUCTION AND MITIGATION STRATEGIES

Waste reduction, reuse, and recycling are undertaken where reasonable to minimize the quantity of waste to be incinerated or directed to the landfill. These initiatives include:

Reduce

- Purchasing only the required amounts of materials and buying in bulk when the opportunity is available.
- Employing inventory control methods 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.
- Evaluation of use of waste oil burners to heat selected facilities.
- Use of oil/water separators to reduce the amount of contaminated water.
- 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.

7.2 DIOXANS AND FURANS

Polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans, commonly known as dioxins and furans, are toxic chemicals which persist in the environment for long periods of time and are subject to bio-accumulation in plants and animals. Their presence in the environment results predominantly from human activity, most notably the large-scale incineration of municipal and medical wastes. The quantity of dioxins and furans in the incinerator emissions will vary depending on the type and volume of the waste stream. Sabina recognizes the importance of reducing the presence of dioxins and furans in emissions. Monitoring of dioxins and furans in the exhaust stream will be conducted and is described in more detail in Section 8.1.

7.3 MERCURY

Mercury is a naturally occurring substance, which can be transformed through biological processes to methyl mercury, a persistent substance which bio-accumulates in the food chain and is particularly toxic to humans and wildlife. The quantity of mercury in the incinerator emissions will vary depending on the type and volume of the waste stream. Sabina understands the importance of reducing the concentrations of mercury in emissions. Monitoring of mercury content in the exhaust stream will be conducted and is described in more detail in Section 8.1.

7.4 PREVENTION OF WILDLIFE ATTRACTION

Project personnel are educated 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 and are burned in the incinerator promptly.

8. Monitoring

Sabina will implement a testing and monitoring program to ensure that criteria for applicable air quality standards and guidelines and ash disposal are being met. The monitoring program is outlined in the following sections.

8.1 INCINERATOR EMISSIONS TESTING

The incinerator stack design will allow stack testing to be undertaken during incineration. Stack emissions testing will occur within the first year of operations when quantities incinerated exceed 26 tonnes/year to ensure achievement of the Canada-wide Standards for Dioxins and Furans and the Canada-wide Standards for Mercury (CCME 2000, 2001) and every 3 years thereafter or as recommended. Should emissions exceed Canada Wide Standards for Dioxins and Furans or Mercury Sabina would consult the incinerator manufacturer for recommendations on improvement and/or conduct a waste stream audit to determine the possible source of elevated emissions and further refine the incinerator waste stream. Manufacturer recommendations and waste stream refinement would be implemented to the extent feasible and the success of these measures would be verified in the subsequent round of stack testing.

8.2 ASH TESTING

Provided the materials that go into the incinerator are controlled to exclude all hazardous materials, then the incinerator ash should be non-hazardous. Ash testing will be implemented as required to ensure that the incinerator ash is suitable for disposal in the landfill. The samples will be compared to the *Environmental Guideline for Industrial Waste Discharges into Municipal Solid Waste and Sewage Treatment Facilities* (GN 2011b) presented in Table 8.2-1.

Table 8.2-1. Guidelines for Solid Waste/Process Residuals (Ash) Leachate Suitable for Landfill

Parameter	Maximum concentration (mg/L)
Arsenic	2.5
Barium	100
Cadmium	0.5
Chromium	5
Lead	5
Mercury	0.1
Selenium	1
Silver	5
Zinc	500

If monitoring indicates the ash is above the guidelines and not suitable for landfilling, an investigation will be undertaken to identify the cause and eliminate the source of exceedance. If monitoring indicates the ash meets the guidelines, ash containers will be stored and backhauled to an off-site licenced landfill or landfilled at an on-site landfill as per the Landfill Management Plan in the container to eliminate any windblown effects.

Containers of ash identified as having elevated metals concentrations will be sent to a licensed hazardous waste disposal facility. Hazardous waste shipments will follow the Transportation of

Dangerous Goods (TDG) regulations as well as the Interprovincial Movements of Hazardous Waste regulations. 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.

8.3 WASTE AUDITING

A waste audit will be completed following incinerator commissioning and periodically thereafter to confirm adherence to waste segregation practices and identify waste stream volumes that can be minimized prior to incineration. The waste audit will inform the improvement of waste segregation procedures and policies as well as revisions to the comprehensive list of acceptable and unacceptable waste for incineration. The identification of unacceptable waste for incineration will be based on the EC Technical Document for Batch Waste Incineration (EC 2010) and the regulations discussed in Section 3.

8.4 QUALITY ASSURANCE/QUALITY CONTROL

The collection and analysis of incinerator emissions samples will be conducted in compliance with appropriate stack test methods and undertaken by an accredited laboratory. Following each stack emissions testing program an Incinerator Stack Testing Compliance Report will be completed. This report will include a description of the incinerator and how it was being operated at the time of the stack emissions testing program, the methods used for sampling and analysis.

Incinerator ash samples will be collected in lab-provided containers and will be appropriately labelled to allow tracking to individual ash containers if exceedances are identified. The samples will be analyzed by an accredited laboratory.

Additional QA/QC procedures for incineration include:

- Incinerator operational data including temperature, differential pressure in the primary chamber, auxiliary burner operation, fan amperage will be recorded continuously, consistent with detailed written operating instructions from qualified personnel;
- Detailed training programs will be implemented to ensure that all staff working with the incinerator are competent and qualified for their respective task;
- Analysis of sampled emissions during monitoring will be completed by an accredited laboratory;
- Stack testing samples of emissions and ash samples will be collected and handled according to operating instructions prepared by qualified personnel; and
- Qualified personnel will calculate emission concentrations for monitored air quality parameters based on laboratory results and compare against the applicable guidelines.

9. Record Keeping

Maintenance and inspection procedures should be carried out in accordance with the manufacturer's specifications.

A maintenance log is required to be kept for regulatory review. The maintenance log will be used to record routine maintenance activities or operational changes, the date completed, personnel responsible, and observations during maintenance activities. The maintenance log will also note any problems encountered. Maintenance personnel should determine the cause of any failure to help avoid or reduce similar failures.

Operational data will be collected by a data logger and stored continuously, even when the incinerator is not operating. The data will be used to monitor operating conditions to ensure that normal operating parameters are not exceeded. In the event that normal operating conditions are not met, the data will be used to identify causes of failure and to optimize the system.

Prior to incineration, the type of waste in each bag will be determined, weighed and the source noted. The total weight of each type of waste will be recorded before the burn cycle is started. After the cool-down period, the ash will be removed and weighed before it is sent for disposal. This information will be stored electronically with the operational data from the incinerator. This data will assist Sabina in determining incinerator waste generation rates at the facility, and in turn, provide data on the effectiveness of waste diversion, reduction and recycling programs.

Regulatory compliance reporting requirements will be defined in various regulatory authorization issued including the water licence.

10. Environmental Reporting

To demonstrate conformity with performance limits, an annual incineration summary will be prepared and submitted as part of annual reporting to authorizing agencies. Any stack testing results will also be integrated into the annual air quality monitoring report.

The following information will be included in the incineration summary report:

- the quantity and type of materials incinerated on-site during operations;
- results from any stack emissions and ash monitoring;
- record of ash disposal, including weight of ash disposed, location of disposal, and the transportation/load details;

The annual reporting will also identify any major changes to the operation and efficiency of the incinerator or necessary changes to this Plan.

11. Adaptive Management

The IMP will be reviewed annually and updated as needed to incorporate any lessons learned, major changes to the incinerator operation or maintenance, and environmental monitoring results and to reflect the operating conditions at the Project during Construction, Operations, and Closure.

The need for any corrective actions related to emission management or installation of additional control measures will be determined on a case-by-case basis. Indications of the need for corrective actions and additional control measures may include:

- monitoring data showing concentration greater than applicable standards (i.e., elevated metals, dioxins, and furans);
- monitoring data showing an increasing trend in contaminant concentrations; and
- issues raised by on-site staff, regulators, or local communities.

Discussions will be initiated to resolve any issues as soon as possible after the issue has been identified.

Relevant employees will be informed of updates to incineration management procedures and the updated IMP will be stored appropriately on-site.

Sabina will retain all raw data records and annual reporting for at least two years. The updated IMP, raw data, and annual reporting will be made available by Sabina at all times for review by the Government of Nunavut, Nunavut Impact Review Board, and Environment and Climate Change Canada.

12. Reclamation

In accordance with the Interim Closure and Reclamation Plan, all buildings, machinery, and equipment that is not salvageable will be disposed of in an on-site landfill after any hazardous material has been removed.

13. References

- CCME (Canadian Council of Ministers of the Environment). 2000. Canada-Wide Standards for Mercury.
- CCME. 2001a. Canada-Wide Standards for Dioxins and Furans.
- EC (Environment Canada. 2003. State of the Environment InfoBase, Environmental Indicator Series 2003. Available online: <http://www.ec.gc.ca>.
- EC. 2010. Technical Document for Batch Waste Incineration. Available online: <http://www.ec.gc.ca/gddmw/default.asp?lang=En&n=F53EDE13-1>
- EC. 2012. National Pollutant Release Inventory (NPRI).
- GN (Government of Nunavut). 2010. Environmental Guideline for Mercury-Containing Products and Waste Mercury. Government of Nunavut, Department of Environment, Environmental Protection Service. Available on-line: http://env.gov.nu.ca/sites/default/files/mercurycontaining_products_and_waste_mercury_2010.pdf
- GN. 2011a. Environmental Guideline for Ambient Air Quality. Government of Nunavut, Department of Environment, Environmental Protection Service. Available online: http://env.gov.nu.ca/sites/default/files/guideline_-_ambient_air_quality_2011.pdf
- GN. 2011b. Environmental Guideline for Industrial Waste Discharges into Municipal Solid Waste and Sewage Treatment Facilities. Government of Nunavut, Department of Environment, Environmental Protection Service. Available online: http://env.gov.nu.ca/sites/default/files/industrial_waste_discharges_2011.pdf
- GN. 2012a. Environmental Guideline for the Burning and Incineration of Solid Waste. Government of Nunavut, Department of Environment, Environmental Protection Service. Available online: http://env.gov.nu.ca/sites/default/files/guideline_-_burning_and_incineration_of_solid_waste_2012.pdf
- GN. 2012b. Environmental Guideline for Used Oil and Waste Fuel. June 2012. Available online: http://www.gov.nu.ca/sites/default/files/guideline_-_used_oil_and_waste_fuel_final_2012-en.pdf
- NIRB (Nunavut Impact Review Board). 2013. *Guidelines for the Preparation of an Environmental Impact Statement for Sabina Gold & Silver Corp.'s Back River Project*. NIRB File No. 12MN036).
- NWB (Nunavut Water Board). 2010a. Mining and Milling Supplemental Information Guideline (SIG) for Mine Development (MM3). February 2010.
- NWB. 2010b. Miscellaneous Supplemental Information Guideline (SIG) for General Water Works (including crossings, flood control, diversions, and flow alterations) (M1). February 2010.
- WHMIS (Workplace Hazardous Materials Information System). 2015. Available at: <http://www.hc-sc.gc.ca/ewh-semt/occup-travail/whmis-simdut/ghs-sgh/index-eng.php>

Appendix A. Ketek CY-100-CA Incinerator

MANUAL **OPERATION &** **MAINTENANCE**

CY-100-CA



20204-110 Avenue NW
Edmonton, Alberta Canada T5S 1X8
Phone: 1-855-447-5050
Fax: (780) 447-4912
info@ketek.ca

1.	Introduction	
2.	Waste Incineration and General Guidelines for Waste Management	- 5 -
3.	Roles and Responsibilities	
3.1	Waste Management In Charge / Site Services	- 6 -
3.2	Incinerator Operator	- 6 -
3.3	Maintenance Personnel	- 6 -
4.	Principles of waste incineration	
4.1	Combustion	- 7 -
4.2	Why incinerate waste?	- 7 -
4.3	Waste components	- 7 -
4.4	Heating Value	- 8 -
4.5	Different Expressions for Heating Value	- 9 -
4.6	Examples of waste characteristics	- 10 -
4.7	Incinerator Capacity and Load Size	- 11 -
5.	System Description	
5.1	Overview	- 13 -
5.2	Description of system components	- 15 -
5.3	Primary Chamber Section	- 16 -
5.4	Secondary Chamber Section	- 16 -
5.5	Control Panel Section	- 19 -
6.	Operation and Maintenance	
6.1	Safety equipment and protocol	- 22 -
6.2	Routine inspection and maintenance	- 22 -
6.3	Waste batch preparation	- 22 -
6.4	Ash removal	- 22 -
6.5	Pre-operational checks	- 23 -
6.6	Operational Procedure	- 23 -
6.7	Waste charging:	
	For Batch feeding (recommended) see Figure 11.	- 26 -
6.8	Waste Incineration Record	- 26 -
6.9	Burn-Down and Cool-Down: see Figure 12	- 27 -
6.10	Maintenance and Inspection	- 27 -
6.11	Trouble Shooting	- 28 -
6.12	Auxiliary Fuel Consumption Rate	- 30 -
7.	Appendix A: Information sheets and Manuals	
7.1	Suggested Spare Parts List	- 33 -
7.2	Burner WIC 201	
7.3	Burner WIC 301	
7.4	Blower Dayton 4C 108	
7.5	Inspection Checklist	
7.6	Wiring Diagram	

LIST OF TABLES

Table 1 Organization of Manual	- 4 -
Table 2 Classification and Properties of Common Wastes	- 10 -
Table 3 High Heating Values (Approximate) of Common Waste Components	- 11 -
Table 4 Proximate Composition of Various Materials	- 12 -
Table 5 Components in the Primary Chamber Section (Figure 6 to Figure 8)	- 16 -
Table 6 Components in the Secondary Chamber Section (Figure 6 to Figure 8)	- 16 -
Table 7 Components in the Control Panel Section	- 19 -
Table 8 Recommended Inspections	- 27 -
Table 9 Trouble Shooting Guidelines	- 28 -

LIST OF FIGURES

Figure 1 Schematic Diagram of Incineration Process	- 7 -
Figure 2 The Concept of Heating Value	- 8 -
Figure 3 Different Bases for Expressing Heating Value (HV)	- 9 -
Figure 4 Schematic of the Incineration System	- 14 -
Figure 5 Overall View showing the Sections	- 15 -
Figure 6 Components in the Primary and Secondary Chamber Sections (1)	- 17 -
Figure 7 Components in the Primary and Secondary Chamber Sections (2)	- 18 -
Figure 8 Overview of Control Panel, Showing the Main Sections	- 20 -
Figure 9 Steps in the Operation of the Incinerator	- 21 -
Figure 10 Operating Sequence	- 25 -
Figure 11 Procedure for Batch Waste Charging	- 26 -
Figure 12 Procedure for Burn Down	- 27 -
Figure 13 Consumption Rates of Propane and Diesel	- 30 -

Thank you for selecting **KETEK GROUP INC.** 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 think that a good understanding of the basic principles would make you knowledgeable, and hence a better operator.

Table 1 outlines the contents of this manual. We encourage you to read Chapter 2 although only Chapters 4 and 5 contain the most relevant 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 on safety aspects

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

Waste Management and segregation before incineration will help in providing cleaner emissions, and provide reduction of waste; maintaining an environmentally 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 (Qualified Incinerator Operators) operate the incinerator.
- Ensure that the Incinerator Operator follows the requirements of the Incinerator Operational Plan, Operation Manual and other relevant guidelines of the company.
- Ensure that all checklists and data logs are filled up, and the records required by this guidance document are collected and maintained.
- Ensure adequate re-training is provided to the operators at regular intervals.
- Ensure the safety of all personnel and the site.
- Carry out periodic inspections and record observations in the 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 other 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 and 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. Principles of Waste Incineration

4.1 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 temperature¹ 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.

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.

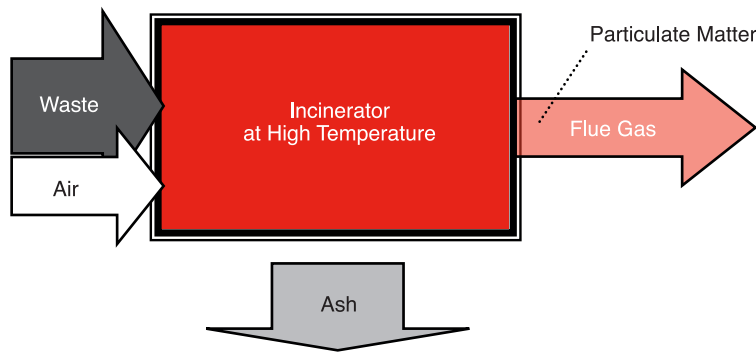


FIGURE 1 SCHEMATIC DIAGRAM OF INCINERATION PROCESS

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. And in remote areas where wildlife is present, scavenging and spreading of diseases 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.

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 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:

- (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 entrained in the flue gas in the form of particulate matter or dust. The higher the ash 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.

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 upon complete combustion. An understanding of the concept can be gained from the hypothetical processes shown in **Figure 2**.

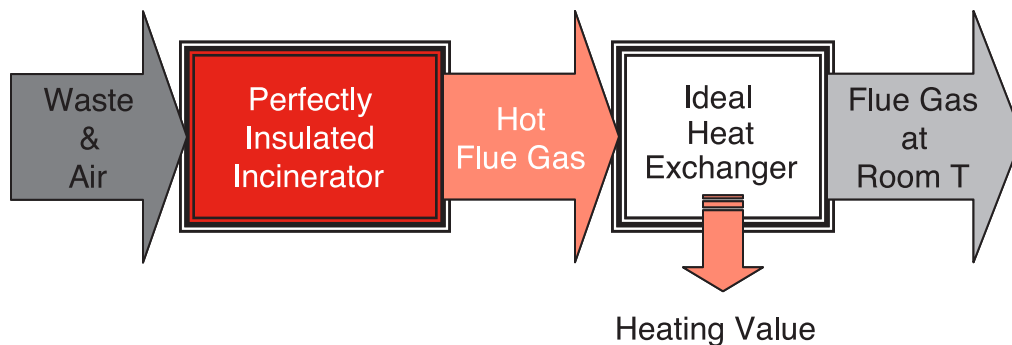


FIGURE 2 THE CONCEPT OF HEATING VALUE

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).

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”.

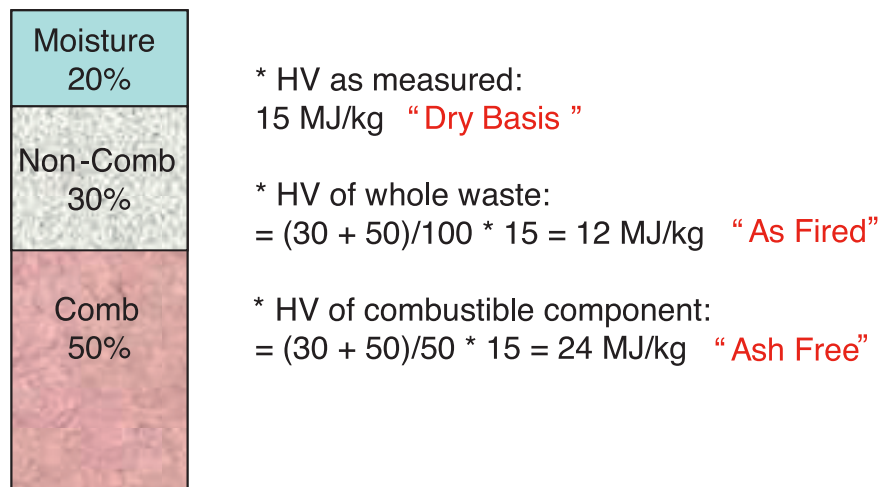


FIGURE 3 DIFFERENT BASES FOR EXPRESSING HEATING VALUE (HV)

4. Principles of Waste Incineration

4.6 Examples of waste characteristics

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

TABLE 2 CLASSIFICATION AND PROPERTIES OF COMMON WASTES

Type*	Description	Components	Weight %			MJ/kg HHV (A/F)
			Moist	Comb	Non-C	
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 wastes, restaurants, hotels, markets, institutional, commercial and club sources	70%	25%	5%	5.8
4	Animal/ Pathological	Carcasses, organs, hospital and laboratory abattoir, animal pound, veterinary sources	85%	10%	5%	2.3

Notes:

Moist = moisture, Comb = Combustible, Non-C = Non-combustible, HHV = High Heating Value, A/F = As Fired

* In some cases Roman numerals are used. That is Types 0, I, II, III and IV

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 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.

4. Principles of Waste Incineration

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
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
 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 primary and secondary chambers.

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

The 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 previous operation. 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.

5. System Description

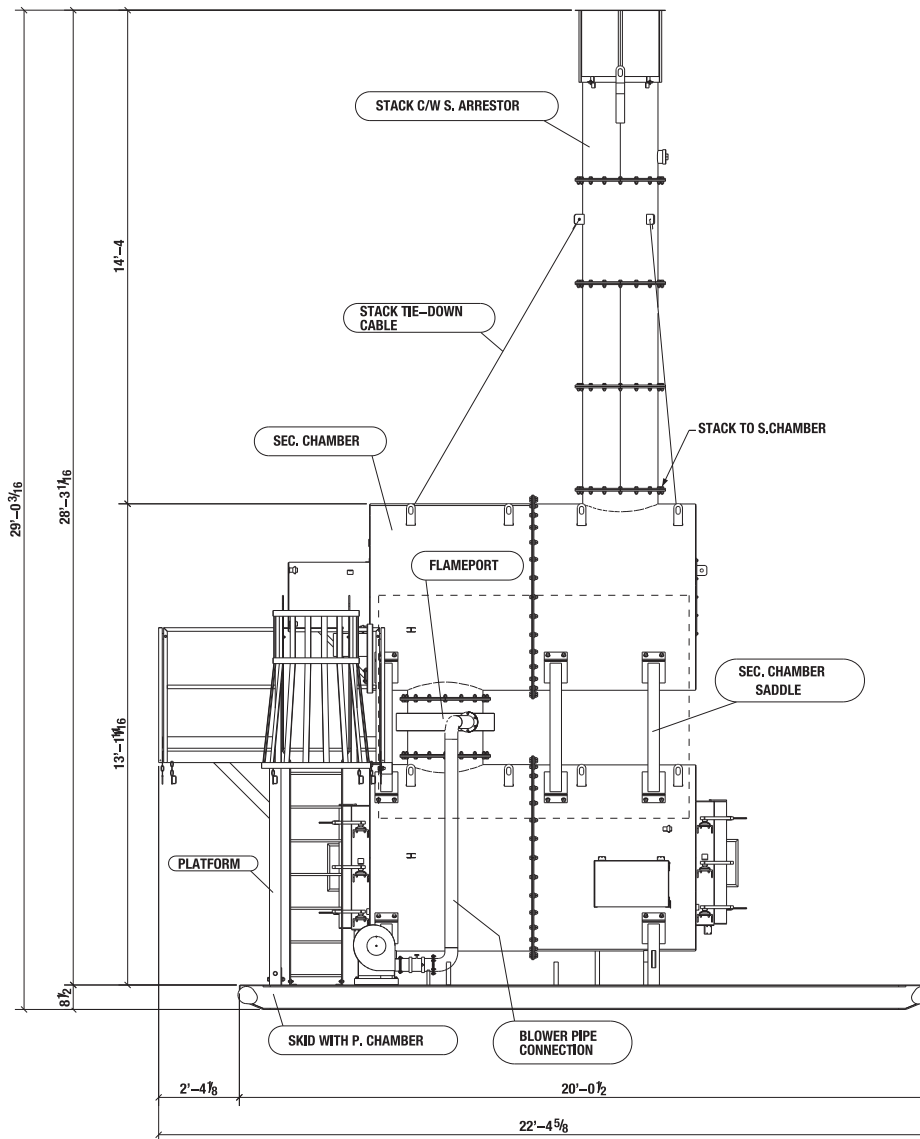


FIGURE 4 SCHEMATIC OF THE INCINERATION SYSTEM

5.2 Description of system components

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

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

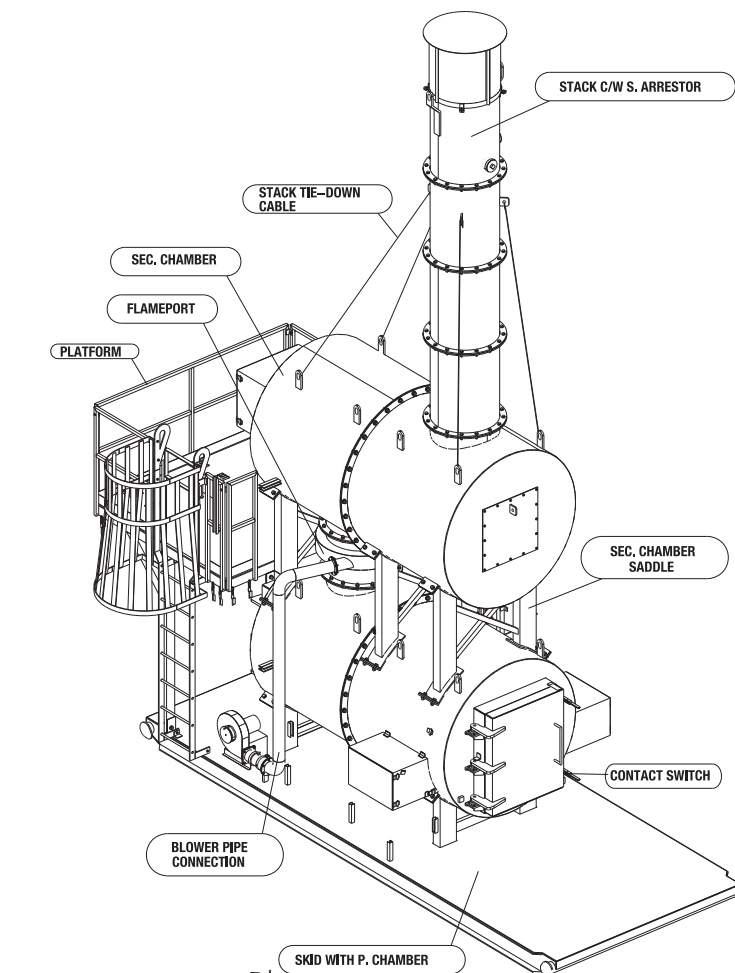


FIGURE 5 OVERALL VIEW SHOWING THE SECTIONS

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: 2.74m ³ Refractory + Insulation	Pyrolysis and gasification Combustion of fixed carbon
PC_B	Auxiliary Burner	Becket 2 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: 90 cm(Height) x 70 cm (Width) Ash Door : 86cm(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: 2.87m ³ 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 in-house.	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

5. System Description

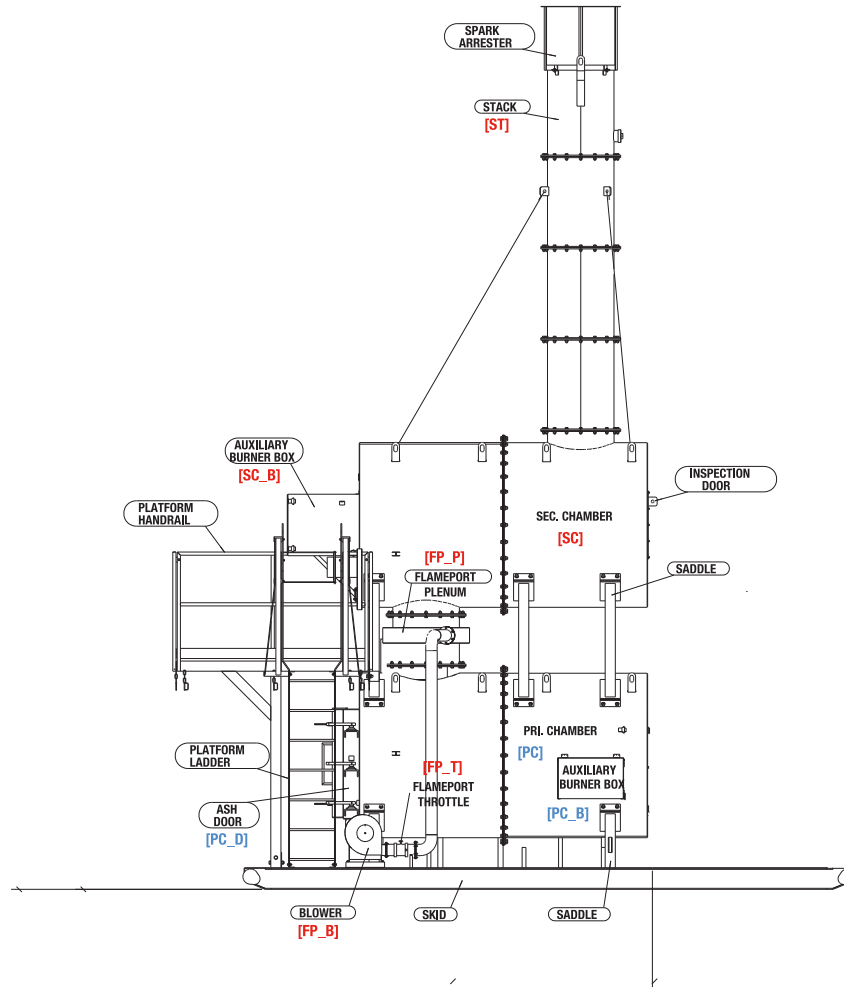


FIGURE 6 COMPONENTS IN THE PRIMARY AND SECONDARY CHAMBER SECTIONS (1)

5. System Description

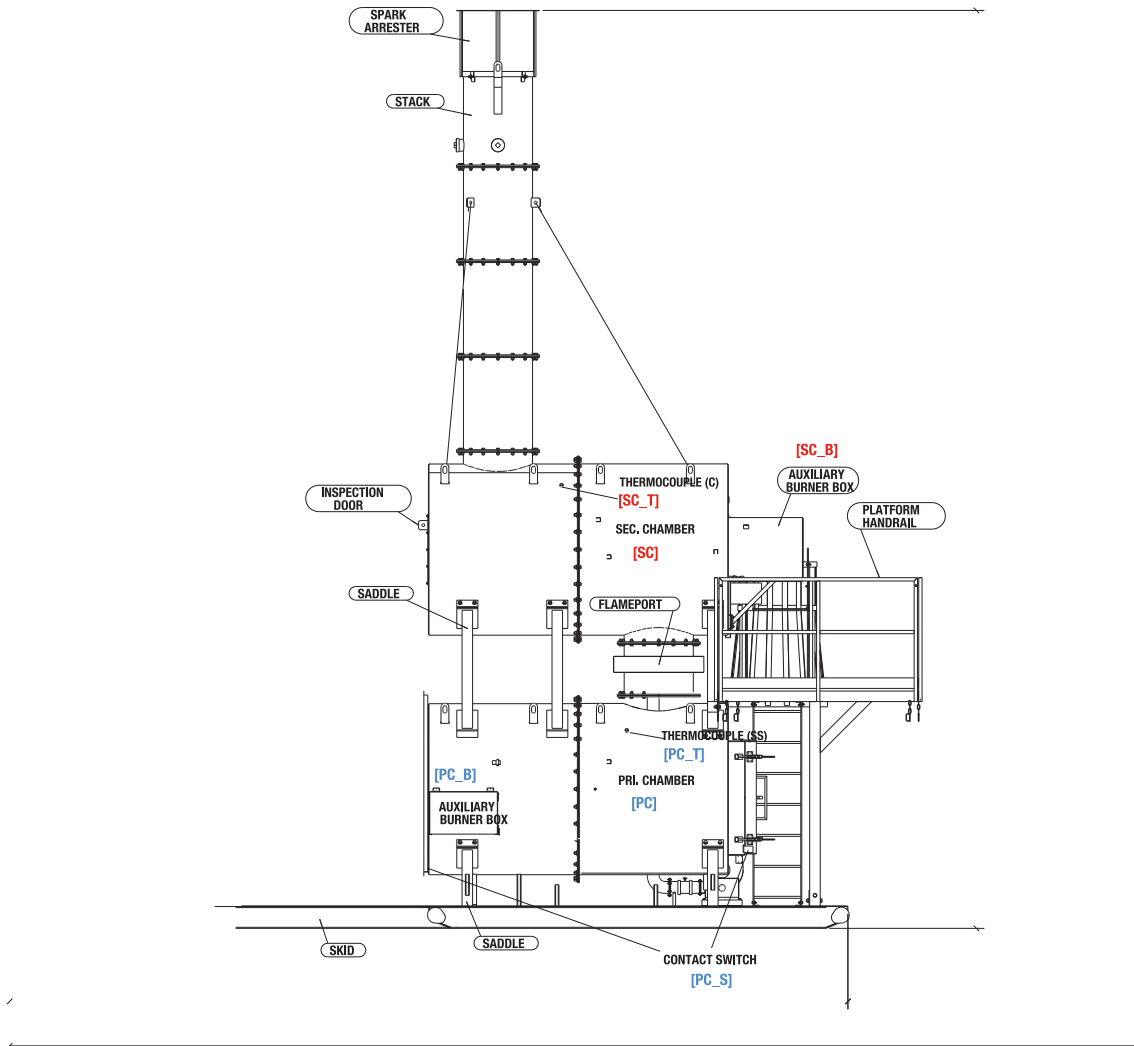


FIGURE 7 COMPONENTS IN THE PRIMARY AND SECONDARY CHAMBER SECTIONS (2)

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 Blower		
PB1	Start Switch	Initiate Pre-Purge, Burn, Burn-Down, Cool-Down Automatic Cycles.
PB2	Emergency Stop	Emergency Use Only. For Normal Stop, Set Burn Time to 0.
R1	Contact Switch	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 Specified Temperature Set Point.
Sub-Section E: Primary Pressure		
	Magnehelic Gauge Box	Displays pressure of Primary Chamber Should be Negative Pressure between 0 and -0.5 inches

NOTE: 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.

5. System Description

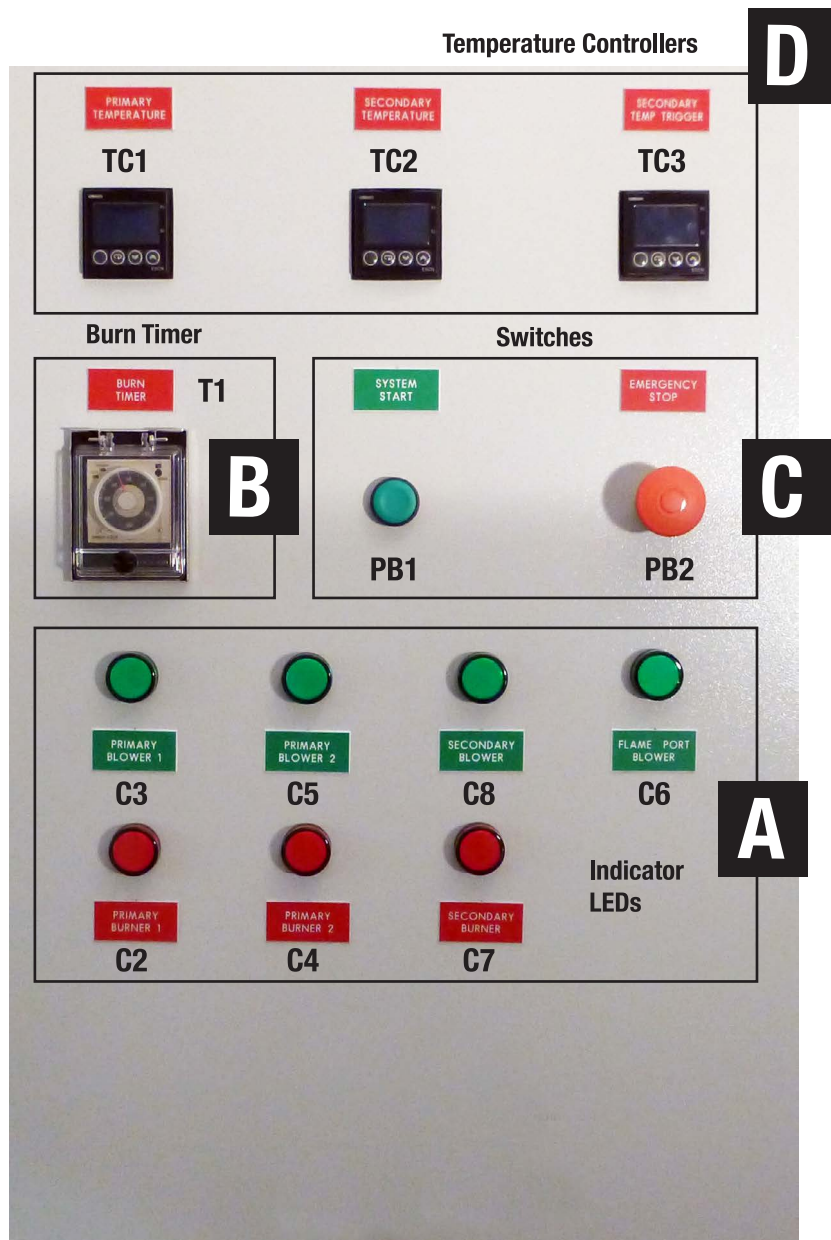


FIGURE 8 OVERVIEW OF CONTROL PANEL, SHOWING THE MAIN SECTIONS

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

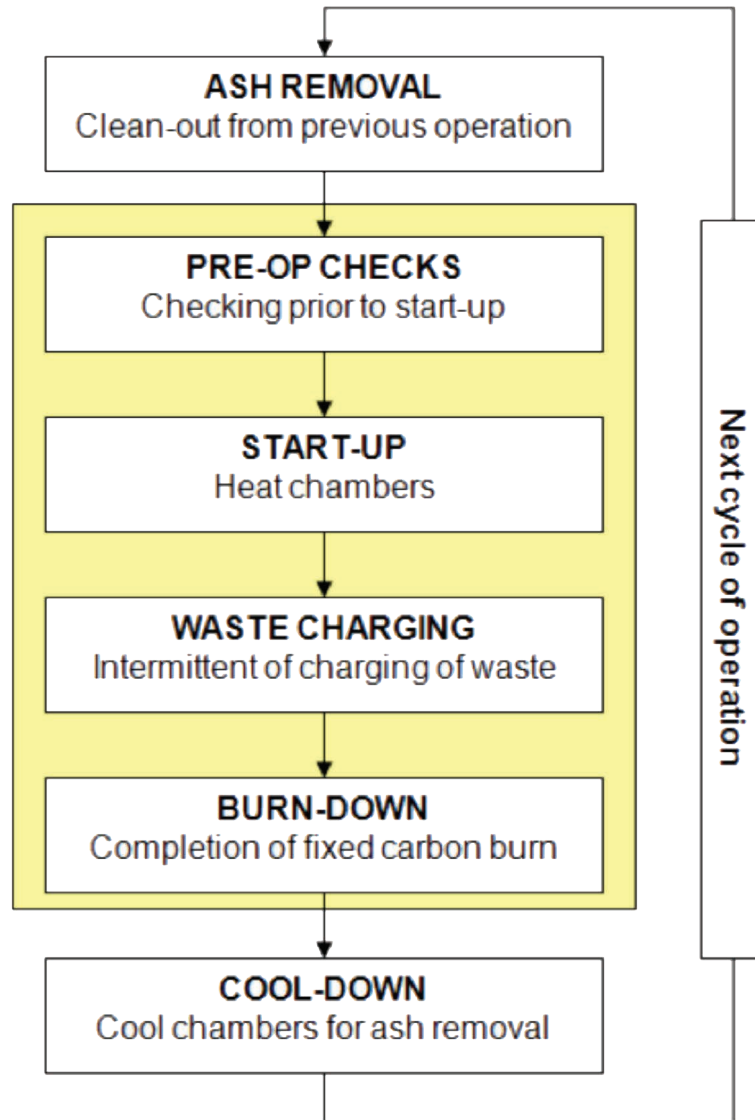


FIGURE 9 STEPS IN THE OPERATION OF THE INCINERATOR

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 personal protective equipment (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):
 - o Inspect refractory for large cracks (not expansion cracks)
 - o 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 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 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 Inc. Sustainability Consulting can provide a Waste Audit for an additional charge) A waste audit 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. Prior before operation of any incinerator the area surrounding the incinerator shall be free of any debris and tripping hazards; maintaining a proper housekeeping procedure for the incinerator is very important and will reduce safety hazards such as slips, trips and falls.
3. A pre-operational checklist should be completed prior before operation of the incinerator. (Pre-Operational Checklist can be created by Ketek Group Inc. for an additional charge) Make sure all ash is removed properly 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 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. Operation & Maintenance

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 (2 burners in primary chamber and 1 in secondary chamber) are functioning correctly.
8. After 5 minutes primary burner motor will shut off and the secondary burner (flame) should be running and 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 would come on and you will see the temperature increasing on the temperature display “Primary Chamber T.C” as well.
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. After about approximately 1 hour after the rake, check the waste status again, if not burned then 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 then lower the set point on “Primary Chamber T.C” 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 and increase the set point on “Primary Chamber T.C” to 600°C by pressing the “▲” up arrow.
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 shuts 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 then 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.

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 again and again, let your supervisor know immediately.
- f) Always ask if unsure about something.

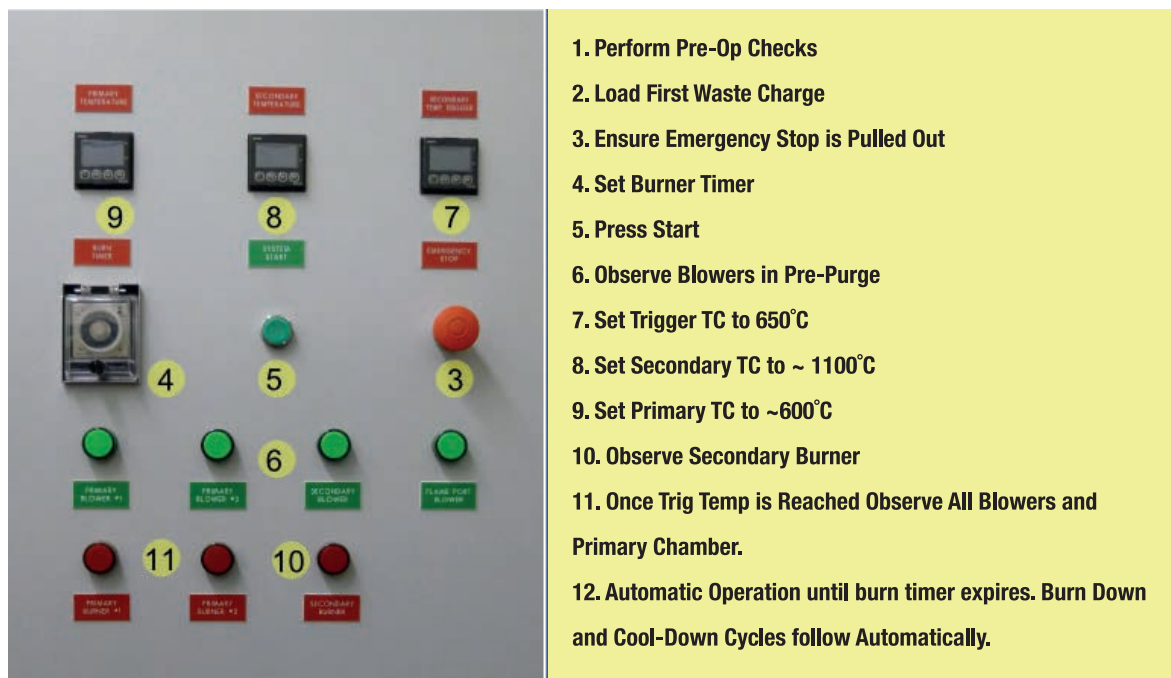


FIGURE 10 OPERATING SEQUENCE

**Note: Temperatures in Steps 8 and 9 may be governed by regulations:
If so, SET TEMPERATURES 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°C)
4. After 3 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 should 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 the training; dates of the 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 3 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 indicates damage to refractory and/or insulation
Annual	Refractory in SC	No large (not expansion) cracks; repair if necessary

6.11 Trouble Shooting

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

TABLE 9 TROUBLE SHOOTING GUIDELINES

Phases	Observation	Points/Items to look at.
Start -Up	Incinerator won't start	<input type="checkbox"/> Make sure there is power. <input type="checkbox"/> Check emergency stop is not engaged. <input type="checkbox"/> Timer is set to an actual value. <input type="checkbox"/> Make sure there is power on all phases/legs coming into the incinerator.
Pre-Purge Phase	Skipping or not starting the Pre-purge.	<input type="checkbox"/> Check that pre-purge timer works correctly. <input type="checkbox"/> Check emergency stop is not engaged. <input type="checkbox"/> Make sure there is power on all phases/legs coming into the incinerator.
	Auxiliary burner blower(s) won't run in pre-purge cycle.	<input type="checkbox"/> Check Fuses. <input type="checkbox"/> Check burner blower contacts are energized. <input type="checkbox"/> Check that overload switch on the motor is not tripped. <input type="checkbox"/> Check there is power at the burner on the wire supplying power to the motor (Use Multi meter) <input type="checkbox"/> Check for a seized motor by manually spinning the blower wheel. (Make sure power is off and locked out)
Pre-heat Phase	Secondary auxiliary burner won't ignite	<input type="checkbox"/> Check Fuses. <input type="checkbox"/> Check there is power at the Genisys Control. <input type="checkbox"/> Check that Genisys control is not locked out.
	Burner keeps Locking out after manual reset.	<input type="checkbox"/> Check all fuel valves are on. <input type="checkbox"/> Check Burner contacts are energized. <input type="checkbox"/> Check there is sufficient fuel in the tank. <input type="checkbox"/> 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. <input type="checkbox"/> 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. <input type="checkbox"/> 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. <input type="checkbox"/> Check that CAD cell is clean. <input type="checkbox"/> Try and hear the spark at the electrodes.
Burn Phase	Primary auxiliary burner(s) won't ignite.	<input type="checkbox"/> Check Door Switch(s) are engaged. <input type="checkbox"/> Check Fuses. <input type="checkbox"/> Check there is power at the Genisys Control. <input type="checkbox"/> Check that Genisys control is not locked out.
	Burner keeps Locking out after manual reset.	<input type="checkbox"/> Check all fuel valves are on. <input type="checkbox"/> Check Burner contacts are energized. <input type="checkbox"/> Check there is sufficient fuel in the tank. <input type="checkbox"/> Bleed the pump at the 3/8" bleed screw and make sure there is fuel flow and no air bubbles

6. Operation & Maintenance

Phases	Observation	Points/Items to look at.
Start -Up	Incinerator won't start	<input type="checkbox"/> Make sure there is power. <input type="checkbox"/> Check emergency stop is not engaged. <input type="checkbox"/> Timer is set to an actual value. <input type="checkbox"/> Make sure there is power on all phases/legs coming into the incinerator.
Pre-Purge Phase	Skipping or not starting the Pre-purge.	<input type="checkbox"/> Check that pre-purge timer works correctly. <input type="checkbox"/> Check emergency stop is not engaged. <input type="checkbox"/> Make sure there is power on all phases/legs coming into the incinerator.
	Auxiliary burner blower(s) won't run in pre-purge cycle.	<input type="checkbox"/> Check Fuses. <input type="checkbox"/> Check burner blower contacts are energized. <input type="checkbox"/> Check that overload switch on the motor is not tripped. <input type="checkbox"/> Check there is power at the burner on the wire supplying power to the motor (Use Multi meter) <input type="checkbox"/> Check for a seized motor by manually spinning the blower wheel. (Make sure power is off and locked out)
Pre-heat Phase	Secondary auxiliary burner won't ignite	<input type="checkbox"/> Check Fuses. <input type="checkbox"/> Check there is power at the Genisys Control. <input type="checkbox"/> Check that Genisys control is not locked out.
	Burner keeps Locking out after manual reset.	<input type="checkbox"/> Check all fuel valves are on. <input type="checkbox"/> Check Burner contacts are energized. <input type="checkbox"/> Check there is sufficient fuel in the tank. <input type="checkbox"/> 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. <input type="checkbox"/> 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. <input type="checkbox"/> 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. <input type="checkbox"/> Check that CAD cell is clean. <input type="checkbox"/> Try and hear the spark at the electrodes.
Burn Phase	Primary auxiliary burner(s) won't ignite.	<input type="checkbox"/> Check Door Switch(s) are engaged. <input type="checkbox"/> Check Fuses. <input type="checkbox"/> Check there is power at the Genisys Control. <input type="checkbox"/> Check that Genisys control is not locked out.
	Burner keeps Locking out after manual reset.	<input type="checkbox"/> Check all fuel valves are on. <input type="checkbox"/> Check Burner contacts are energized. <input type="checkbox"/> Check there is sufficient fuel in the tank. <input type="checkbox"/> Bleed the pump at the 3/8" bleed screw and make sure there is fuel flow and no air bubbles

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:

$$V = Y * t \text{ USG}$$

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

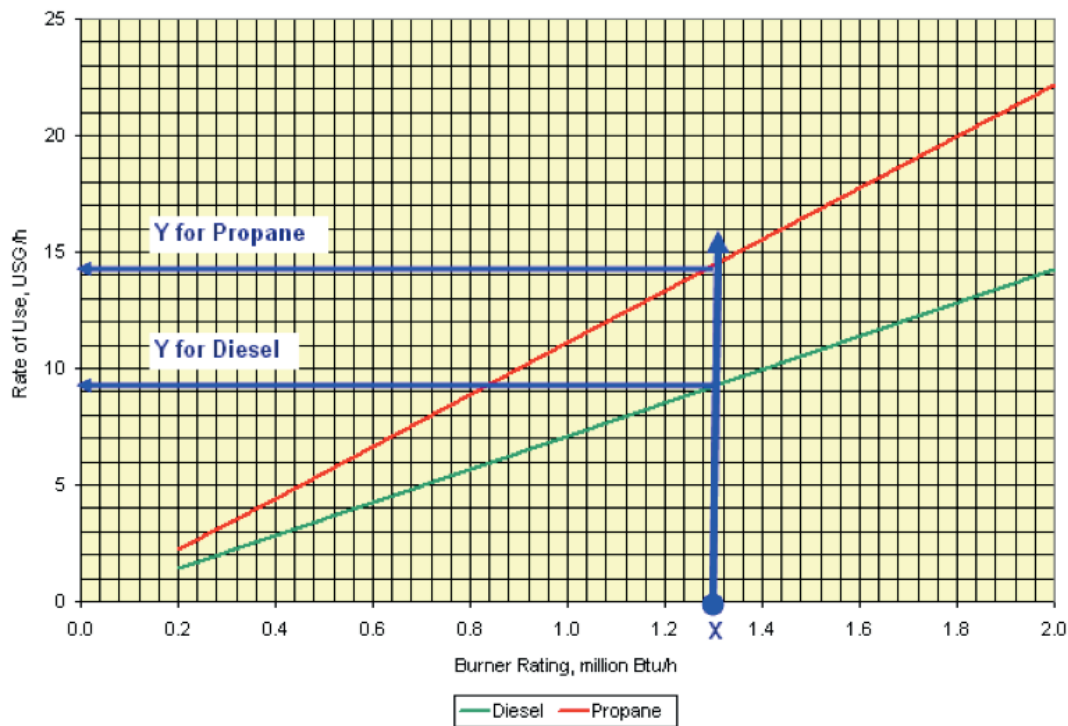


FIGURE 13 CONSUMPTION RATES OF PROPANE AND DIESEL

APPENDIX A

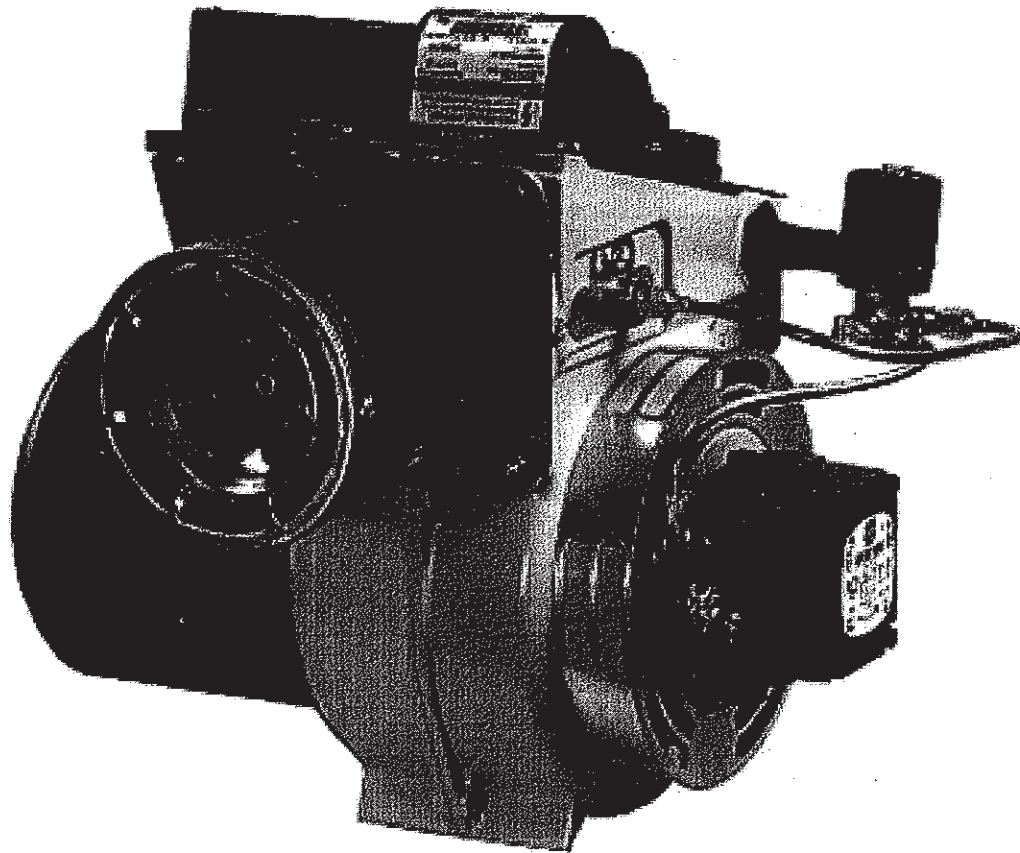
1. **Suggested Spare Parts List**
2. **Burner WIC 201**
3. **Burner WIC 301**
4. **Blower Dayton 4C 108**
5. **Inspection Checklist**
6. **Wiring Diagram**

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 Cell (If Applicable)	4	120730
Beckett Genysis Control (If Applicable)	2	177800
Timer, H3CR-A 11pin	1	152760
Omron Temperature Controller	1	131850
Panel Fuse 10A	2	no item #
Panel Fuse 15A	6	no item #
Thermocouple Ceramic (Secondary Chamber)- 12.75"	2	130140
Thermocouple Stainless Steel (Primary Chamber)- 12.75"	2	163670
Proximity Switch Door	1	132600
Limit Switch Assembly	1	130090
Gasket, Ceramic Fibre 1/4" 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

Models SF & SM Oil Burners



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

Owner's Information	3
Hazard Definitions	4

Information To Be Used Only By Qualified Service Technicians

General Information	4
Table 1 Burner Specification	4
Notice Special Requirements	5
Table 2 Air Tube Combination (ATC) Codes	5
Inspect/Prepare Installation Site	5
Chimney or Vent	5
Combustion Air Supply	5
Clearances to burner and appliance	6
Combustion chamber - Burner Retrofitting	6
Prepare the Burner	6
Burner Fuel Unit	6
Attach Air Tube	6
Install Burner Nozzle	6
Check/Adjust Electrodes	7
Servicing nozzle line assembly	7
Check/Adjust 'Z' Dimension - F Heads	7
Mount Burner on Appliance	8
Mounting Options	8
Mounting Dimensions	8
Connect Fuel Lines	8
Wire Burner	10
Burner Packaged with Appliance	10
Burner Installed at Job Site	10
Start-up Burner/Set Combustion	10
Set Combustion with Test Instruments	12
Perform Regular Maintenance	13
Parts Diagram	14
Beckett Limited Warranty Information	16

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.



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/UL296 & 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.



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



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.

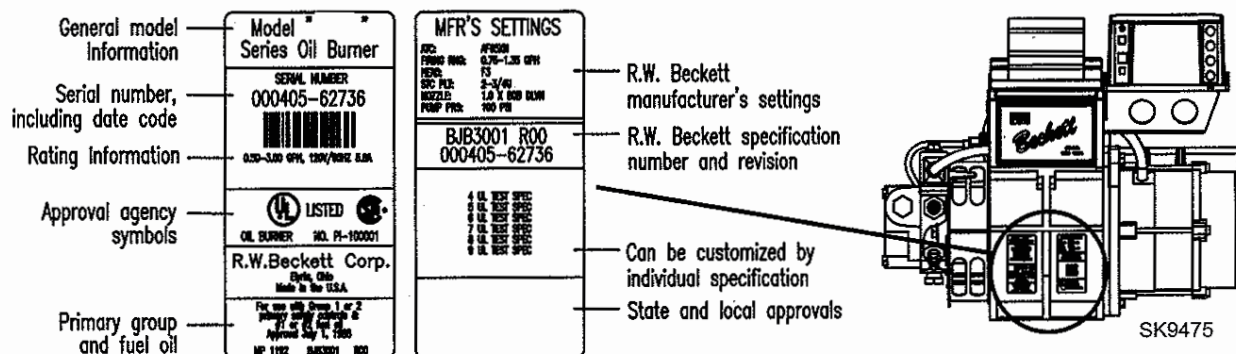
• Combustion chamber — Burner retrofitting

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

Figure 1. Burner Label Location



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 $\frac{3}{4}$ " open-end wrench on the nozzle adapter. Insert the nozzle into the adapter and finger tighten. Finish tightening with a $\frac{5}{8}$ " open-end wrench. Use care to avoid bending the electrodes.

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

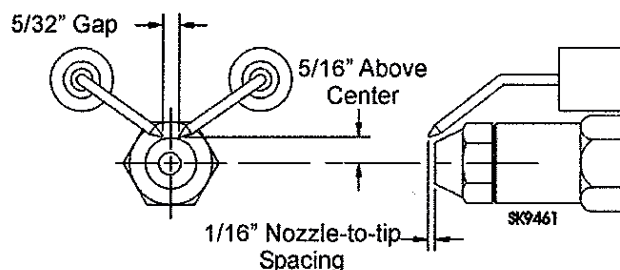
Recommended nozzle spray angles	
"F" head	70°, 80° or 90° nozzle

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



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

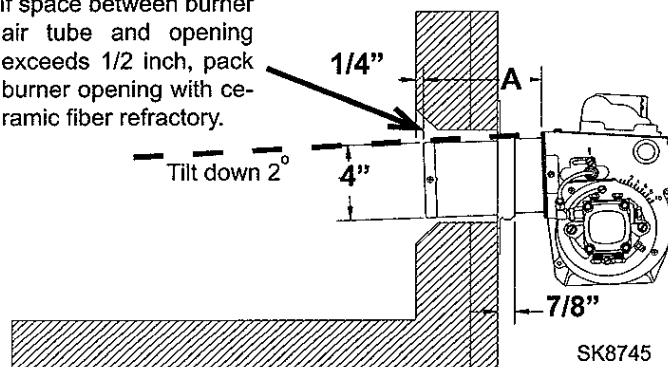
Bolt the burner to the appliance using the factory-mounted flange or an adjustable flange.

• 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 1/4" 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

If space between burner air tube and opening exceeds 1/2 inch, pack burner opening with ceramic fiber refractory.



• Connect fuel lines

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



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**.



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 anti-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

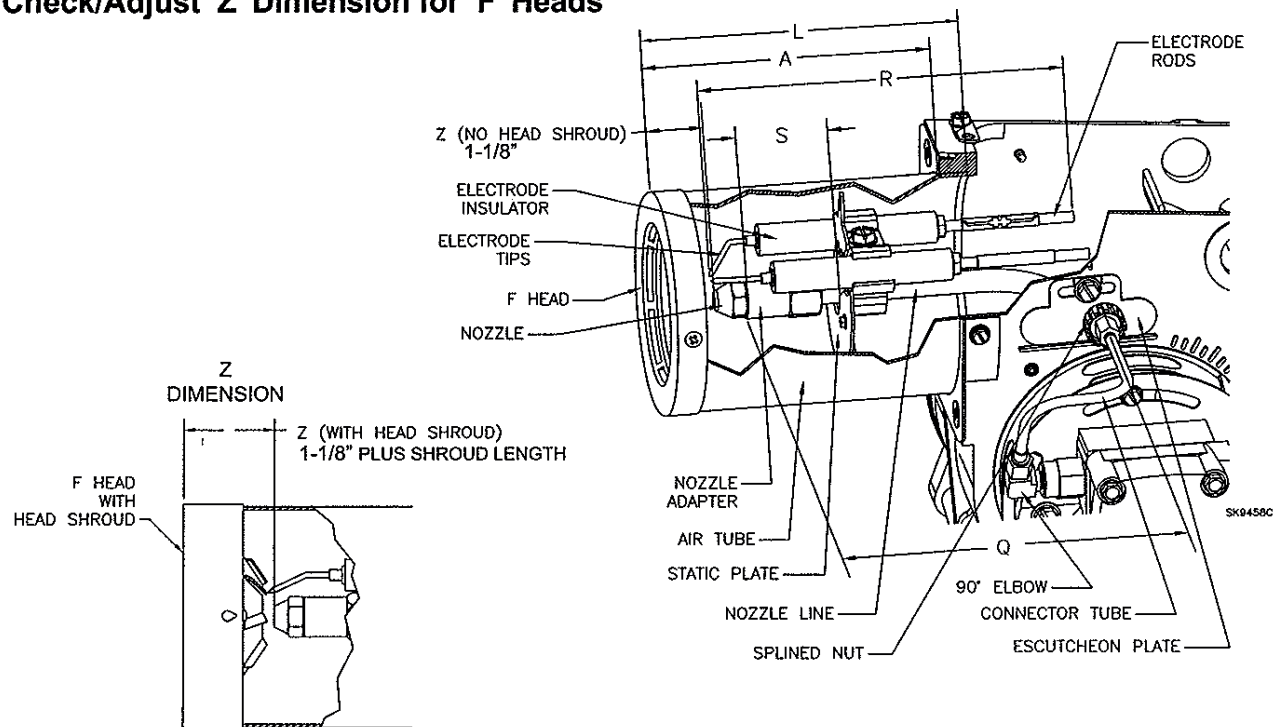


Figure 4. 'F' Head

• 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 $1\frac{1}{8}$ " ($1\frac{3}{8}$ " 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 $1\frac{1}{8}$ " ($1\frac{1}{8}$ " 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), $\pm 1/4$	A+2-1/4
S (adapter to static plate), $\pm 1/16$	(Note 1)
Q (nozzle line length),	A+ 15/16
Z (F head w/o head shroud)	1-1/8
Z (F head-with head shroud)	1-1/8 + shroud length. (Note 2)

Note 1: $1\frac{3}{8}$ for dimension A less than 4"; $1\frac{5}{8}$ for dimension A from 4" through 4-1/2", $2\frac{13}{32}$ 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 shutoff 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.

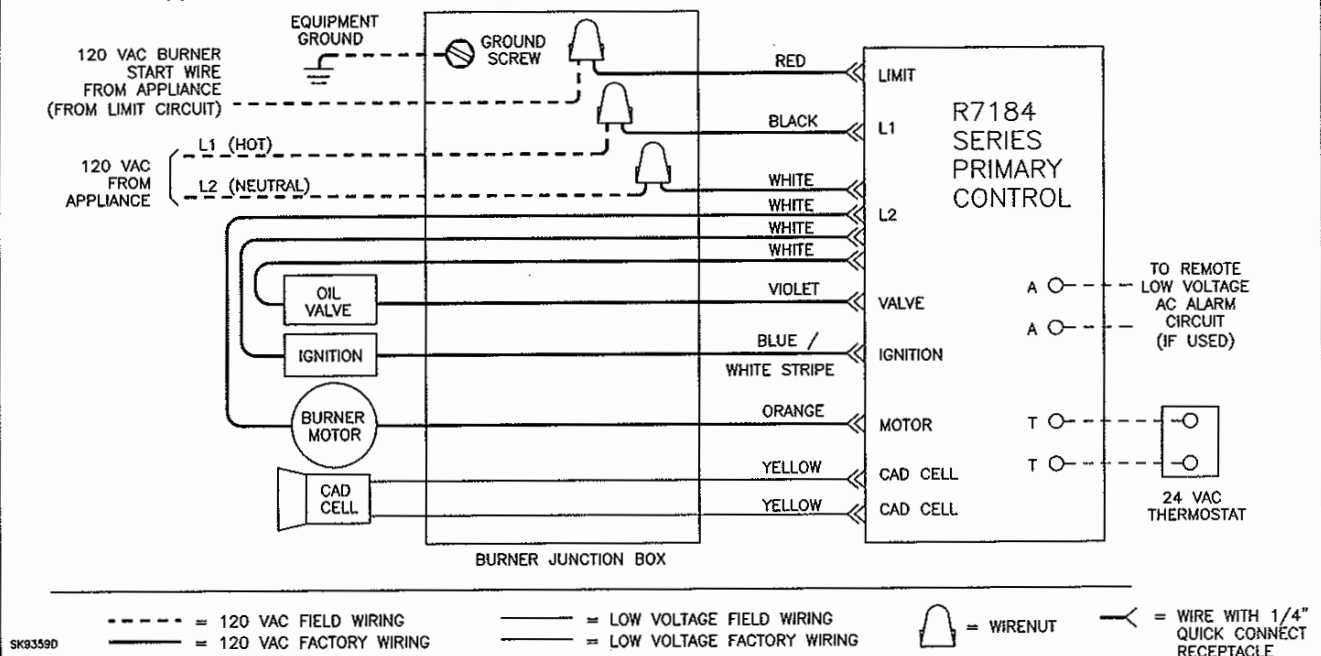
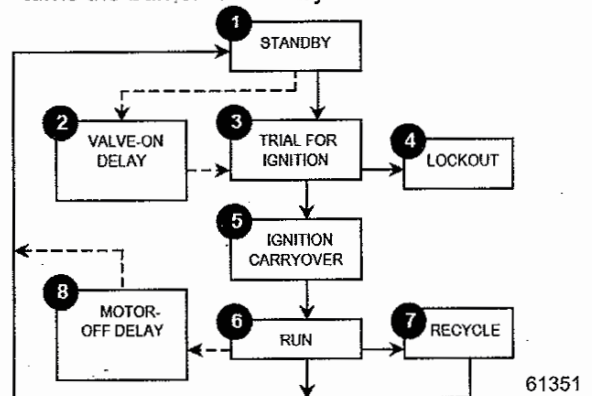


Figure 5. – Typical Burner Wiring

- 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 satisfied. 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 1/4" 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 CO₂ (or O₂) . This is the vital reference point for further adjustments. Example: 13.5% CO₂ (2.6% O₂)
 - Step 3:** Increase the air to reduce the CO₂ by 1.5 to 2 percentage points. (O₂ will be increased by approximately 2.0 to 2.7 percentage points.) Example: Reduce CO₂ from 13.5% to 11.5% (2.6% to 5.3% O₂).
 - 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



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.

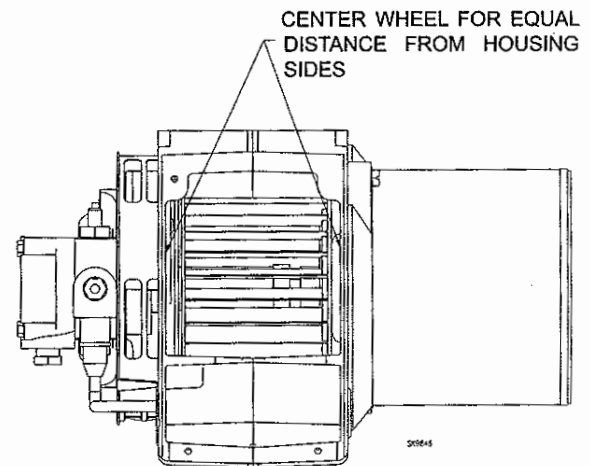
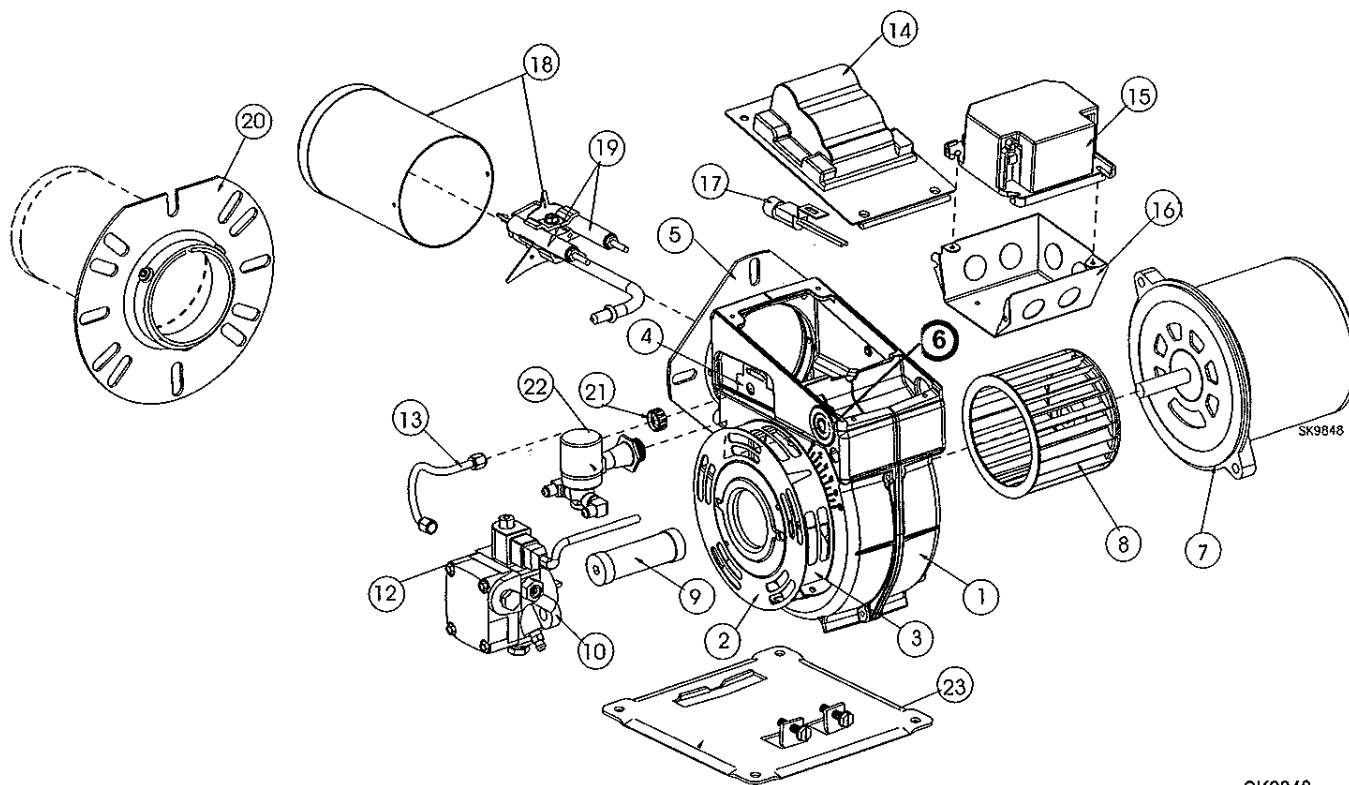


Figure 6. Blower Wheel Assembly

Burner Parts Diagram



SK9848



For best performance specify genuine *Beckett* replacement parts

#	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
	5780	Electrode Kit - F Head up to 9"
19	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.



Beckett
COMMERCIAL

CF1400
CF2300

OIL BURNER MANUAL

Operation: Low/High

Rate: CF1400: 4.0 to 13.6 GPH

CF2300: 7.0 to 19.9 GPH



WARNING

Potential for Fire, Smoke and Asphyxiation Hazards



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

To the Homeowner or Equipment Owner:

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

To the Professional, Qualified Installer or Service Agency:

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

Before you begin . . .

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

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

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

To the Owner:

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

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

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

Table of Contents

General Information	3-4
Hazard Definitions	3
Specifications	3
Owner's Responsibility	4
Installer/Service Agency Responsibility	4
Pre-installation checklist	4-8
Combustion air supply	4
Clearances	4
Fuel supply	5
Nozzle Pressure	5
Electrical supply	5
Vent system	5
Verify burner components	6
Verify firing range	6
Verify air tube	6
Stray Light	8
Dust and Moisture	8
Mount the burner	8-11
Mount flanges on air tubes	8
Mount air tube to burner	9
Install Nozzle	9
Check Electrode Settings	9
Install Nozzle Line Assembly	9
Set Dimension Z	10
Insert Burner	11
Fuel unit By-pass plug	11
One pipe oil system by-pass loop	11
Oil supply/return lines	11
Burner fuel flow	11
Wire the burner	13
Sequence of operation	14
Prepare the burner for start-up	15-17
Start-up checklist	15
Z Dimension	15
Adjusting plate assembly	15
Initial head position	15
Initial air settings	17
Set appliance limit controls	17
Prepare the fuel unit for air venting	17
Start the burner	18-19
Start burner and vent air from oil line	18
Set high-fire air	18
Set low-fire air	18
Maintenance and Service	20
Annual Professional Service	20
Monthly maintenance	20
Replacement Parts	22-23
Warranty	Back Cover

Hazard definitions



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



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



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

NOTICE

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

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

Specifications

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

Agency approvals



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

Owner's Responsibility:



WARNING

Follow These Instructions Exactly



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

Contact a professional, qualified service agency for the installation, adjustment and service of your oil burning system. Thereafter, have your equipment adjusted and inspected at least annually to ensure reliable operation. This work requires technical training, trade experience, licensing or certification in some states and the proper use of special combustion test instruments.

Please carefully read and comply with the following instructions:

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

Professional Installer/Service Agency Responsibility:



WARNING

Follow These Instructions Exactly



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

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

NOTICE

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

NOTICE

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

Pre-installation checklist

☐ Combustion air supply



WARNING

Adequate Combustion and Ventilation Air Supply Required

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

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

The burner requires combustion air and ventilation air for reliable operation. Assure that the building and/or combustion air openings comply with National Fire

Protection Standard for Oil-Burning Equipment, NFPA 31. For appliance/burner units in confined spaces, the room must have an air opening near the top of the room plus one near the floor, each with a free area at least one square inch per 1,000 Btu/hr input of all fuel burning equipment in the room. For other conditions, refer to NFPA 31 (CSA B1139-M91 in Canada).

If there is a risk of the space being under negative pressure or of exhaust fans or other devices depleting available air for combustion and ventilation, the appliance/burner should be installed in an isolated room provided with outside combustion air.

☐ Clearances

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

☐ Fuel supply



Oil Supply Pressure Control Required

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

- The oil supply inlet pressure to the burner *cannot exceed 3 psig*.
- Do not install valves in return line.
- Insure that a pressure limiting device is installed in accordance with the latest edition of NFPA 31.
- Gravity Feed Systems: Always install an anti-siphon valve in the oil supply line or a solenoid valve (RWB Part # 21789) in the pump/nozzle discharge tubing to provide backup oil flow cut-off protection.

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

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

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

When fuel supply is below the burner fuel unit —

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

☐ Nozzle pressure



Correct Nozzle and Flow Rate Required



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

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

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

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

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

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

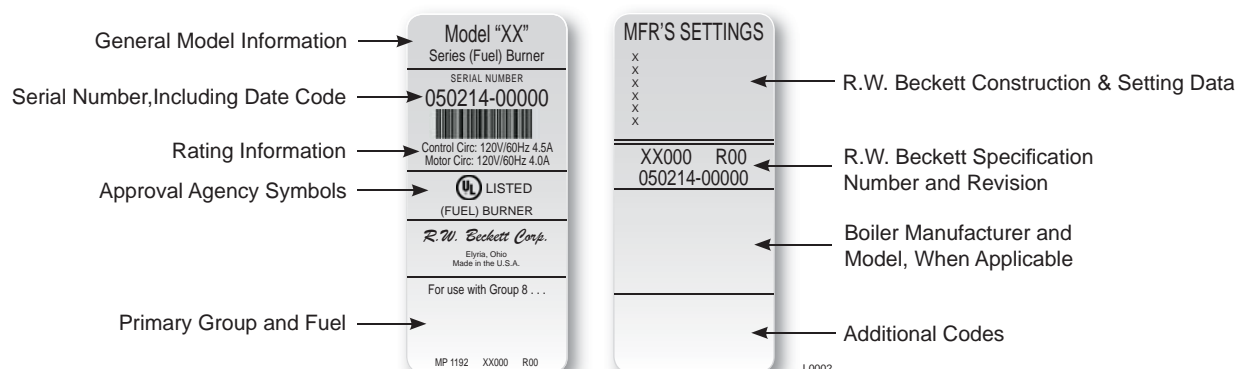
☐ Electrical supply

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

☐ Vent system

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

Figure 1 – Typical Nameplate



❑ Verify burner components —

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

Find the required firing rate in the 300 psig column (high fire rate).

Select the corresponding nozzle from column 1 (*Rated gph @ 100 psig*).

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

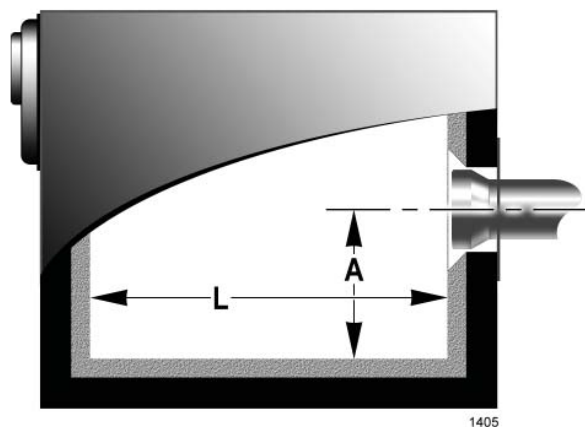
Table 1 - Nozzle capacities

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

❑ Verify firing rate

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

Figure 2 – Chamber Dimensions



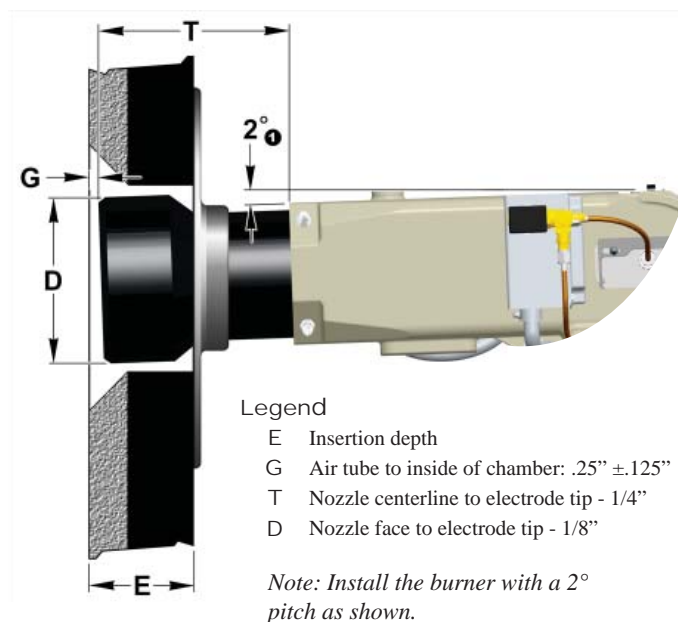
Model	Firing Rate (gph)	Minimum Dimensions			
		Refractory Lined		Wet-based Boilers	
		A	L	A	L
CF1400	0 to 5	7.0"	25.0"	7.0"	25.0"
	5 to 10	8.0"	35.0"	8.0"	40.0"
CF2300	5 to 10	8.0"	35.0"	8.0"	40.0"
	10 to 15	9.0"	40.0"	9.0"	50.0"
	15 to 20	11.0"	55.0"	11.0"	60.0"

❑ Verify air tube

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

- On the **CF1400**, there are two tube arrangements available –
Tube A — 4.0 to 11.0 GPH per Table 2
Tube B — 7.0 to 13.6 GPH per Table 2
- The **CF1400** maximum firing capacity depends on the firebox pressure. Use *Table 2* to verify the correct air tube type for the firing rate required. Use Tube B only when Tube A cannot provide the firing rate required.
- On the **CF2300**, there are two tube arrangements available –
Tube A — 7.0 to 19.9 GPH per Table 2
Tube B — 10.0 to 19.9 GPH per Table 2
- The **CF2300** maximum firing capacity depends on the firebox pressure. Use *Table 2* to verify the correct air tube type for the firing rate required. Use Tube B only when Tube A cannot provide the firing rate required.
- See *Figure 3* to verify the correct air tube length and air tube combination code.

Figure 3 – Air tube mounting dimensions



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

Table 2 - Air tube capacity Versus firebox pressure

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

Note: 10% turndown indicates sufficient reserve air to reduce the CO₂ in the flue to 90% of its value. The above ratings may vary 5% due to variations in actual job conditions.

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

❑ Stray light

CAUTION Protect Against Stray Light Lockout

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

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

❑ Dust and Moisture

WARNING Protect Against Dust and Moisture

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

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

Mount the burner

❑ Mount flange(s) on air tube

CAUTION Protect the Air Tube From Overheating

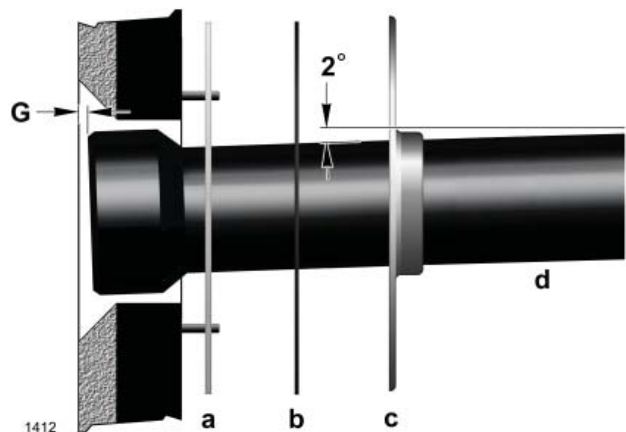
Overheating could cause damage to the air tube and other combustion components leading to equipment malfunction and impaired combustion performance.

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

the air tube as shown. Wrap ceramic fiber rope (not shown) around the air tube and press tightly into the inside diameter of the flange (item c).

- Slide the air tube (item d) into position in the appliance front. Tighten the flange-mounting-stud nuts. Set the insertion of the air tube so dimension G is 1/4" nominal.
- Pitch the air tube at 2° from horizontal as shown and secure the flange to the air tube.

Figure 4 – Mount flange(s) on air tube



This section does not apply to burners with welded flanges.

- Do not install air tube on burner.
- For non-pressure firing flange, refer to **Figure 4**: Install gasket (item a) and flange (item c). Ignore the next paragraph.
- For pressure-firing flange, refer to **Figure 4**: Slide gasket (item a) onto the air tube, making sure the top of the air tube is up. Predrill holes in the pressure firing plate (item b) to match the appliance studs. Slide the pressure firing plate (item b) and flange (item d) onto

□ Mount air tube to burner

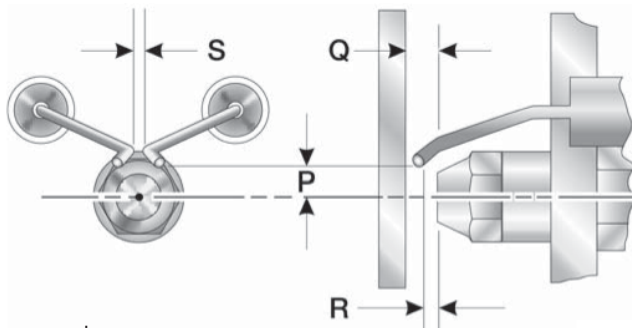
- Remove the rear access door from the back of the burner for improved access to the interior.
- Attach the air tube to the burner with the bolts and acorn nuts provided. The acorn nuts must go on the outside of the burner, with the bolts inserted from the inside.

□ Install nozzle

See **Figure 5**. Install the oil nozzle in the nozzle adapter. Use a $\frac{3}{4}$ " open-end wrench to steady the nozzle adapter and a $\frac{5}{8}$ " open-end wrench to turn the nozzle. Tighten securely but do not overtighten.

Check, and adjust if necessary, the critical dimensions **P**, **Q**, **R** and **S** shown in the drawing. Verify that the oil tube assembly and electrodes are in good condition, with no cracks or damage.

Figure 5 – Nozzle and nozzle line assembly



Legend

- S Electrode spacing - $\frac{3}{32}$ "
- Q Nozzle to head - $\frac{1}{4}$ "
- P Nozzle centerline to electrode tip - $\frac{1}{4}$ "
- R Nozzle face to electrode tip - $\frac{1}{8}$ "

□ Check electrode settings

WARNING Maintain Electrode Specifications

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

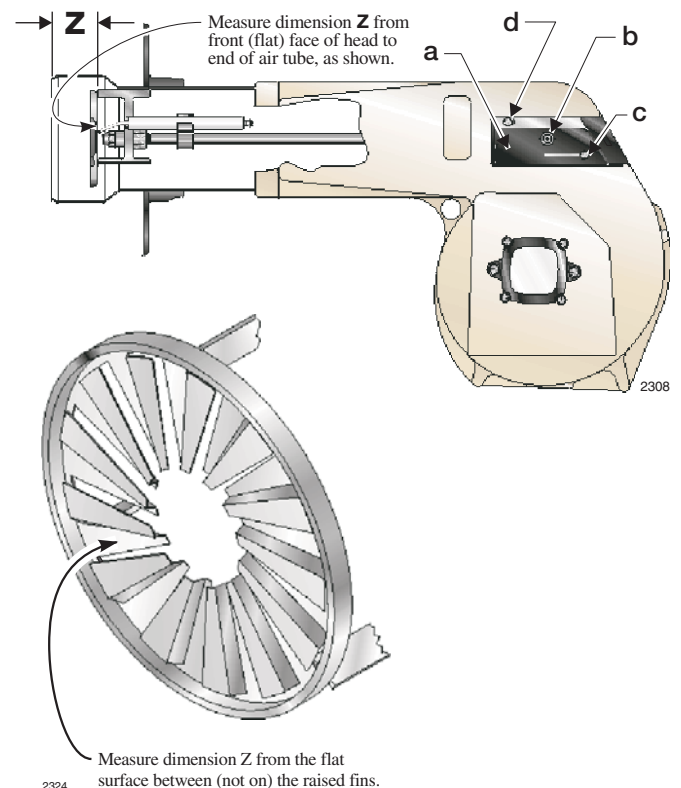
- Adjust the electrode gap and position in relation to the nozzle to the specifications shown in **Figure 5**.

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

□ Install nozzle line assembly

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

Figure 6 – Nozzle line assembly in burner



$$Z = 1\text{-}\frac{3}{4}\text{' } \pm \frac{1}{16}\text{'}$$

Legend (Figure 6)

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

❑ Set dimension Z

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

❑ Insert burner

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

Figure 7 – Adjusting plate assy.

Legend

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

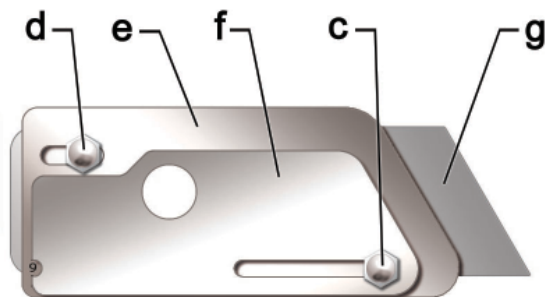
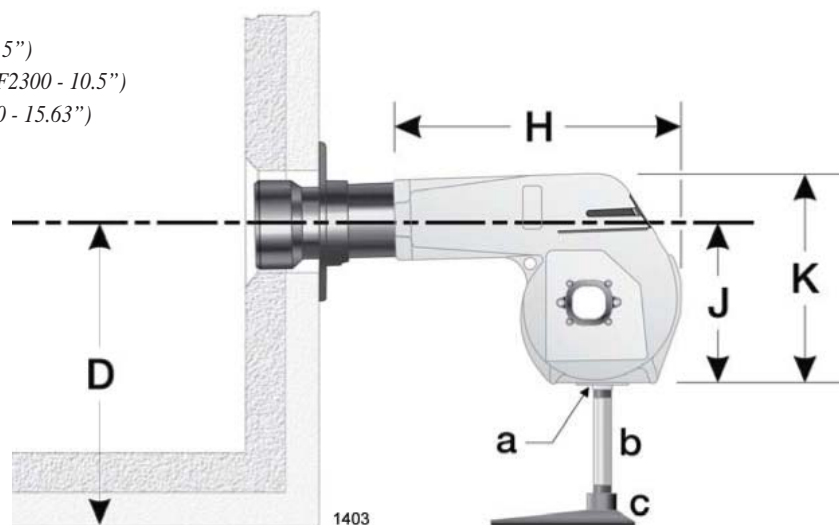


Figure 8 – Burner installed in appliance front

Legend

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



□ Fuel unit by-pass plug



WARNING

Install Oil Supply To Specifications



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

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

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

□ One-pipe oil system by-pass loop



WARNING

Factory-Installed Pump Bypass Plug

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

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

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

□ Oil supply/return lines

- Install the oil tank and oil lines in accordance with all applicable codes.
- Size the oil supply and return lines using the

guidelines given in the fuel unit literature included in the literature envelope. Oil line flow rate will equal the burner rate for one-pipe systems. For two-pipe systems, refer to **Table 3** for the fuel unit gearset capacity - the rate at which fuel is recirculated when connected to a two-pipe system. Size two-pipe oil lines based on this flow rate.

- Use continuous lengths of heavy-wall copper tubing, routed under the floor where possible. Do not attach fuel lines to the appliance or to floor joists if possible. This reduces vibration and noise transmission problems.
- Install an oil filter sized to handle the fuel unit gearset flow capacity (**Table 3**) for two-pipe systems. However, size the filter for the firing rate for one-pipe systems. Locate the filter immediately adjacent to the burner fuel unit.
- Install two high-quality shutoff valves in accessible locations on the oil supply line. Locate one valve close to the tank. Locate the other valve close to the burner, upstream of the fuel filter.

□ Burner fuel flow

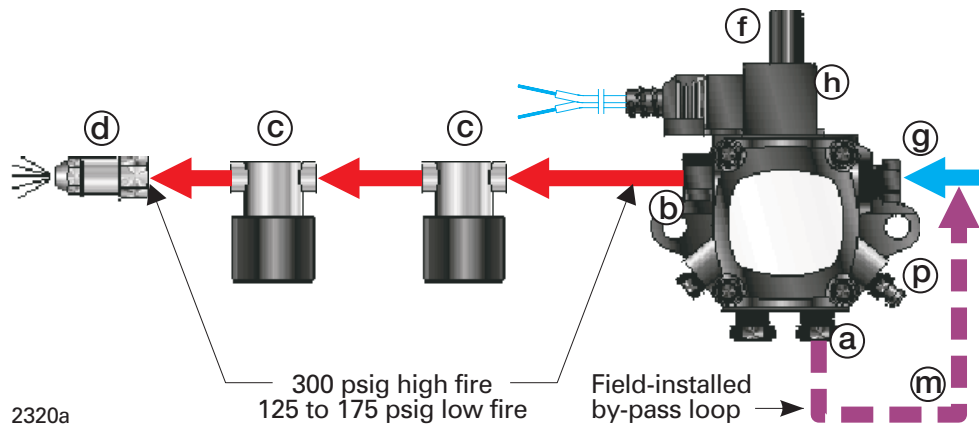
One-pipe systems – See **Figure 9** for the fuel flow paths for high-fire and low-fire operation. The low-fire by-pass regulation is done internally for type **B** fuel units. Oil supply connects to one of the fuel unit Inlet ports.

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

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

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

Figure 9 – One-pipe oil flow with “B” pump



Legend (figure 9 & 10)

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

Figure 10 – Two-pipe oil flow with “B” pump

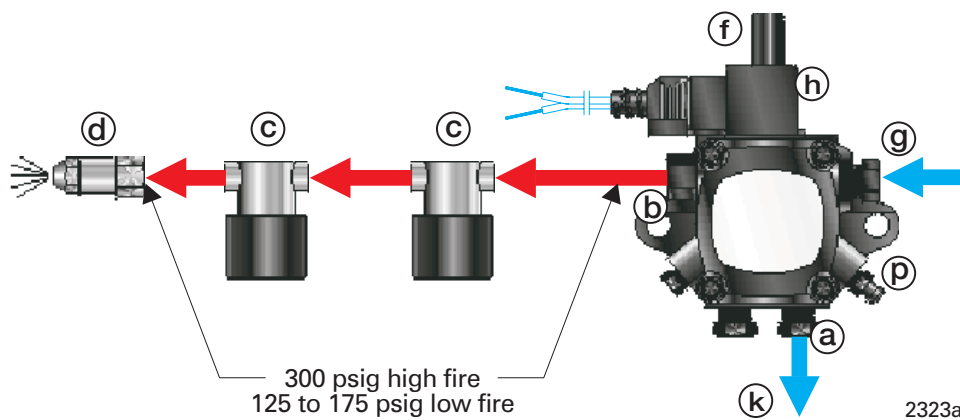


Table 3 – Fuel unit gearset capacities

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

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

Wire the burner — R7184B



WARNING Electrical Shock Hazard

Electrical shock can cause severe personal injury or death.

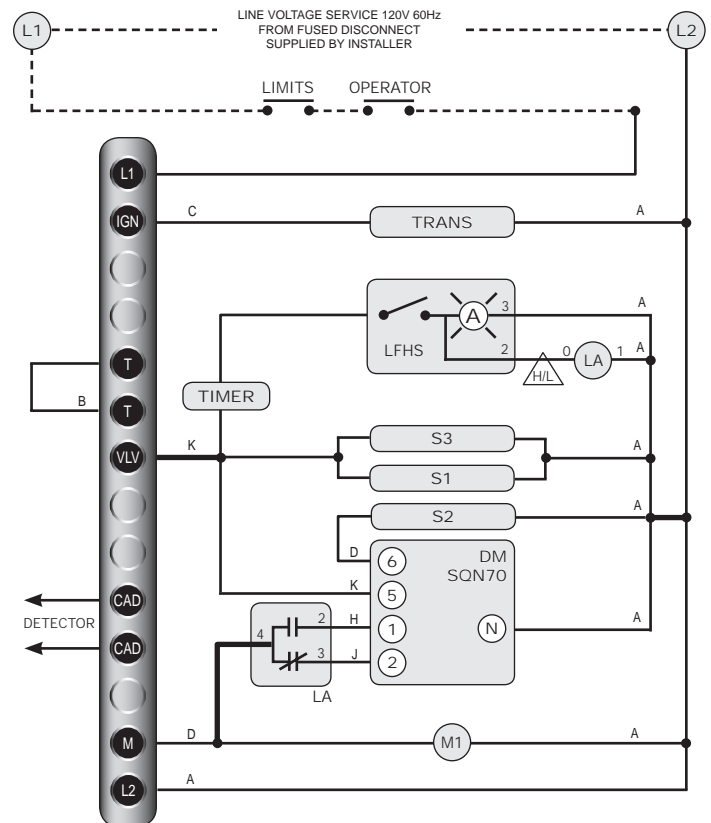
- Disconnect electrical power before installing or servicing the burner.
- Provide ground wiring to the burner, metal control enclosures and accessories. (This may also be required to aid proper control system operation)
- Perform all wiring in compliance with the National Electric Code ANSI/NFPA 70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

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

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

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

Figure 11. - Typical wiring (R7184B)



Legend

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

Sequence of operation — typical

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

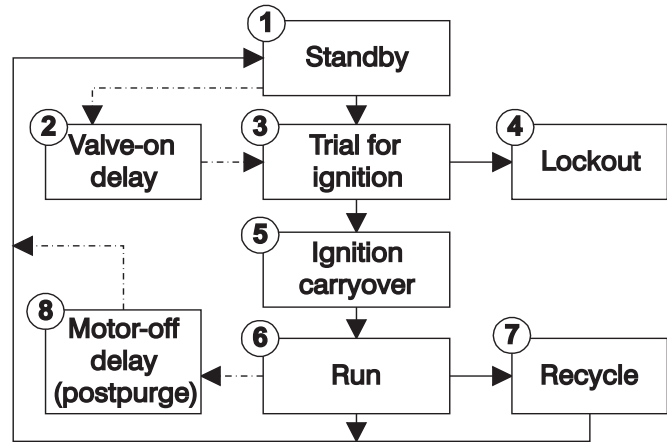
Wire the burner in compliance with all instructions provided by the appliance manufacturer. Verify operation of all controls in accordance with the appliance manufacturer's guidelines.

Sequence of operation — typical

1. **Standby** — The burner is idle, waiting for a call for heat. When a call for heat is initiated, there is a 3- to 10-second delay while the control performs a safe start check.
2. **Valve-on delay** — As applicable, the ignition and motor are turned on for a 15-second prepurge.
3. **Trial for ignition (TFI)** — The fuel valve is opened, as applicable. A flame should be established within the 15-second lockout time (30-second lockout time is available).
4. **Lockout** — If flame is not sensed by the end of the TFI, the control shuts down on safety lockout and must be manually reset. If the control locks out three times in a row, the control enters restricted lockout. Call a qualified service technician.
5. **Ignition carryover** — Once flame is established, the ignition remains on for 10 seconds to ensure flame stability. It then turns off.
6. **Run** — The burner runs until the call for heat is satisfied. The burner is then sent to burner motor-off delay, as applicable, or it is shut down and sent to standby.
7. **Recycle** — If the flame is lost while the burner is firing, the control shuts down the burner, enters a 60-second recycle delay, and then repeats the ignition steps outlined above. If the flame is lost three times in a row, the control locks out to prevent continuous cycling with repetitious flame loss caused by poor combustion.
8. **Burner motor-off delay** — If applicable, the fuel valve is closed and the burner motor is kept on for the selected postpurge time before the control returns the burner to standby.

Resetting to OHM

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



Prepare the burner for start-up



WARNING

Professional Installation and Service Required

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

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



WARNING

Do Not Bypass Safety Controls

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

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



CAUTION

Keep Service Access Covers Securely Installed

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

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

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

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

☐ Z dimension

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

☐ Adjusting plate assembly (Figure 12)

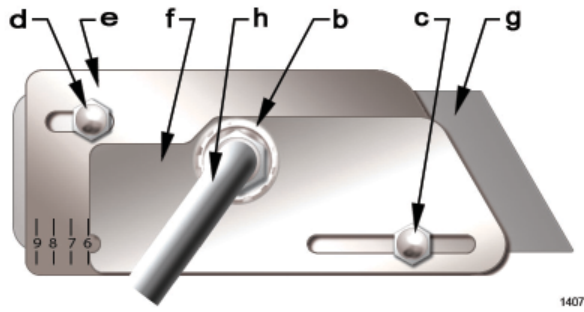
Make sure spline nut (item **b**) and bottom acorn nut (item **c**) are loose before proceeding to next section.

☐ Initial head position (Figure 12)

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

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

Figure 12 – Adjusting plate initial setting, typical



Legend

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

Table 4a. CF1400 Initial indicator adjustment plate settings

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

Table 4b. CF2300 Initial indicator adjustment plate settings

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

□ Initial air settings

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

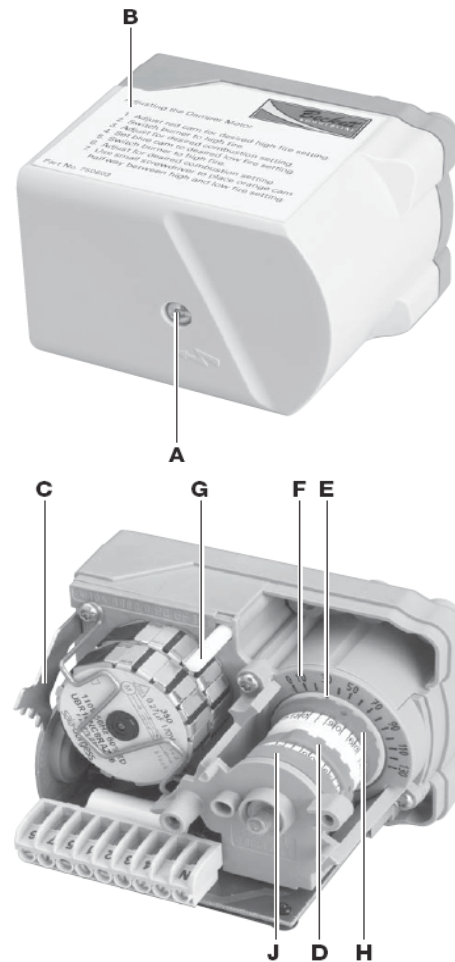
1. Remove the cover screw (A) then the cover (B) and place to one side.
2. Using the wrench (C) supplied with the damper motor, adjust the blue low fire cam (D) to the initial setting listed in **Tables 4a** or **4b**.
3. Using the same wrench, adjust the red high fire cam (H) to the initial settings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

NOTICE

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

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

Figure 13 - Damper Motor



Legend (figure 13)

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

□ Set appliance limit controls

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

□ Prepare the fuel unit for air venting

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

Start the burner



WARNING

Explosion and Fire Hazard



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

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



WARNING

Professional Service Required



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

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

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

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

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

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

- Start burner and vent air from oil line



WARNING

Hot Gas Puff-back and Heavy Smoke Hazard



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

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

- Disable function

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

- CAD cell resistance check

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

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

* Lockout can occur above 4000 ohms.

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

❑ Operating the burner

1. Move the **low-fire hold** switch to the **low fire hold** position (to hold burner in low fire when started).
2. Verify that the air adjusting cam (*Figure 13b*, item **d**) has been set to the initial low-fire air setting as described under Initial air settings.
3. Open the oil shutoff valves in the oil supply (and return) line(s) to the burner.
4. Set the thermostat (or operating control) to call for heat.
5. Close the line switch to the burner. The burner motor should start immediately.
6. If the burner motor does not start, reset the motor overload switch (if so equipped) and press the reset switch of the burner primary control.
7. Vent the fuel unit as soon as the burner motor starts rotating. To vent —
 - Attach a clear plastic tube to the air bleed valve (*Figure 9 or 10 as applies, item p*).
 - Place the end of the tube in a container to catch the oil. Then loosen the fuel unit air vent valve.
 - Tighten the air vent valve after all air has been purged.
 - **IF burner stops during venting** —
 - The burner primary control will lockout if flame is not established within its time limit. This is typically 15 seconds for R7184B primary controls, but may be less for other flame supervisory controls.
 - The burner may lockout several times during the period needed to purge all the air. To extend air venting time, press the red reset button for 1/2 second during the prepurge cycle to continue purging.
 - **IF burner stops after flame established** —
 - Additional venting is probably required. Repeat the air venting procedure.
8. Once flame is steady, proceed to Set high-fire air.

❑ Set high-fire air

1. Allow the burner to run at **low fire** until the appliance has warmed sufficiently.
2. Visually check the flame. The flame should not be dark orange or smoky. If the flame appears to be smoking, increase the amount of air by readjusting the damper indicator to a higher number.

3. Once the appliance has warmed, the **high-fire** setting can be checked and adjusted.
4. Locate the approximate air adjusting plate setting for **high fire** in *Table 4a or 4b*.
5. Place the **low-fire hold** switch in the **high-fire position**. The damper motor will begin to rotate after four seconds.
6. Use combustion test instruments to adjust the burner.
 - a. Adjust the air by moving the red cam to a lower number until a trace of smoke is achieved with CO₂ level as high as possible (lowest possible O₂).
Example: 13.5% CO₂ (2.5% O₂) with a trace of smoke.
 - b. Increase the air by increasing the red cam number to reduce CO₂ by 2 percentage points at a zero smoke level. (Increase O₂ by 3 percentage points at a zero smoke level.)
Example: Reduce CO₂ from 13.5% to 11.5%, with zero smoke (or increase O₂ from 2.5% to 5.5%).
 - c. A margin of reserve air has been added to accommodate variable conditions.
7. Check the breech draft pressure against the appliance manufacturer's recommended setting (typically + 0.1" W.C.).
8. If the breech pressure is higher or lower than recommended level, adjust the appliance breech damper to achieve the specified setting. Recheck the smoke and CO₂ levels. Adjust burner air if necessary.
9. Once all settings are complete and satisfactory, proceed to 'Set low-fire air'.

❑ Set low-fire air

1. Move the **low-fire hold** switch from the "**High Fire position**" to the "**Low Fire Hold**" position.
 - a. The damper will return to the **low-fire** air setting.
2. Check the smoke and CO₂ (O₂) levels.
 - a. Pull a smoke sample from the flue.
 - b. The sample should be clean (zero smoke level).
 - c. Check the CO₂ (O₂) level:
CO₂ should be at 11 to 12% (O₂ at 5.9 to 4.5%).
If the CO₂ is less than 11% (O₂ more than 5.9%), decrease the air and check the smoke level.
3. Operate the burner from **low fire** to **high fire** and back to verify operation.
4. Turn the burner off. Wait one or two minutes (for chamber to clear) and then turn on again to verify starting characteristics.
5. Perform limit circuit performance test specified by appliance manufacturer to verify operation of burner/appliance combination.

Maintenance and Service



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.

- ☐ 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.

Annual Service

- ☐ Replace the oil supply line filter. The line filter cartridge must be replaced to avoid contamination of the fuel unit and nozzle.
- ☐ Inspect the oil supply system. All fittings should be leak-tight. The supply lines should be free of water, sludge and other restrictions.
- ☐ Remove and clean the pump strainer if applicable.
- ☐ Replace the nozzle with the exact brand, pattern, gph, flow rate and spray angle.
- ☐ Clean and inspect the electrodes for damage, replacing any that are cracked or chipped.
- ☐ Check electrode tip settings. Replace electrodes if tips are rounded.
- ☐ Inspect the igniter spring contacts.
- ☐ Clean the cad cell lens surface, if necessary.
- ☐ Inspect all gaskets. Replace any that are damaged or would fail to seal adequately.
- ☐ Inspect the combustion head and air tube. Remove any carbon or foreign matter. Replace all damaged units with exact parts.
- ☐ Clean the blower wheel, air inlet, air guide, burner housing and static plate of any lint or foreign material.
- ☐ If motor is not permanently lubricated, oil motor with a few drops of SAE 20 nondetergent oil at each oil hole. DO NOT over oil motor. Excessive oiling can cause motor failure.

Monthly maintenance — by owner

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

See next page for *Beckett* replacement parts ►

Replacement Parts

For best performance specify genuine *Beckett* replacement parts

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

Figure 14 – Burner Replacement Parts

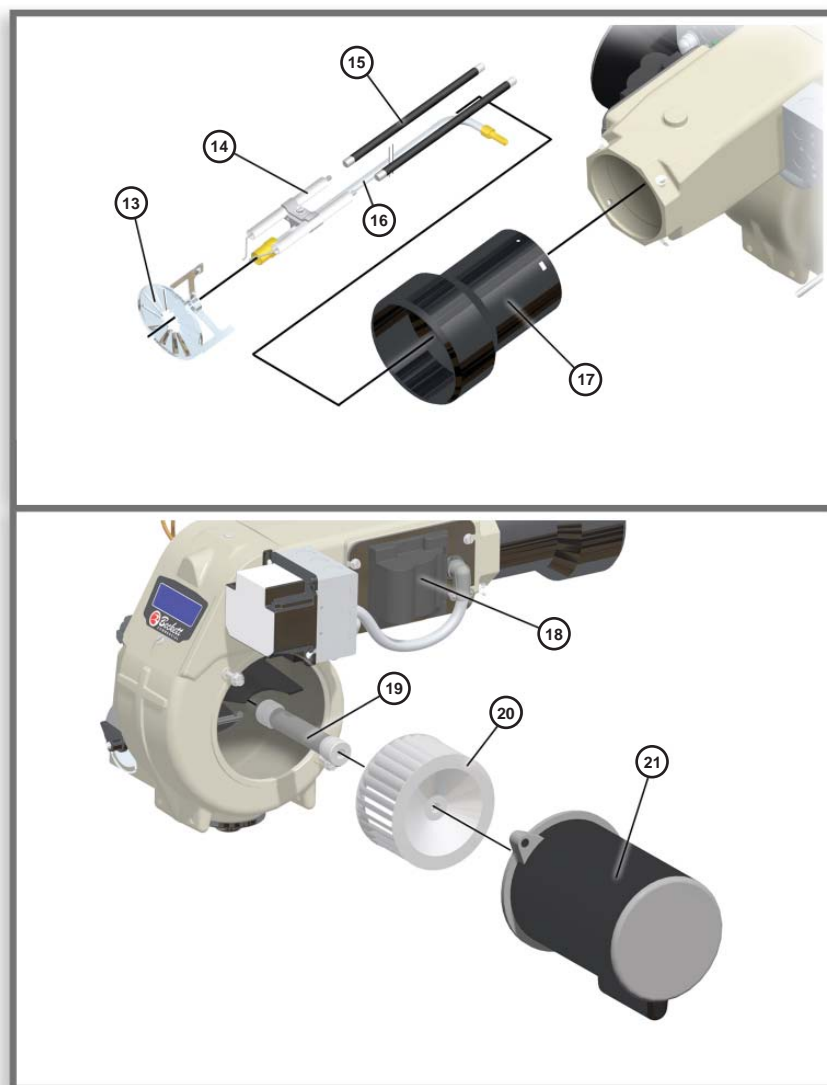
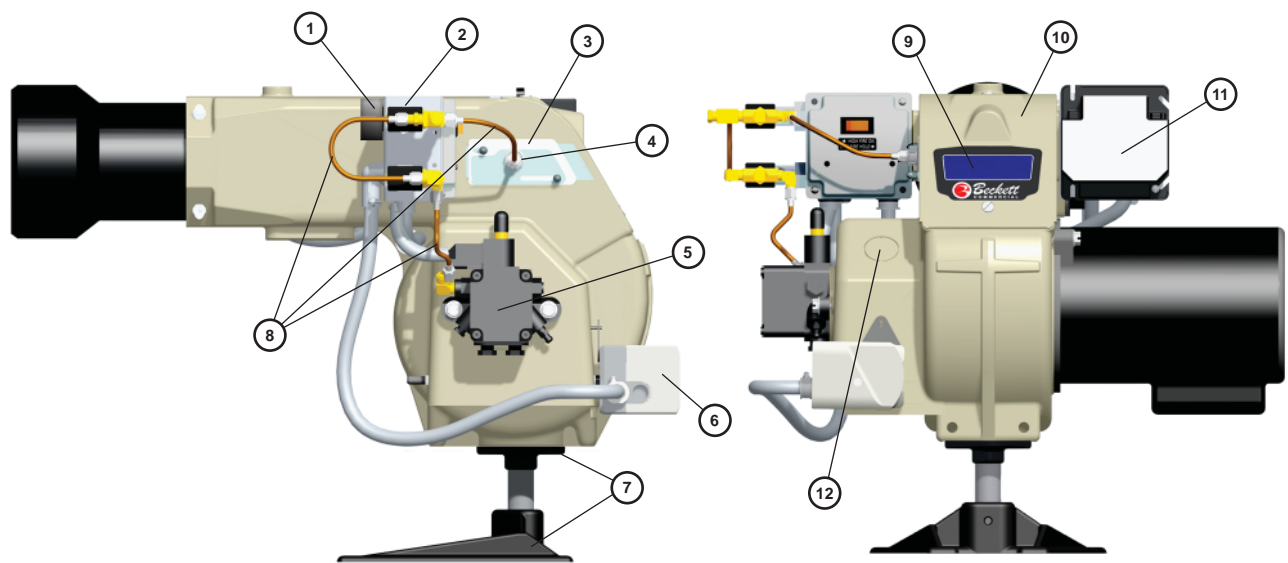
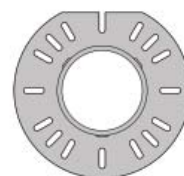
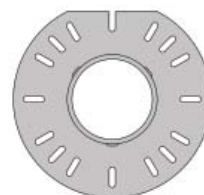


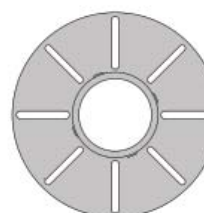
Figure 15 – Adjustable mounting plates



Flange A



Flange B



Flange C

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

Limited Warranty Information

Limited WARRANTY

For Residential, Commercial and Specialty Burners

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

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

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

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

Equipment, which is defective in material or workmanship and within the warranty period, may be returned for credit as follows:

Beckett Burners, Beckett-branded major components and non-Beckett-branded major components that came as original equipment on a Beckett burner or were sold as a replacement part by Beckett should be returned, freight prepaid, to Beckett's home office. Credit will be issued to the customer unless the returned equipment is determined by Beckett to be out of warranty or damaged by user, in which case the equipment will be scrapped.

Note: Beckett is not responsible for any labor cost for removal and replacement of equipment.

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

R.W. BECKETT CORPORATION

P.O. Box 1289 Elyria, Ohio 44036

Form No. 61545 R72905

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

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

R.W. BECKETT CORPORATION

U.S.A.: P.O. Box 1289 · Elyria, Ohio 44036

www.beckettcorp.com

Canada: R.W. Beckett Canada, Ltd. · Unit #3, 430 Laird Road · Guelph, Ontario N1G 3X7

Printed in U.S.A.

© R.W. Beckett Corporation

INSTALLATION INFORMATION



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

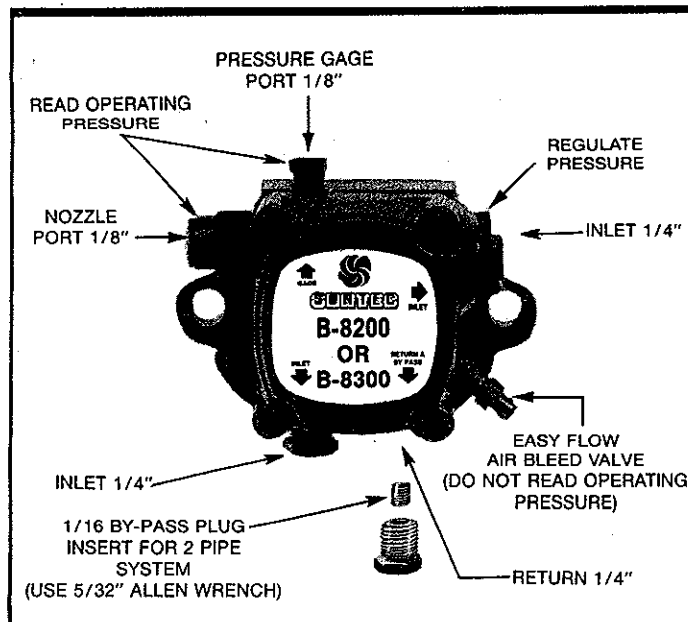


FIGURE 1

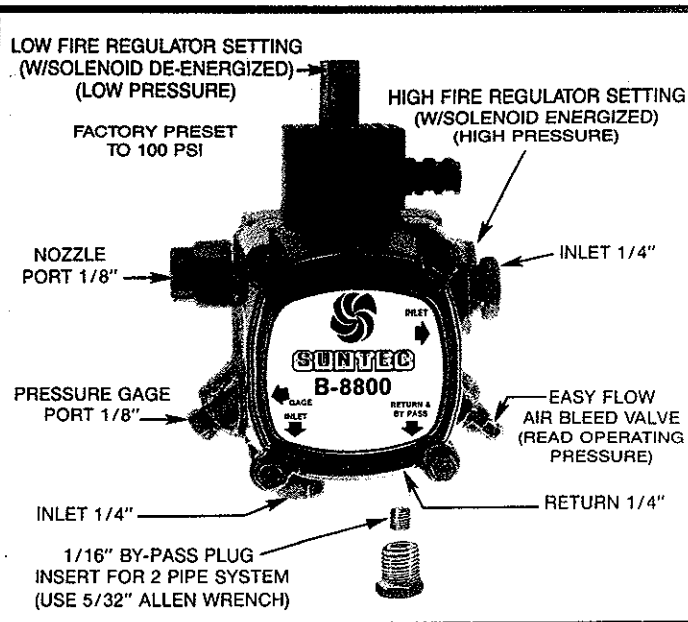


FIGURE 2

ONE-PIPE SYSTEM • FIGURE 3

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

TWO-PIPE SYSTEM • FIGURE 4

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

TWO STEP PUMPS • FIGURE 2

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

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

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

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

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

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

GENERAL INFORMATION • ALL SYSTEMS

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

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

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

CAUTION

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

ONE-PIPE SYSTEM • MODEL A

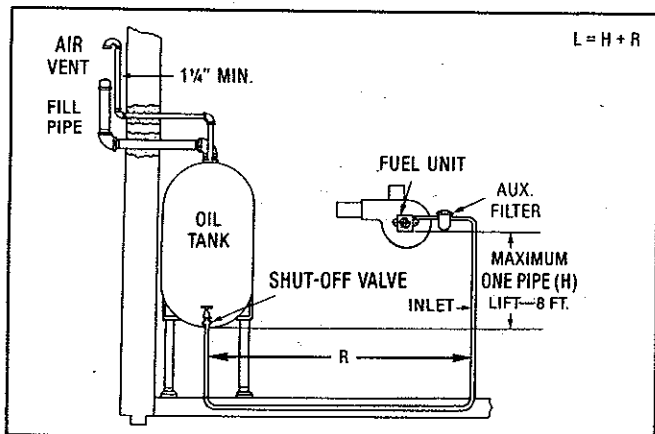


FIGURE 3

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

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

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

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

$$\frac{3}{8}" \text{ line } L = 6 - .75H$$

$$\frac{1}{2}" \text{ line } L = 6 - .75H$$

$$.0086 Q$$

$$.00218 Q$$

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

TWO-PIPE SYSTEM • MODEL A AND B

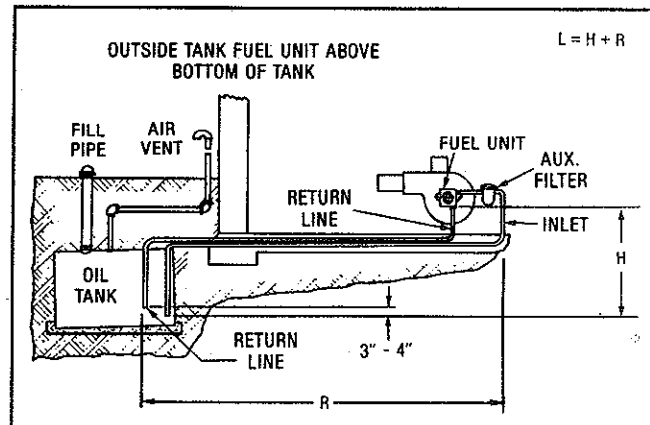


FIGURE 4

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

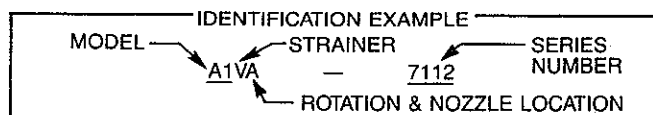
MODEL A SINGLE-STAGE TWO-STEP • TWO-PIPE MAXIMUM LINE LENGTH (H + R)

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

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

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

PUMP USAGE IDENTIFICATION



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

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

ALL INSTALLATIONS SHOULD BE MADE WITH LOCAL AND NATIONAL CODES.

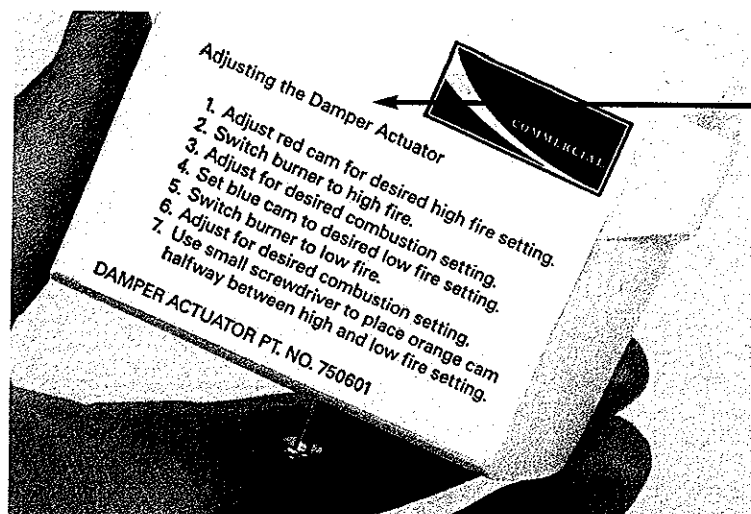


GLASGOW, KY 42142-5000

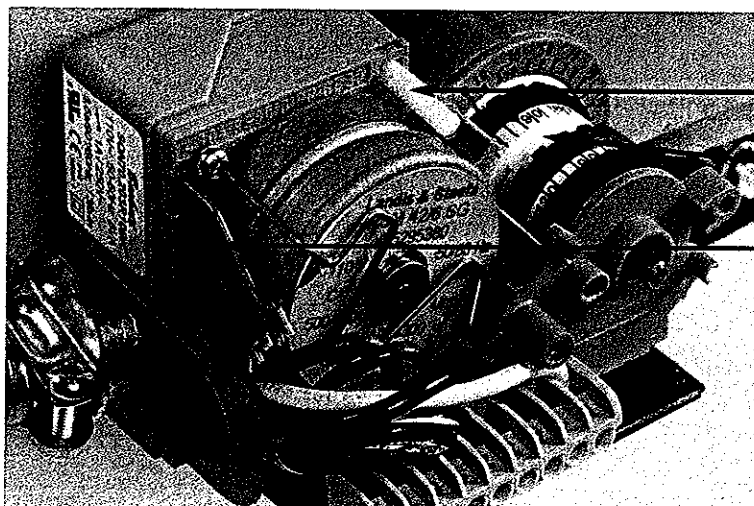
... working harder to serve you even better.

Beckett

Damper Actuator For Commercial Two-Stage Burners Adjustment Instructions



Adjustment Instructions
Printed on Cover



Disengaging Pin in the
Engaged (out) Position

Cam Stack

Adjustment Wrench

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

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



Damper Position Indicator
(Notch in White Ring)

Damper Position Scale

Red High Fire Cam with
White Adjustment Scale

Blue Low Fire Cam with
White Adjustment Scale

Transition Cam shares
Adjustment Scale

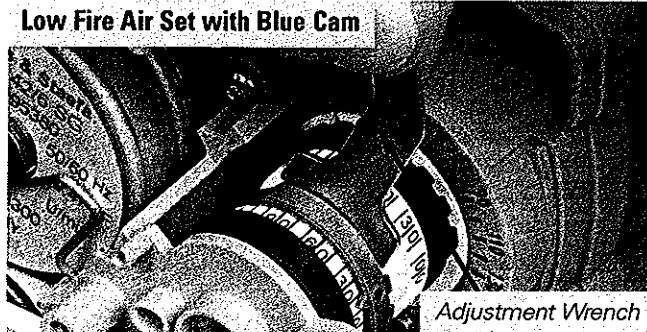
Damper Actuator

For Commercial Two-Stage Burners

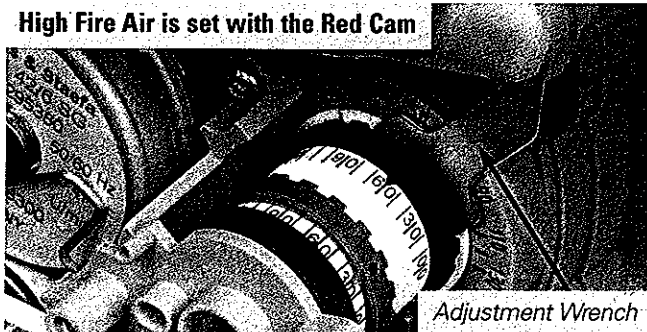
Adjustment Instructions

Setting the High Fire Air and Low Fire Air

Low Fire Air Set with Blue Cam



High Fire Air is set with the Red Cam

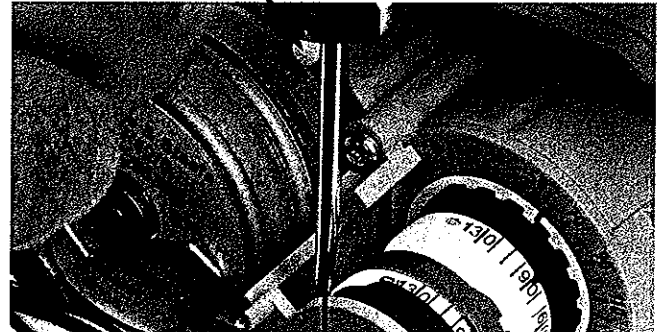


An old air setting specification of 7 is equal to 70° on the damper position scale of this new damper actuator.

If adjusting the air settings while the burner is operating, it is necessary to cycle the burner from High to Low Fire or Low to High by using the lighted low fire hold switch.

Setting the Transition

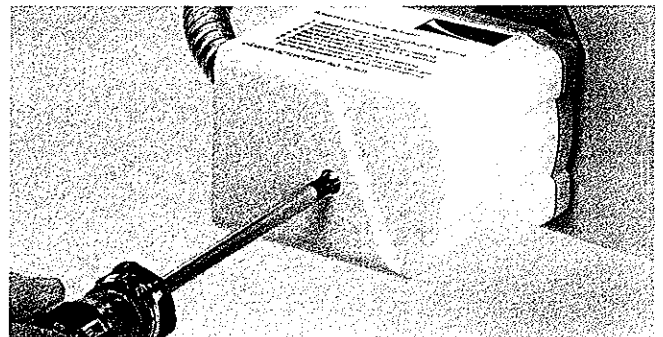
Cam is disengaged



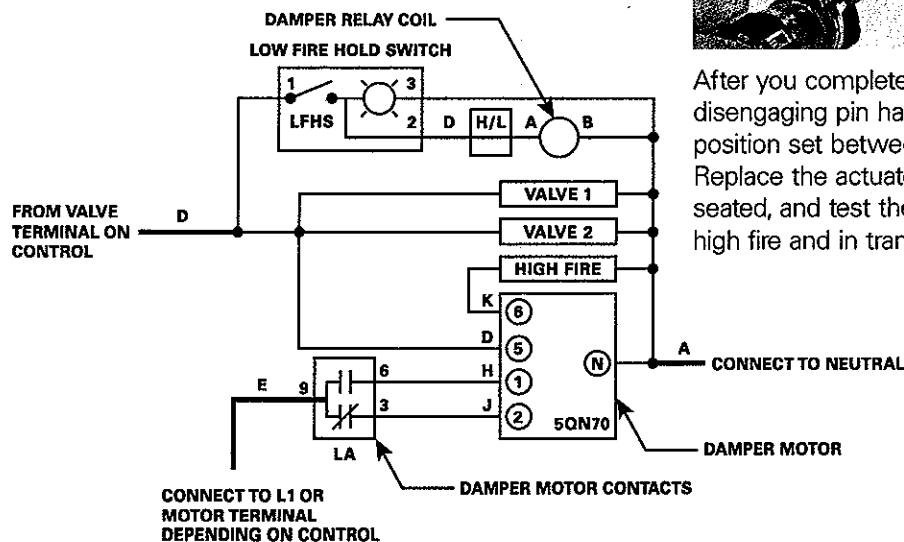
Transition Cam is set with Screwdriver

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

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



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



For more information, contact:

www.beckettcorp.com

R.W. Beckett Corporation • P.O. Box 1289 • Elyria, Ohio 44036 • (800) 645-2876 • (440) 327-1060 • FAX (440) 327-1064

R.W. Beckett Canada Ltd. • Unit 3 - 430 Laird Road • Guelph, Ontario, Canada N1G 3X7 • (800) 665-6972 • FAX (519) 763-5656

© 2004 R.W. Beckett Corporation

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

KEY

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

LEGEND

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

WIRE COLOR

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

MOTOR WIRE - 14GA.
ALL OTHER WIRE - 16 GA.
UNSPECIFIED WIRE COLORS
BASED ON COMPONENTS

LIGHT COLOR

- R = RED
- G = GREEN
- A = AMBER

NOTES

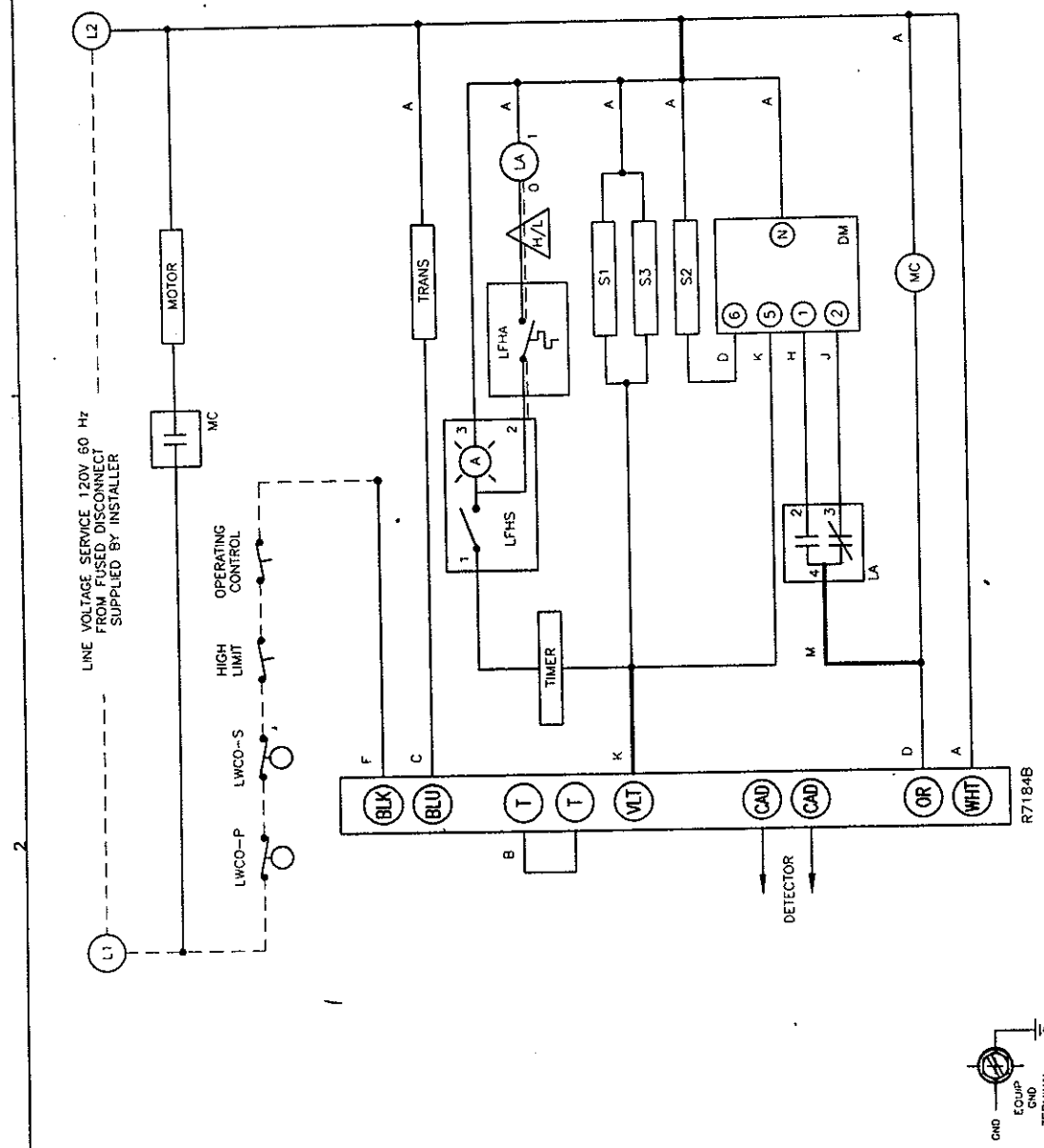
- LOCATE HIGH/LOW OPERATOR BETWEEN DAMPER MOTOR AND LFHS.

Beckett
COMMERCIAL

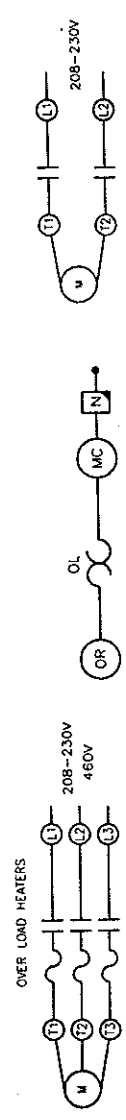
CF1400 / CF2300
LOW/HIGH/OFF
R7184B CONTROL

DATE	REV	BY	CHKD	DATE
12/07/06	1			

6998004



OPTIONAL MOTORS





OPERATING INSTRUCTIONS & PARTS MANUAL

HIGH PRESSURE DIRECT-DRIVE BLOWERS

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

FORM 5S2052

06820
0390/073/5M

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

Description

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

General Safety Information

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

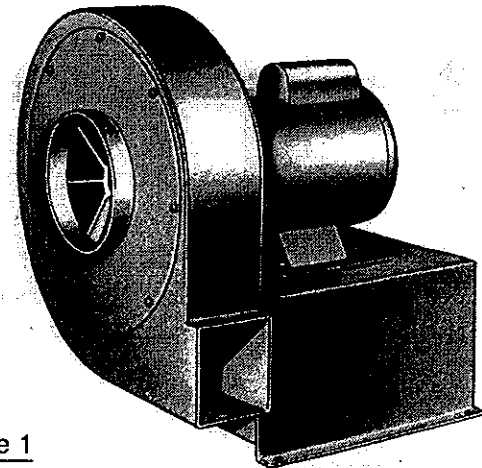


Figure 1

▲ WARNING ▲

KEEP HANDS AWAY FROM INLET WHILE BLOWER IS IN OPERATION.

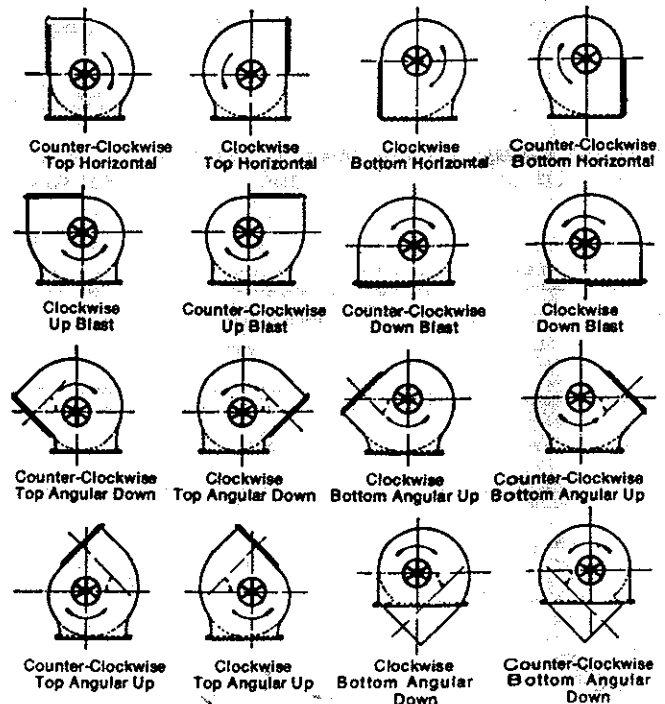


Figure 2

Specifications

MODEL	WHEEL			HIGH-PRESSURE BLOWER DIMENSIONS																X ADJ. MIN.	X ADJ. MAX.
	DIA.	W	BORE	A	B	C	D	E	F	G	H	J	K	L	O	P	R	S	V		
2C940	7 $\frac{3}{4}$ "	2 $\frac{5}{16}$ "	$\frac{1}{2}$ "	11"	8"	3"	3"	5"	7"	$\frac{1}{2}$ "	5 $\frac{3}{8}$ "	4 $\frac{7}{8}$ "	5 $\frac{7}{8}$ "	5 $\frac{7}{8}$ "	12 $\frac{1}{4}$ "	4"	6 $\frac{5}{8}$ "	5 $\frac{1}{2}$ "	—	8 $\frac{1}{4}$ "	9 $\frac{3}{4}$ "
2C820	9	2 $\frac{13}{16}$	$\frac{1}{2}$	12 $\frac{1}{8}$	8	3 $\frac{1}{2}$	3 $\frac{1}{2}$	5 $\frac{5}{8}$	7	$\frac{1}{2}$	6 $\frac{3}{8}$	5 $\frac{3}{4}$	6 $\frac{7}{8}$	6 $\frac{3}{4}$	12 $\frac{3}{4}$	5	7 $\frac{1}{2}$	6 $\frac{3}{8}$	—	9 $\frac{1}{8}$	10 $\frac{5}{8}$
4C108	10 $\frac{9}{16}$	3	$\frac{5}{8}$	14 $\frac{3}{4}$	9	4	3 $\frac{1}{2}$	6 $\frac{7}{8}$	7 $\frac{1}{2}$	$\frac{3}{4}$	7 $\frac{1}{4}$	6 $\frac{1}{2}$	8	7 $\frac{5}{8}$	14	6	8 $\frac{5}{8}$	8 $\frac{1}{4}$	—	11 $\frac{5}{8}$	12 $\frac{7}{8}$
4C329	12 $\frac{1}{2}$	3	$\frac{7}{8}$	17	11 $\frac{1}{4}$	5	4	8	9 $\frac{3}{4}$	$\frac{3}{4}$	8 $\frac{1}{4}$	7 $\frac{1}{2}$	9	9 $\frac{5}{8}$	17	7	10	7 $\frac{1}{8}$	—	10 $\frac{5}{8}$	10 $\frac{5}{8}$
4C330	13 $\frac{1}{2}$	4 $\frac{3}{8}$	1 $\frac{1}{8}$	17 $\frac{1}{2}$	11 $\frac{1}{4}$	7 $\frac{1}{8}$	5 $\frac{1}{4}$	8	9 $\frac{1}{2}$	1	10 $\frac{1}{2}$	9 $\frac{5}{8}$	11 $\frac{3}{8}$	11	18 $\frac{1}{8}$	8	11 $\frac{1}{2}$	8 $\frac{1}{8}$	7 $\frac{1}{4}$	12 $\frac{5}{8}$	12 $\frac{5}{8}$

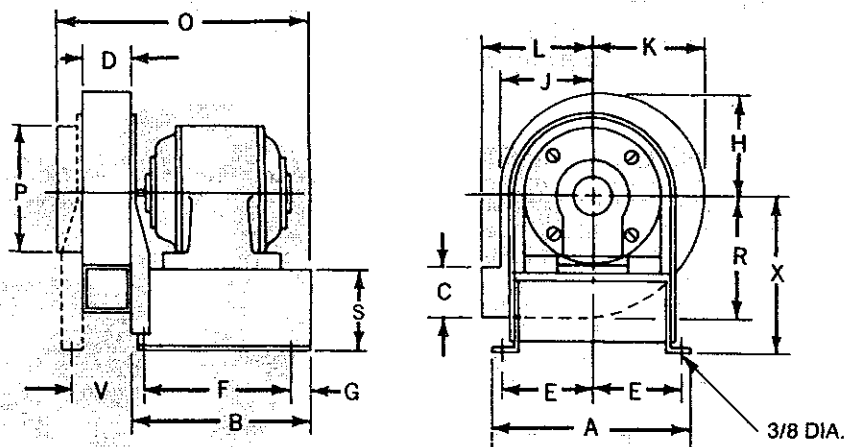


Figure 3

Performance

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

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

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

▲ CAUTION

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

LIMITED WARRANTY

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

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

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

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

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

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

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

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

Assembly

1. Attach base upright to the motor mounting base as shown in the exploded view. Hand tighten (4) 1/4-20 x 1/2" bolts, washers, and nuts through slotted holes in base upright. Place motor on motor base and align the center hole of the base upright with the motor shaft. Secure the four 1/4-20 bolts. Models 4C329 and 4C330 have a welded motor base assembly.
2. Bolt the housing to the base upright in the desired discharge position using #10 x 3/8 or 5/16-18 x 3/4" self tapping bolts. Blower is clockwise rotation. Refer to exploded view showing clockwise bottom horizontal discharge.
3. With the motor shaft through the center hole of the base upright, align the mounting holes of the motor to the pre-drilled holes in the motor base. Install two bolts to retain proper motor alignment but do not tighten. Mount the wheel to the motor shaft. Refer to exploded view drawing.
4. Mount the inlet ring to the housing and secure with #10 x 3/8" or 5/16-18 x 3/4" self tapping bolts.
5. Slide the wheel toward the inlet ring so there is at least 1/4" clearance between the wheel and cone. The motor shaft should extend through the hub of the wheel so when the setscrews are securely tightened, they will make contact with the motor shafts.
6. Install the remaining nuts, bolts, and washers (not provided) to the motor mounting holes of the motor and secure to the blower motor base.

Installation

1. Make sure all bolts and screws are tightened before mounting on a rigid, flat, level foundation. Bolt the blower securely into position.
2. Check the interior of the fan housing to be sure it is free of debris. Rotate the wheel to insure that it is not rubbing or binding. Check the clearance of the

wheel and the inlet ring. If rubbing exists, loosen the bolts on the ring and shift the ring until clearance is obtained. If still rubbing, loosen the set screw on the wheel and shift the wheel rearward to obtain clearance. Retighten the set screw.

Operation

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

⚠ CAUTION

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

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

Maintenance**⚠ CAUTION**

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

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

Troubleshooting Chart

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

**ORDER REPLACEMENT PARTS
BY CALLING TOLL FREE**

1-800-323-0620

Please provide the following information:

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

Address parts correspondence to:

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

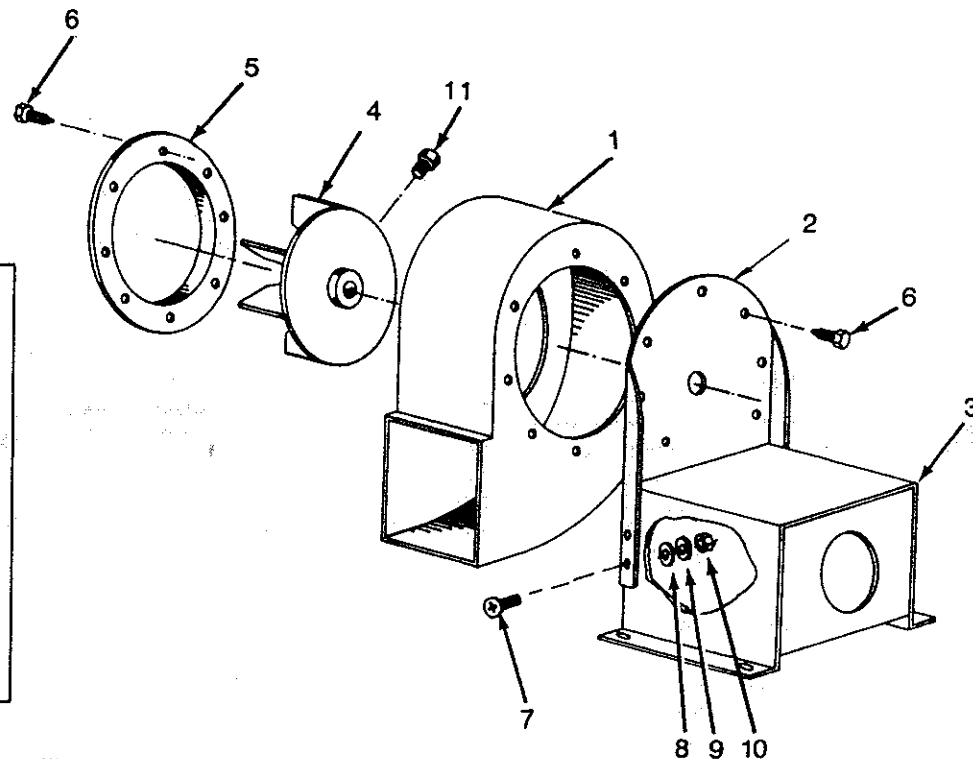


Figure 4 — Replacement Parts Illustration

Replacement Parts List

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

NOTE — Models 4C329 and 4C330 have welded 1 piece motor base & upright assembly.

(†) Model 4C330 has inlet upright supports (not shown) to support housing. Order by P/N 617-13-7002-5.

(*) Standard hardware item, available locally.

(†) Available with wheel.

Inspection Checklist for Supervisors

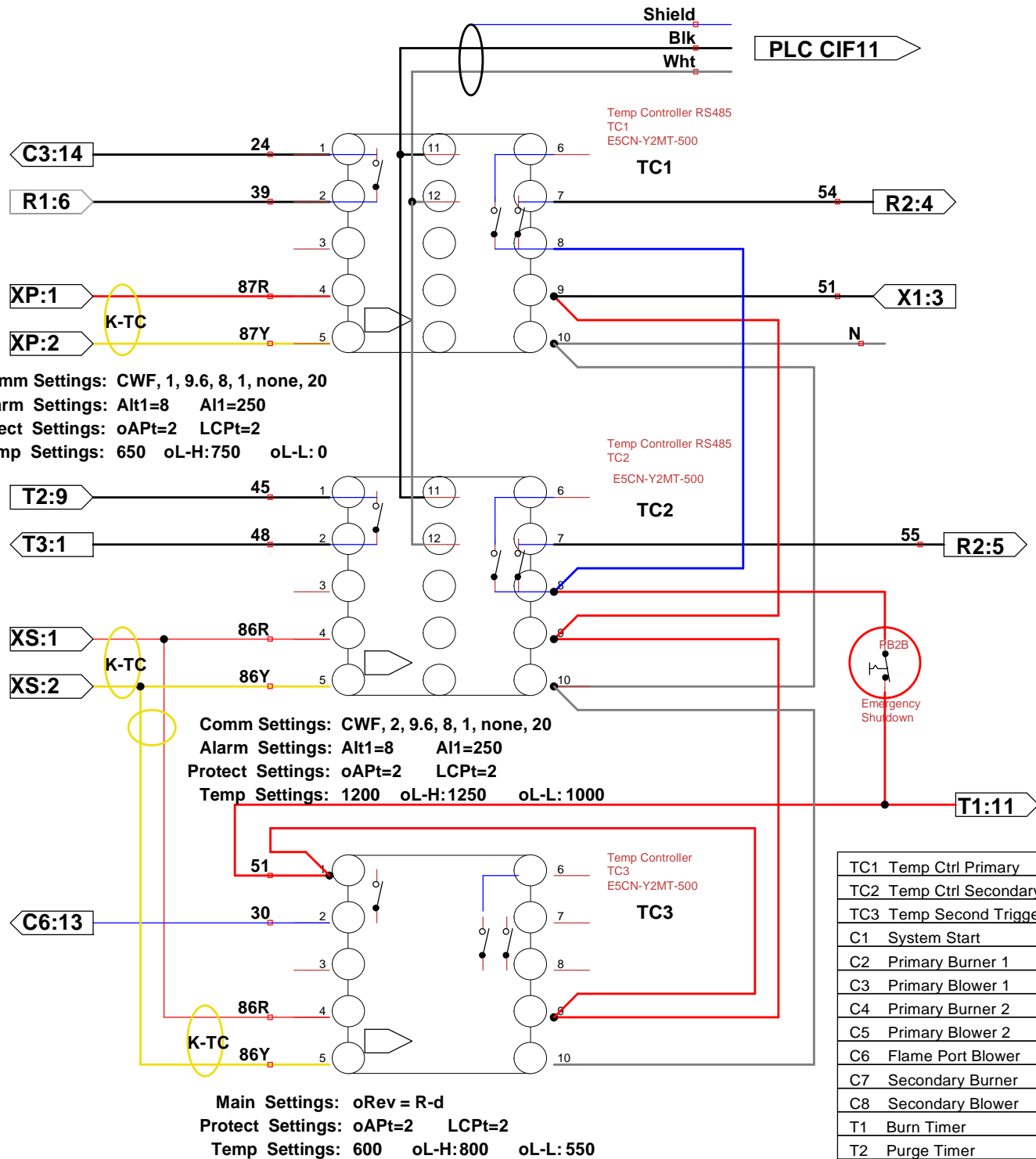
Facility:			Date:	
	Activity	Yes	No	Remarks
A.	Safety			
1.	Is there adequate personal protective equipment (PPE)?			
2.	Is the PPE being used?			
3.	Is the PPE in good condition?			
4.	Is there restricted entry to the waste incineration/ash disposal site?			
5.	Is there functional fire safety equipment?			
6.	Do the operators know how to use the equipment?			
7.	Is there adequate first aid kit?			
8.	Are the operators conversant with use of the kit?			
9.	Is flammable material stored away from the incinerator?			
10.	Are warning signs distinctly displayed?			
Additional Comments on Safety:				

Inspection Checklist for Supervisors

B.	Operation	Yes	No	Remarks
1.	Is there a sufficient supply of fuel?			
2.	Is the procedure for preparation of waste for incineration being followed?			
3..	Is the incinerator cleaned daily?			
4.	Is the waste weighed upon reception?			
5.	Is the waste temporarily stored neatly?			
6.	Is the loading of incinerator done in the right way?			
7.	Is the temperature regulated adequately during the burn?			
8.	IS the incinerator allowed to burn down and cool before cleaned?			
9.	Is the ash properly disposed as specified by compliance procedures?			
10.	Are the following tools and equipment available?			
a.	Ash Rake			
b.	Shovel			
c.	Hand brush/Dustpan			
d.	Hard broom			
e.	Non-Combustible Ash Disposal Drums			
f.	Weighing Scale			
g.	Fire Extinguisher			
h.	Fire Retardant Gloves			
i.	Eye Protection/ Face Mask			
j.	Fire Retardant Coveralls or suitable clothing to cover the upper body, including the lower arms			
k.	Safety First Aid Kit			
Additional Comments on Operation:				

Inspection Checklist for Supervisors

C.	Maintenance			
	Activity	Yes	No	Remarks
1.	Is there evidence of cracks in the refractor? (Do not include heat expansion cracks)			
2.	Is there good housekeeping?			
3.	Is the status of the ash handling and disposal system good?			
Additional Comments on Maintenance:				
D.	Records			
	Activity	Yes	No	Remarks
1.	Are the relevant forms available?			
2.	Are the forms filled accurately and completely?			
3.	Are incidents recorded?			
4.	Are reports of the waste incinerated done on time?			
Additional Comments on Records:				
Name of Supervisor:		Signature:		Designation:

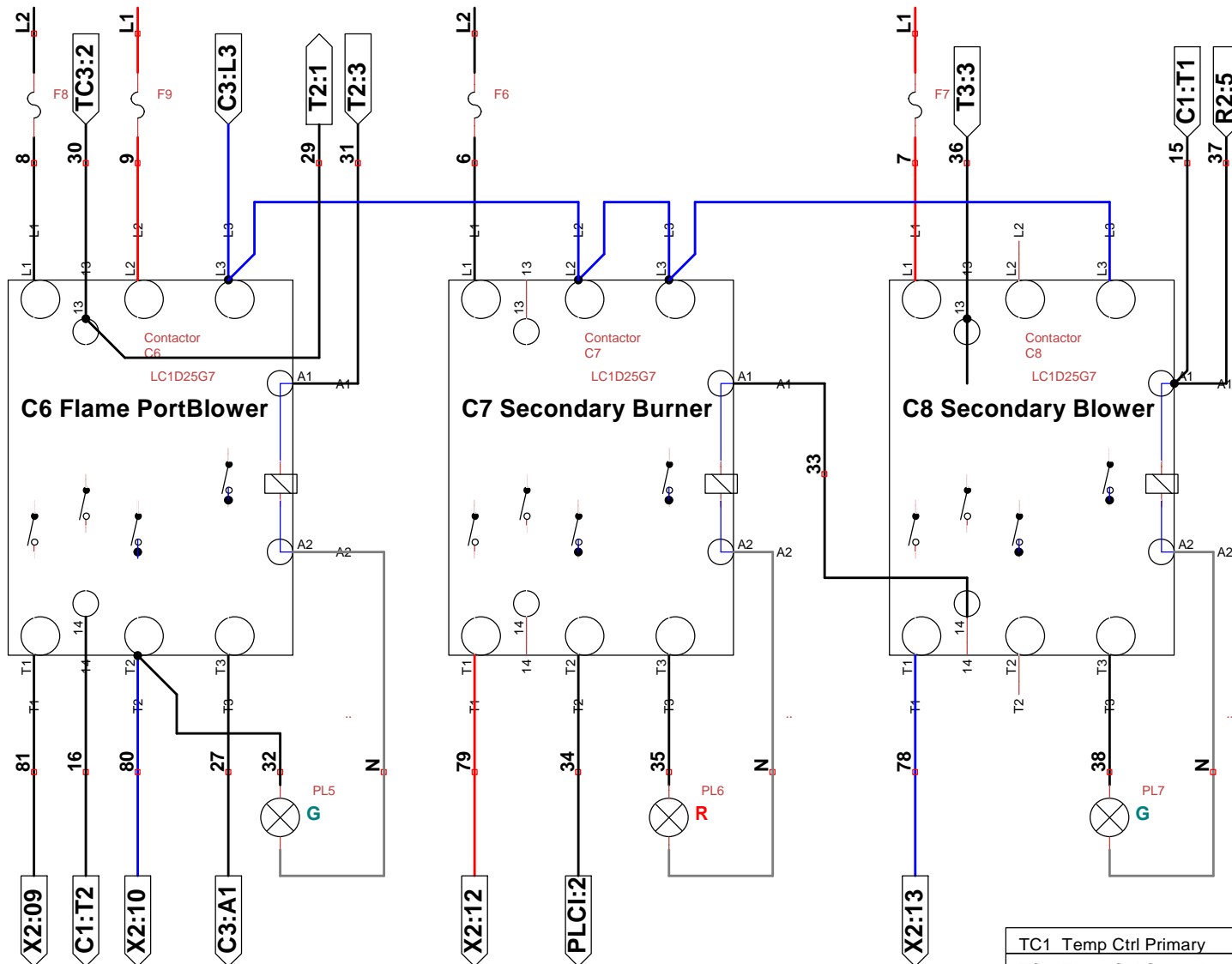


© 2017 Ketek Group Inc.

Design, Drawings are Proprietary Property
 Provided to Incinerator Owner for In-House
 Operational and Maintenance Purposes Only
 Any circulation outside Incinerator Owner's
 Facility is strictly prohibited.
 All Rights Reserved

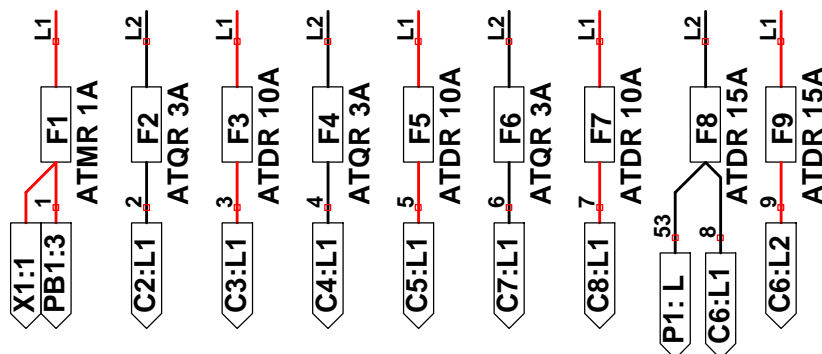
Title		
TC1 TC2 TC3 Temperature Controllers		
Author		
kurt klingbeil		
Electrical Engineer		
File		Document
els\PanelKM10xxDoubleSchematic20170613.dsn		
Revision	Date	Sheets
1.37	2017-01-05	1 of 7





TC1	Temp Ctrl Primary
TC2	Temp Ctrl Secondary
TC3	Temp Second Trigger
C1	System Start
C2	Primary Burner 1
C3	Primary Blower 1
C4	Primary Burner 2
C5	Primary Blower 2
C6	Flame Port Blower
C7	Secondary Burner
C8	Secondary Blower
T1	Burn Timer
T2	Purge Timer
T3	Burn Down Timer
T4	Cool DownTimer
R1	Door Relay
R2	Purge Relay
R3	Timer Reset Relay
P1	Instrument Plug
PB1	System Start Push Btn
PB2	E-Shutdown Push Btn
X1	Terminal Block 1
X2	Terminal Block 2

FUSES - SUMMARY



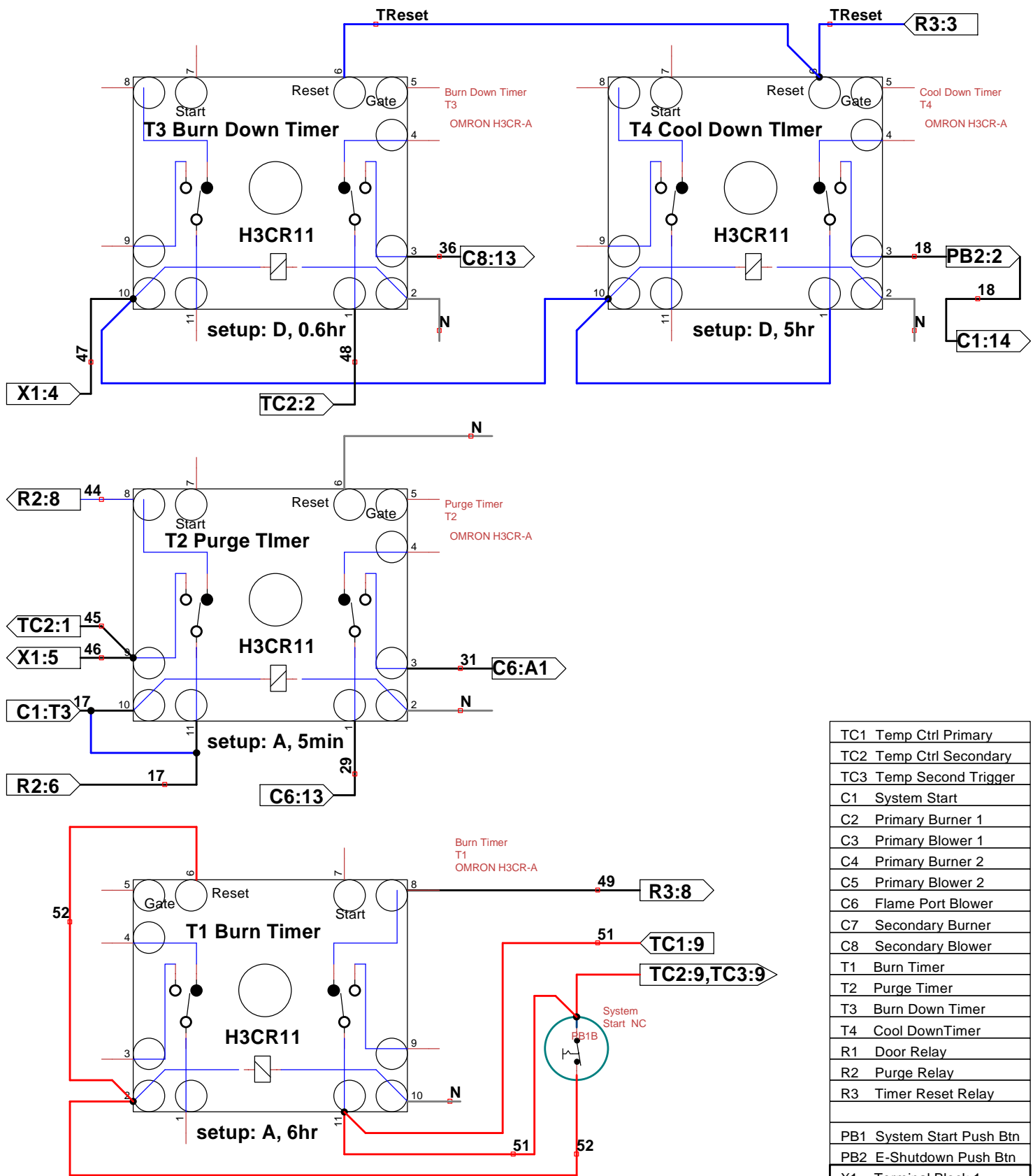
Fuse sizes could change based on model of Burners/Blowers

© 2017 Ketek Group Inc.

Design, Drawings are Proprietary Property
 Provided to Incinerator Owner for In-House
 Operational and Maintenance Purposes Only
 Any circulation outside Incinerator Owner's
 Facility is strictly prohibited.
 All Rights Reserved

Title		
C6 C7 C8 Secondary Burner & Blower Contactors		
Author		
kurt klingbeil		
Electrical Engineer		
File		Document
els\PanelKM10xxDoubleSchematic20170613.dsn		
Revision	Date	Sheets
1.36	2017-01-05	3 of 7





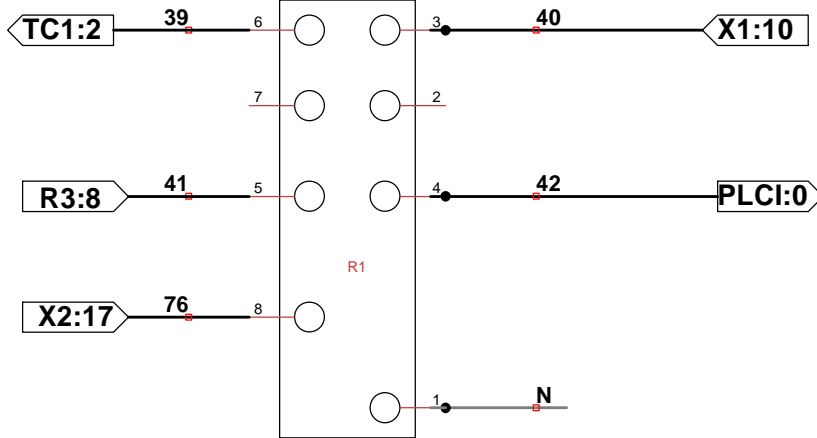
© 2017 Ketek Group Inc.

Design, Drawings are Proprietary Property
 Provided to Incinerator Owner for In-House
 Operational and Maintenance Purposes Only
 Any circulation outside Incinerator Owner's
 Facility is strictly prohibited.
 All Rights Reserved

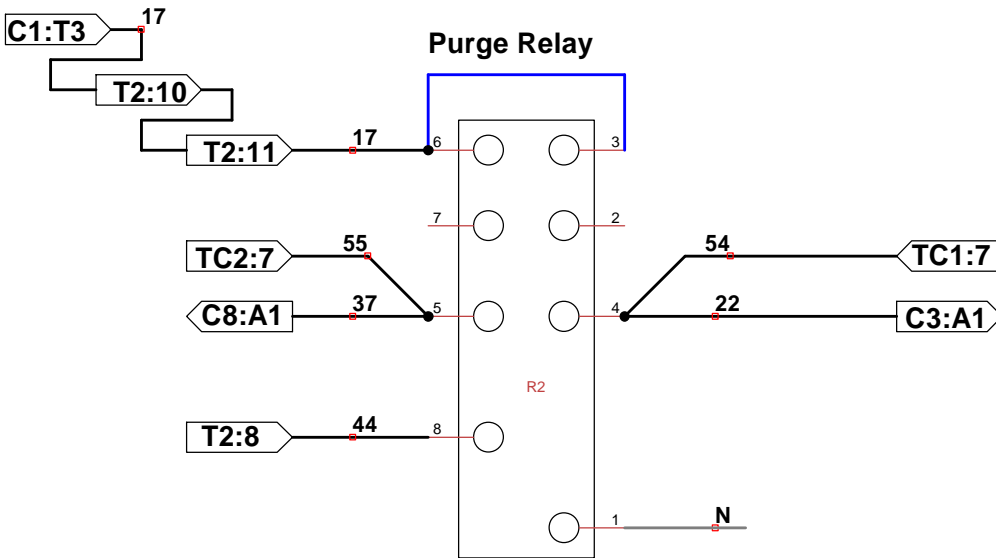
Title		
Timers: T1-Burn, T2-Purge, T3-BurnDown, T4 -CoolDown		
Author		
kurt klingbeil		
Electrical Engineer		
File		Document
els\PanelKM10xxDoubleSchematic20170613.dsn		
Revision	Date	Sheets
1.36	2017-01-05	4 of 7



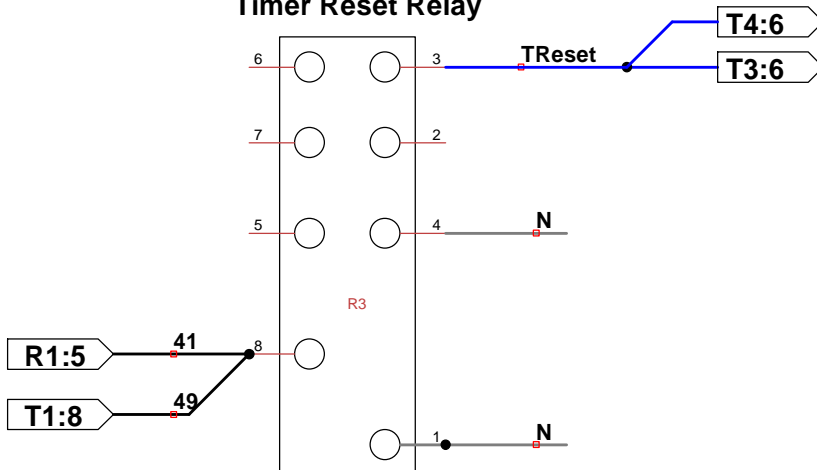
Door Relay



Purge Relay



Timer Reset Relay



TC1	Temp Ctrl Primary
TC2	Temp Ctrl Secondary
TC3	Temp Second Trigger
C1	System Start
C2	Primary Burner 1
C3	Primary Blower 1
C4	Primary Burner 2
C5	Primary Blower 2
C6	Flame Port Blower
C7	Secondary Burner
C8	Secondary Blower
T1	Burn Timer
T2	Purge Timer
T3	Burn Down Timer
T4	Cool DownTimer
R1	Door Relay
R2	Purge Relay
R3	Timer Reset Relay
PB1	System Start Push Btn
PB2	E-Shutdown Push Btn
X1	Terminal Block 1
X2	Terminal Block 2

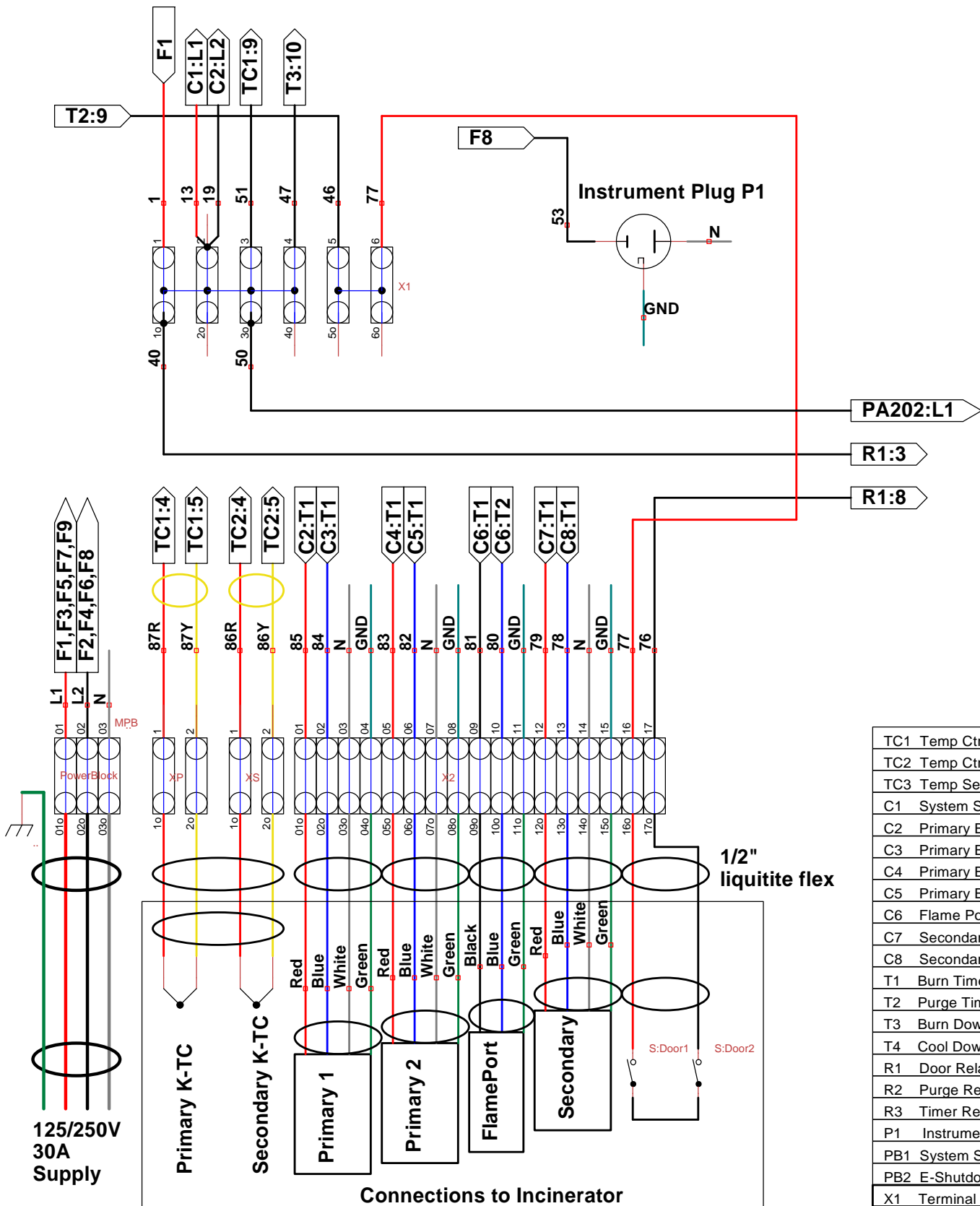
© 2017 Ketek Group Inc.

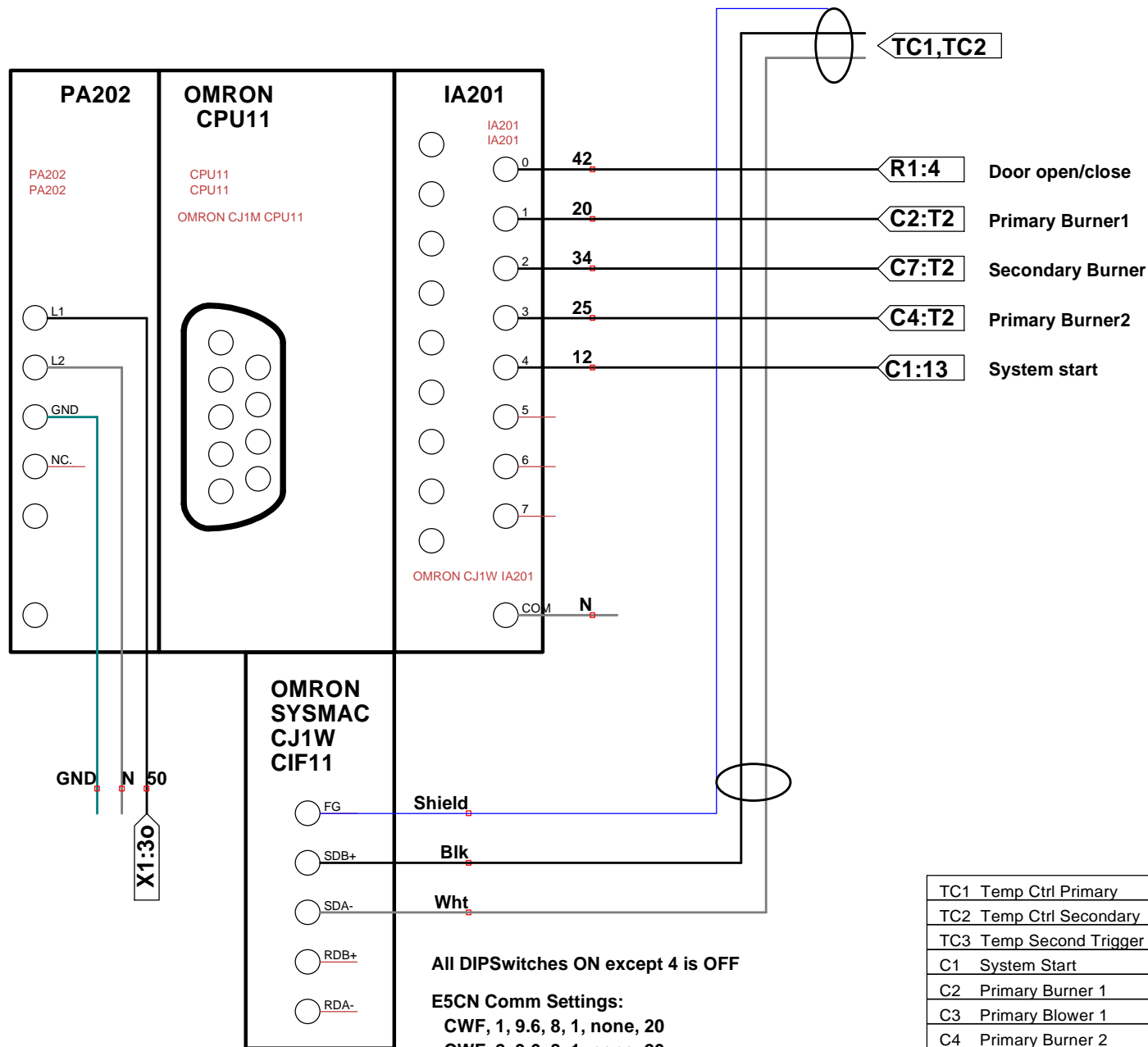
Design, Drawings are Proprietary Property
 Provided to Incinerator Owner for In-House
 Operational and Maintenance Purposes Only
 Any circulation outside Incinerator Owner's
 Facility is strictly prohibited.
 All Rights Reserved

Title		
Relays: R1-Door Switch, R2 Timer Reset, R3 Purge1, R4 Purge 2		
Author		
kurt klingbeil		
Electrical Engineer		
File		Document
els\PanelKM10xxDoubleSchematic20170613.dsn		
Revision	Date	Sheets
1.36	2017-01-05	5 of 7



KETEK
GROUP INC.





© 2017 Ketek Group Inc.

Design, Drawings are Proprietary Property
Provided to Incinerator Owner for In-House
Operational and Maintenance Purposes Only
Any circulation outside Incinerator Owner's
Facility is strictly prohibited.
All Rights Reserved

Title		
PLC and Data collection Hardware		
Author		
kurt klingbeil		
Electrical Engineer		
File		Document
els\PanelKM10xxDoubleSchematic20170613.dsn		
Revision	Date	Sheets
1.36	2017-01-05	7 of 7





CERTIFICATE OF REGISTRATION

This is to certify that

Ketek Group Inc.

Main Site

20204 110 Avenue NW, Edmonton, Alberta T5S 1X8 Canada

operates a

Quality Management System

which complies with the requirements of

ISO 9001:2008

for the following scope of certification

Design, manufacture, sales and service of air, water and solid waste treatment equipment and their components.

This registration is supported by the following site(s) at:

11004 205 Street NW Edmonton, Alberta T5S 1Z4 Canada

Certificate No.: CERT-0097513
File No.: 1647520
Issue Date: August 8, 2016

Original Certification Date: July 17, 2013
Certification Effective Date: August 25, 2016
Certificate Expiry Date: September 14, 2018

Paul Simpson
Global Head of Policy, Risk and Compliance



ISO 9001



Registered by:
QMI-SAI Canada Limited (SAI Global), 20 Carlson Court, Suite 200, Toronto, Ontario M9W 7K6 Canada. This registration is subject to the **SAI Global** Terms and Conditions for Certification. While all due care and skill was exercised in carrying out this assessment, **SAI Global** accepts responsibility only for proven negligence. This certificate remains the property of **SAI Global** and must be returned to them upon request.
To verify that this certificate is current, please refer to the **SAI Global** On-Line Certification Register: www.qmi-saiglobal.com/qmi_companies/



KETEK GROUP INC.

Warranty - New

1. Ketek Group Inc. hereby warrants to the Purchaser, for a one (1) year period of time from the date of acceptance and upon the conditions hereinafter set forth, each new product sold by it, to be free from defects in material and workmanship (specifically excluding there from component parts and accessories manufactured, furnished, and supplied by others) under normal use, maintenance and service. Except for the above Warranty, it is agreed and understood that no other WARRANTY or CONDITION whether express, implied, or statutory is made by Ketek Group Inc.
2. The obligation of Ketek Group 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 Ketek Group 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 Ketek Group 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 Ketek Group Inc. indemnified against any such claim. In no event shall Ketek Group 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 Ketek Group 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 Ketek Group Inc. under this Warranty shall cease and determine if:
 - (a) The Purchaser shall not have paid in full all invoices as submitted by Ketek Group Inc., or affiliated companies on or before their due dates:
 - (b) Representatives of Ketek Group Inc., are denied full and free right of access to the units:
 - (c) The Purchaser permits persons other than the agents of Ketek Group Inc. or those approved or authorized by Ketek Group Inc. to effect any replacement of parts, maintenance, adjustments, or repairs to the units:
 - (d) The Purchaser has not properly maintained the units in accordance with instructions, pamphlets or directions given or issued by Ketek Group 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 Ketek Group 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 Ketek Group 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 Ketek Group 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 Ketek Group Inc. regular billing rates on usual credit terms.
9. The liability of Ketek Group 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: _____

PURCHASED BY: _____

MODEL NUMBER: _____

SELLING BRANCH: _____

SERIAL NUMBER: _____

Appendix B. Ketek CY-50-CA Incinerator



**KETEK
MANUFACTURING**
MEMBER OF KETEK GROUP INC.

ketek.ca

OPERATING & MAINTENANCE

MANUAL



CY-50-CA

Phone: (780) 447-5052
Fax: (780) 447-4912
info@ketek.ca



1.	Introduction	3
2.	Principles of waste incineration	4
2.1.	Combustion	4
2.2.	Why incinerate waste?	4
2.3.	Waste components	5
2.4.	Heating Value	6
2.5.	Different Expressions for Heating Value	7
2.6.	Examples of waste characteristics	8
2.7.	Incinerator Capacity and Load Size	9
2.8.	Dual-Chamber Design and Starved-Air Operation	9
3.	System Description	11
3.1.	System components	15
4.	Operation and Maintenance	18
4.1.	Safety equipment	18
4.2.	Routine inspection and maintenance	18
4.3.	Ash removal	18
4.4.	Waste batch preparation	18
4.5.	Pre-operational checks	19
4.6.	Incineration (Batch Operation)	19
4.7.	Notes on Intermittent Feeding Operation	19
4.8.	Shut-down and Cool-down	19
4.9.	Burner and blower maintenance	19
4.10.	Diesel Requirement	20
5.	Warranty	21

LIST OF TABLES

Table 1	Organization of Manual	3
Table 2	Classification and Properties of Common Wastes	7
Table 3	High Heating Values (Approximate) of Common Waste Components	8
Table 4	Proximate Composition of Various Materials	9
Table 5	Components and Their Functions	15
Table 6	Control Panel (Figure 8)	16

LIST OF FIGURES

Figure 1	Schematic Diagram of Incineration Process	4
Figure 2	The Concept of Heating Value	5
Figure 3	Different Bases for Expressing Heating Value (HV)	6
Figure 4	Schematic a Diagram of Dual-Chamber, Starved-Air Incinerator	10
Figure 5	Overall View of System and Its Major Components	11
Figure 6	Primary Chamber	12
Figure 7	Secondary Chamber and Other Components	13
Figure 8	Control Panel	14
Figure 9	Schematic of Operational Steps	17
Figure 10	Requirement for Diesel	20



Thank you for selecting **KETEK MANUFACTURING** 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 think that a good understanding of the basic principles would make you knowledgeable, and hence a better operator.

Table 1 outlines the contents of this manual. We encourage you to read Chapter 2 although only Chapters 2 and 3 contain the most relevant information.

TABLE 1 ORGANIZATION OF MANUAL

Chapter Number	Title Brief Description
2	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.
3	System Description List and photographs of the components of the system and their functions.
4	Operation and Maintenance How to operate and maintain the system, including discussion on safety aspects
5	Warranty Terms of the warranty



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 temperature¹ 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.

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.

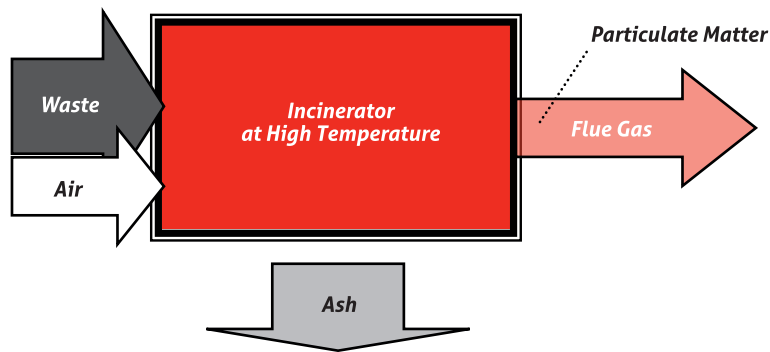


FIGURE 1 SCHEMATIC DIAGRAM OF INCINERATION PROCESS

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 and spreading of diseases 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:

- (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 entrained in the flue gas in the form of particulate matter or dust. The higher the ash 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.

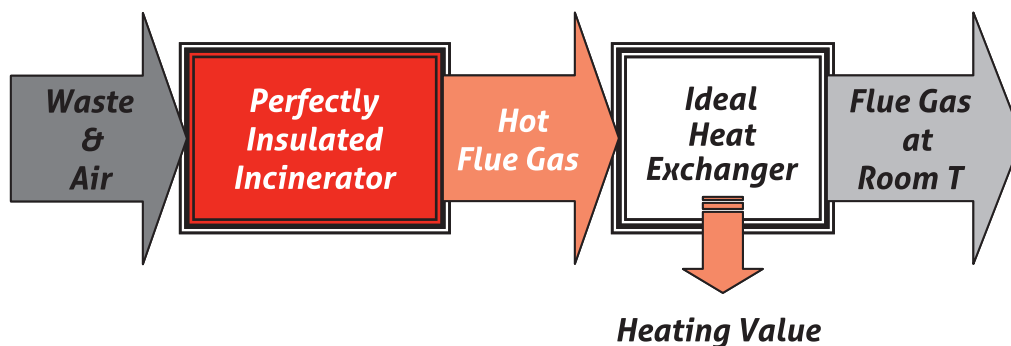


FIGURE 2 THE CONCEPT OF HEATING VALUE

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).

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.



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".

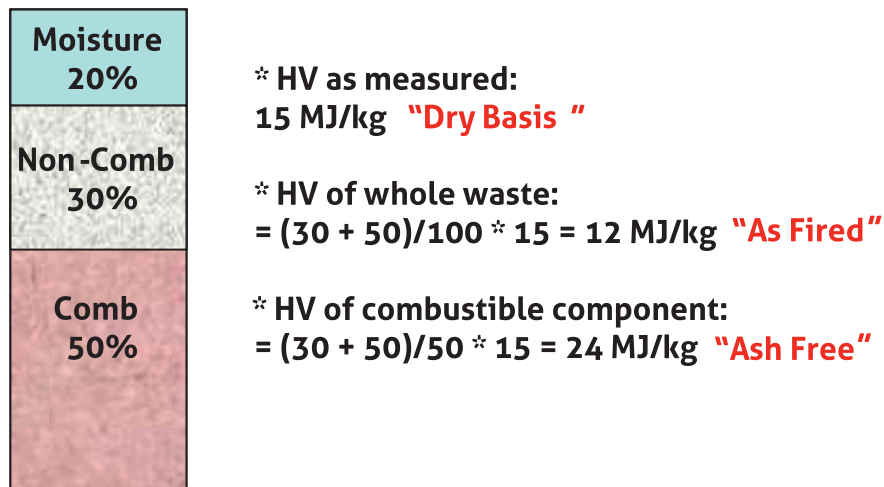


FIGURE 3 DIFFERENT BASES FOR EXPRESSING HEATING VALUE (HV)



2.6. Examples of waste characteristics

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

TABLE 2 CLASSIFICATION AND PROPERTIES OF COMMON WASTES

Type*	Description	Components	Weight %			MJ/kg HHV (A/F)
			Moist	Comb	Non-C	
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 wastes, restaurants, hotels, markets, institutional, commercial and club sources	70%	25%	5%	5.8
4	Animal/ Pathological	Carcasses, organs, hospital and laboratory abbatoit, 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 (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
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
RDF = Refuse Derived Fuel; **PDF** = Paper Derived Fuel;
TDF = Tire Derived Fuel; **PE** = Polyethylene; **PP** = Polypropylene;
PS = Polystyrene; **PVC** = Polyvinylchloride

2.8. Dual-Chamber Design and Starved-Air Operation

The mechanisms of solid waste combustion consist of the following stages:

- Evaporation of water or drying,
- Devolatilization, involving pyrolysis and gasification, generating "volatile" combustible gas and in some cases, soot ; ⁶
- Combustion of the devolatilization products in the gas phase, and
- Char oxidation, where the "fixed carbon" is oxidized, leaving the ash residue.

With a dual chamber design operated under a starved air condition, stages (a), (b) and (d) take place in the primary chamber, and (d) in the secondary chamber. The initial stages (a) and (b) occur under starved-air (sub-stoichiometric) condition, meaning that there is not sufficient air for complete combustion. Stage (c) occurs in the secondary chamber following the addition of flameport air, introduced into the flameport which connects the primary and secondary chambers. The final stage (d) occurs in the primary chamber.

The low flow rate in the primary chamber reduces the entrainment of particulate matter (dust) and hence its emission. The flameport can be designed to promote good mixing ("turbulence") between flameport air and the "volatiles" generated in the primary chamber, which promotes complete combustion.

⁶ Pyrolysis: thermal break-down in the absence of O₂; gasification: partial oxidation with sub-stoichiometric O₂; soot: fine carbonaceous particles.



A schematic diagram of the system is shown in [Figure 4](#).

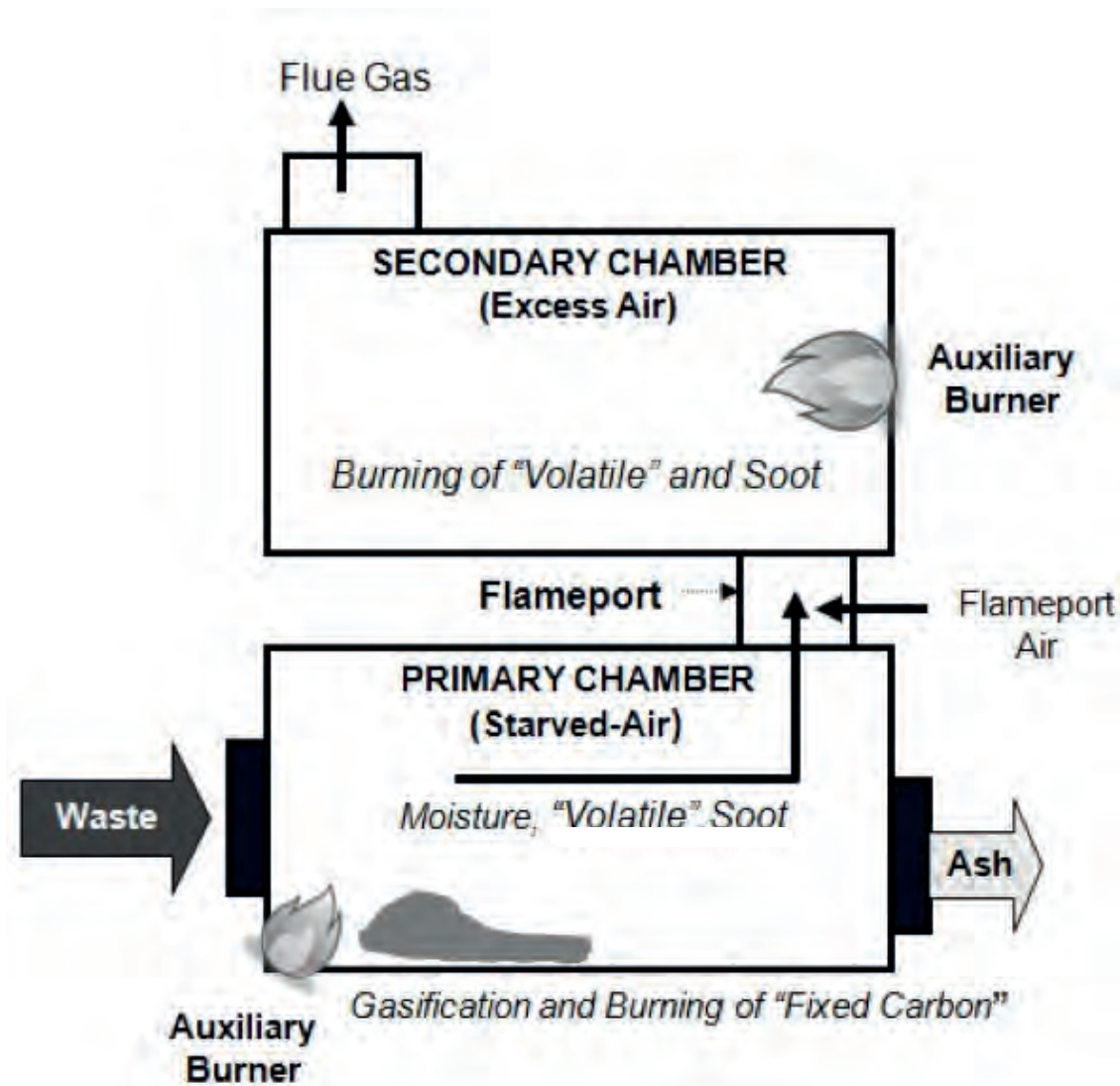


FIGURE 4. SCHEMATIC A DIAGRAM OF DUAL-CHAMBER, STARVED-AIR INCINERATOR



A photograph of the system is shown in Figure 5, identifying its major components:

- Primary Chamber
- Secondary Chamber
- Flameport
- Control Panel
- Stack

The components are shown in more detail in Figure 6 to Figure 8, and their functions are summarized in the next Section in Table 5.

Notes on design simplification. (i) No underfire air blower is used. The underfire air is supplied by the excess air in the auxiliary burner in the primary chamber. (ii) Ash removal is done via the waste loading door



FIGURE 5. OVERALL VIEW OF SYSTEM AND ITS MAJOR COMPONENTS

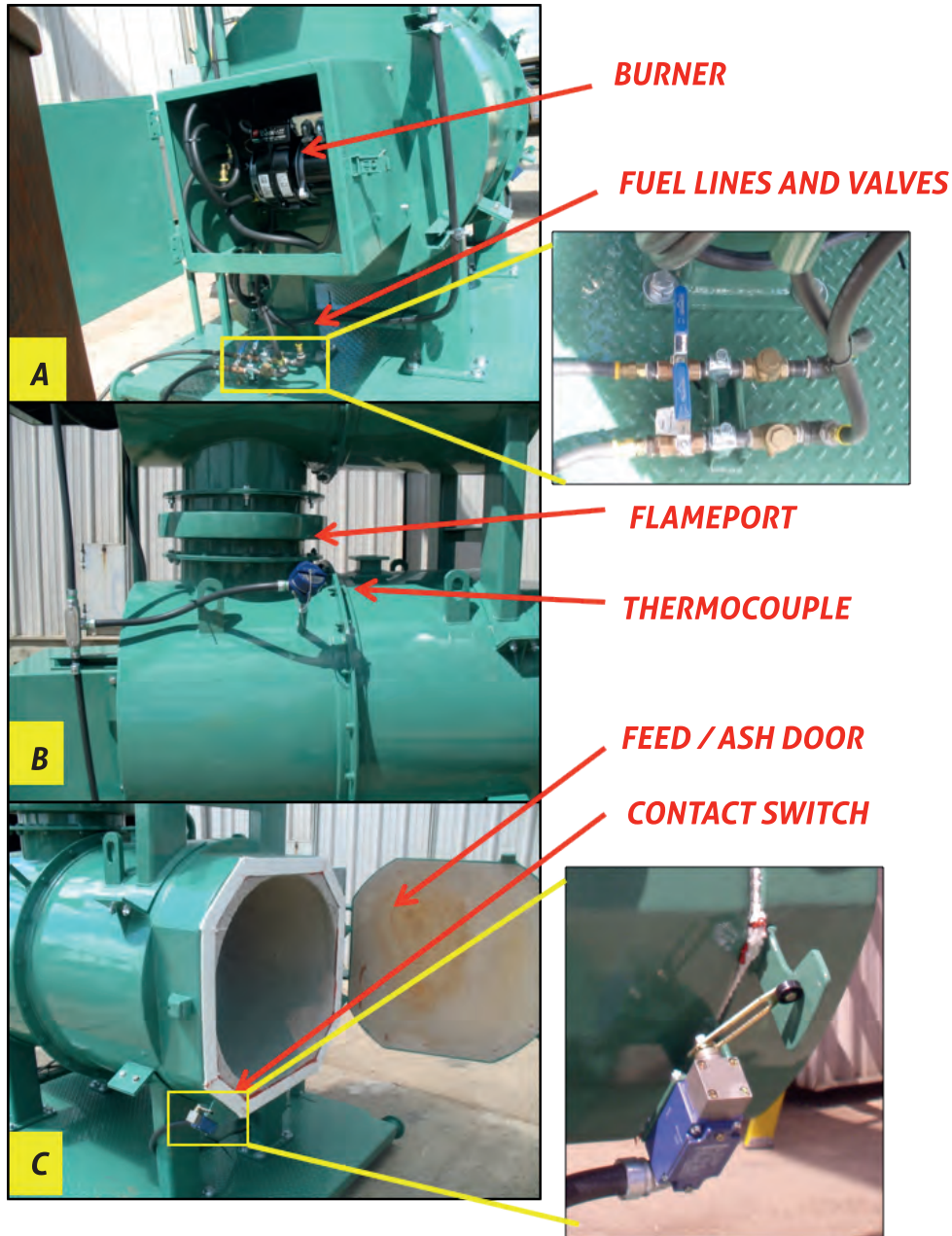


FIGURE 6. PRIMARY CHAMBER

CY-50-CA



**KETEK
MANUFACTURING**
MEMBER OF KETEK GROUP INC.

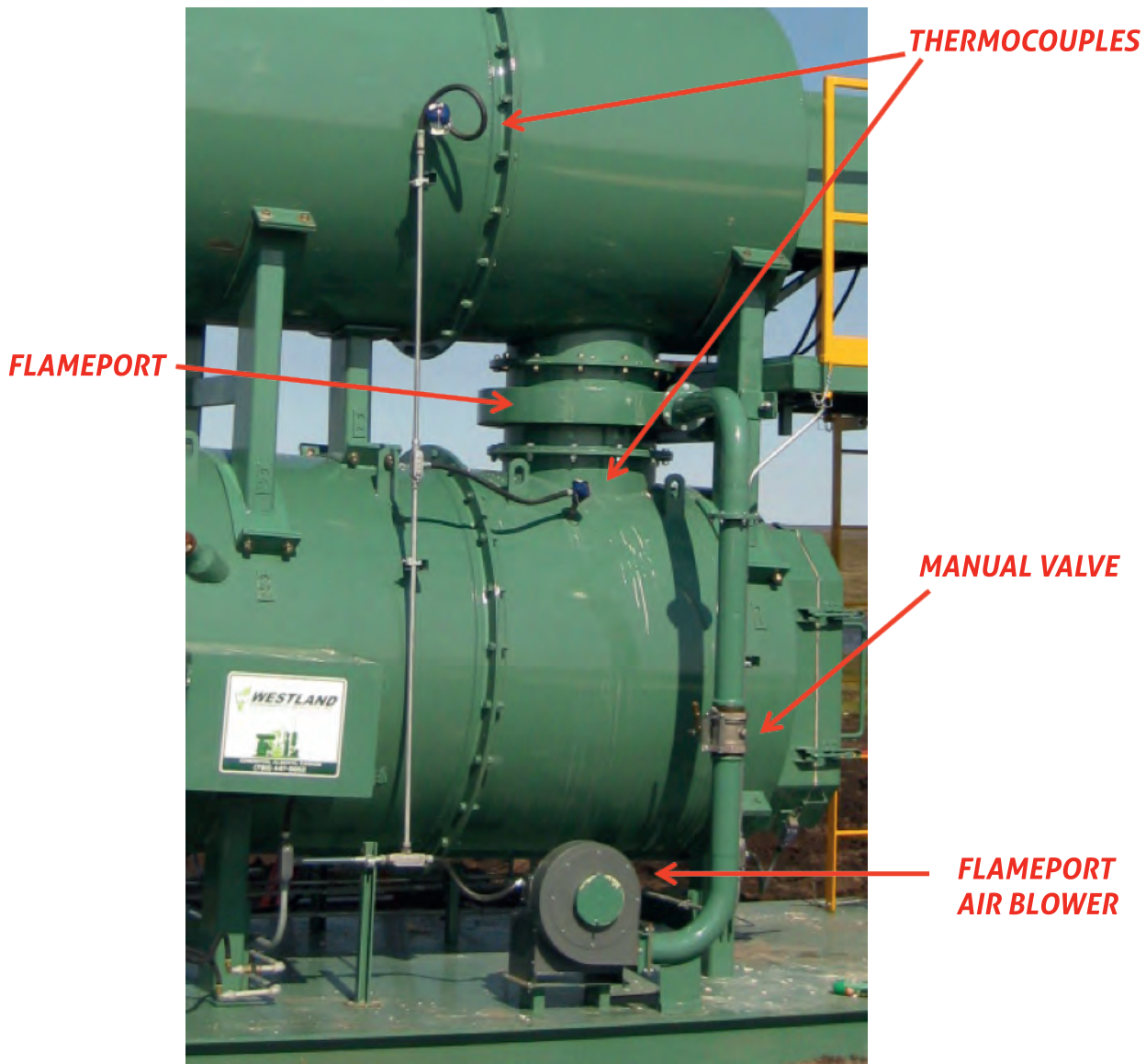


FIGURE 7. SECONDARY CHAMBER AND OTHER COMPONENTS

CY-50-CA

ketek.ca

13

3. SYSTEM DESCRIPTION

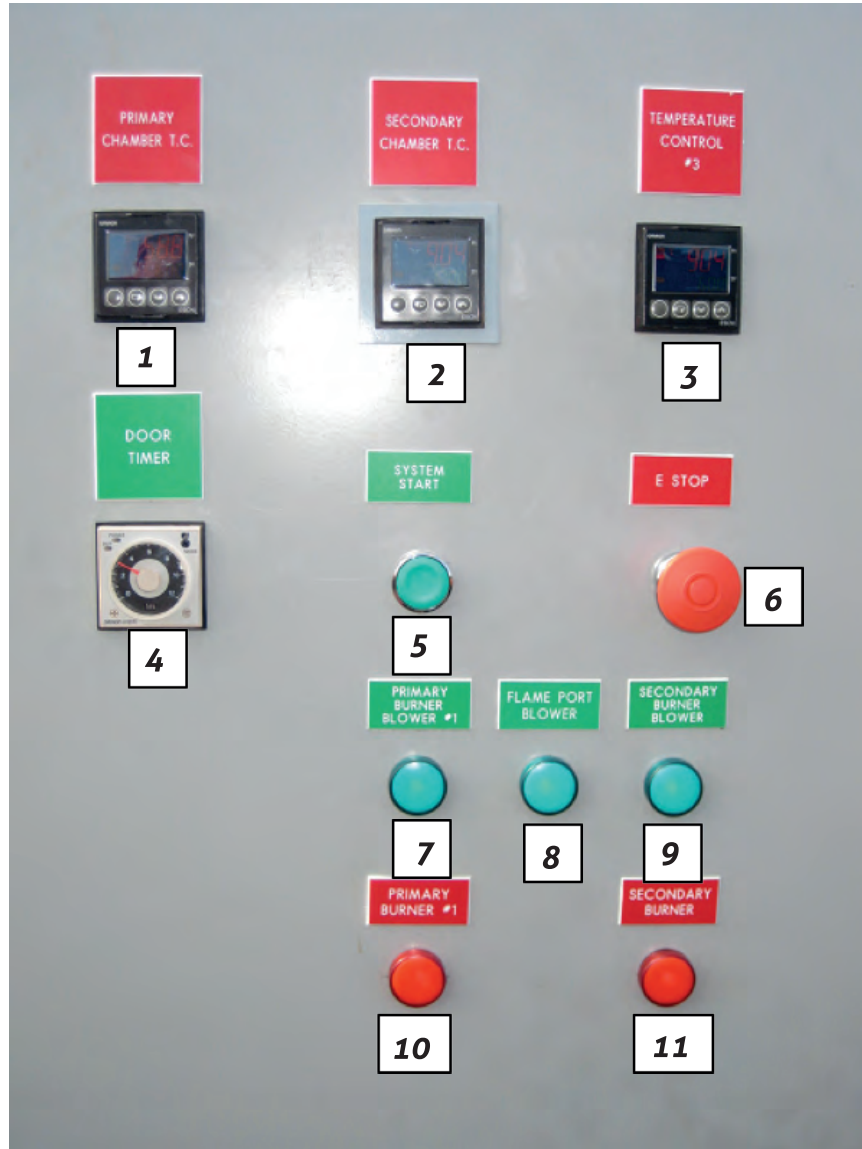


FIGURE 8. CONTROL PANEL

LEGEND. 1. Primary Chamber Temperature Indicator and Controller (TIC); 2. Secondary Chamber TIC; 3. Controller for set point of secondary chamber temperature to trigger Primary Chamber Burner during pre-heating; 4. Timer for Burn Time; 5. Start Button; 6. Emergency Stop Button 7 to 9: Light Indicators for Blowers; 10 and 11: Light Indicators for Burners (Flame ON).



3.1. System components

The components are listed in Table 5, together brief descriptions of their functions and reference photographs.

TABLE 5 COMPONENTS AND THEIR FUNCTIONS

COMPONENT	FUNCTION	Reference
Primary Chamber	Water evaporation, pyrolysis and gasification, generating combustible gases (volatiles) and soot	Figure 6
1 Burner	Supply heat to maintain a minimum pre-set (variable) temperature	Figure 6 A
2 Fuel line and valve	Connection to fuel supply	Figure 6 A
3 Thermocouple	Measure, display and input to ON-OFF controller	Figure 6 B
4 Feed/ash door	Access to primary chamber for waste loading and ash removal	Figure 6 C
5 Contact switch	Input to safety interlock to shut-off burner when door is open.	Figure 6 C
Secondary Chamber	Complete combustion of gases and soot generated in the primary chamber	Figure 7
6 Burner	Supply heat to maintain a minimum pre-set (variable) temperature	Figure 7
7 Fuel line and valve	Connection to fuel supply	Figure 6 A
8 Thermocouple	Measure, display and input to ON-OFF controller	Figure 7
Flameport	Mixing of combustible gas and air, promoting "turbulence"	Figure 6 B Figure 7
9 Blower	Supply air (oxygen) for combustion	Figure 7
10 Manual valve	Control flameport air flow rate	Figure 7
Control Panel	Automation of operation	Figure 8
Stack	Disperse hot flue gas	Figure 5
(Fuel Supply Tank)	Supply of auxiliary fuel	Not shown

The controllers and indicators of in the Control Panel are described below (see Figure 8):



TABLE 6. CONTROL PANEL (FIGURE 8)

LEGEND	FUNCTION
1	<ul style="list-style-type: none">Displays Primary Chamber temperatureSet-point for minimum temperature in the Primary Chamber
2	<ul style="list-style-type: none">Displays Secondary Chamber temperatureSet-point for minimum temperature in the Secondary Chamber
3	Set-point for Secondary Chamber temperature to trigger Primary Chamber Burner during pre-heating (Factory pre-set)
4	START-UP BUTTON to initiate pre-heating and execute complete burning cycle after waste loading
5	Burn TIMER to pre-set period of burning time in the Primary Chamber
6	(Spare)
7, 8, 9	Indicator lights showing BLOWER ON for flameport, primary and secondary chamber burners.
10, 11	Indicator lights showing BURNER (fuel/flame) ON for primary and secondary burners.



The operation of the system is cyclic, as shown in Figure 9 and each step is described in the following sections.

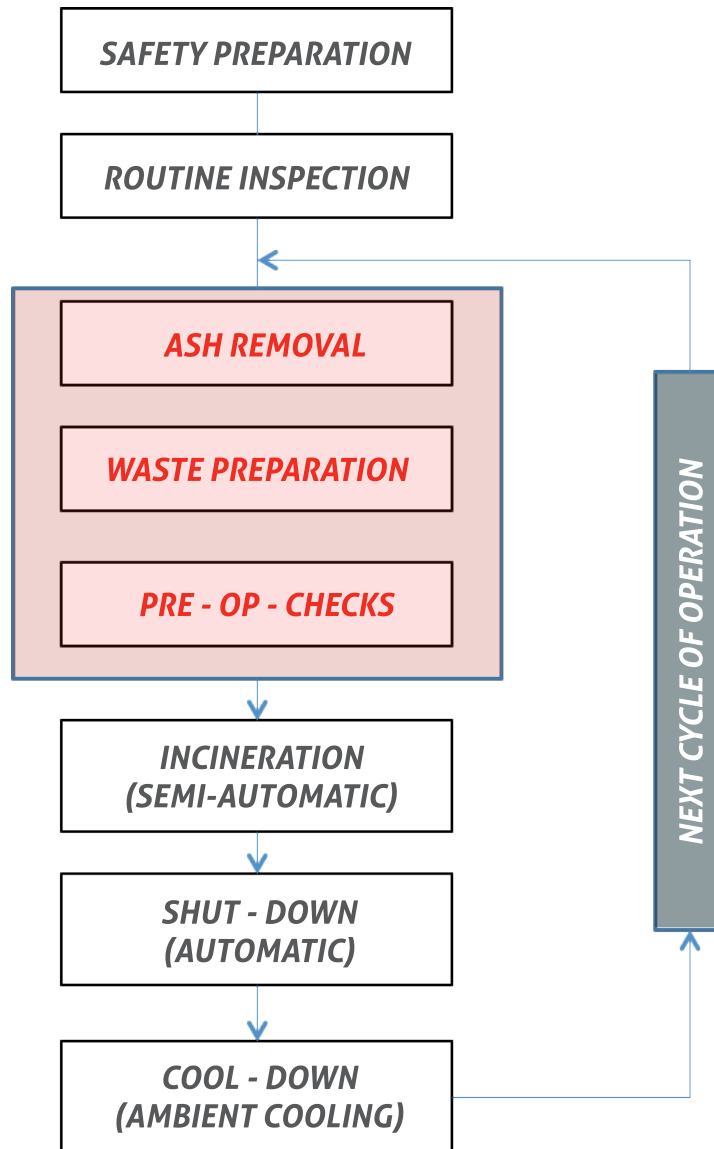


FIGURE 9. SCHEMATIC OF OPERATIONAL STEPS



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
- [See Chapter 4.7: Intermittent feeding and raking : (i) heat protective clothing and gloves, and (2) CSA/ANSI approved full face shield. Note: This is NOT required under batch operation.]

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):
 - o Inspect refractory for large cracks (not expansion cracks)
 - o 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. 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. This system can generally be loaded with 200 kg of Type 3 waste (Table 2). In general, the higher the heating value, the smaller batch should be loaded. The proper size should be determined from experience.

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.



4.5. Pre-operational checks

- Check fuel tank to make sure enough fuel.
- Open fuel valves.
- (Connect electrical plug and turn power ON)).
- Prime burner pumps if necessary.

4.6. Incineration (Batch Operation)

1. [Check and reset if necessary set points in primary chamber (650 C) and secondary chamber (900 C)]
2. Open feed/ash door and load waste to Primary Chamber (For Type 3 waste, about 80% of the chamber volume).
3. Close feed/ash door.
4. Set burner timer according to the size of the load
5. Press "Start" button.

4.7. Notes on Intermittent Feeding Operation

In intermittent feeding operation, waste is loaded **while incineration process is occurring**. This mode of operation increases incinerator capacity, especially when "raking" is also practiced. But it has the following drawbacks:

- Disturbance and cooling in the primary chamber will increase emission of particulate matter and generates "spikes" of carbon monoxide, and potentially also dioxin emission;
- Particular attention should be paid with respect to safety, including the need for additional PPE as mentioned in *Chapter 4.1*.
- Increased in man-power requirement.

The protocol for intermittent feeding consists of undertaking Steps (2) to (5) described in previous Chapter 4.6. Note that the size of the batch loaded is much smaller, a maximum of about 20 kg for Type 3 waste. Otherwise, black smoke could be generated. Raking is done in the same way, except that no waste is loaded, but instead, the waste in primary chamber is "raked" to expose un-burnt components, thereby increasing the burn rate, and hence the incinerator capacity.

4.8. Shut-down and Cool-down

- Automatically done.

4.9. Burner and blower maintenance

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 supplied.



4.10. Diesel Requirement

Figure 10 shows the requirement for diesel as a function of running time and total capacity, expressed in USG/h. Note that: 1 USG/h ~ 140,000 Btu/h or 0.15 GJ/h.

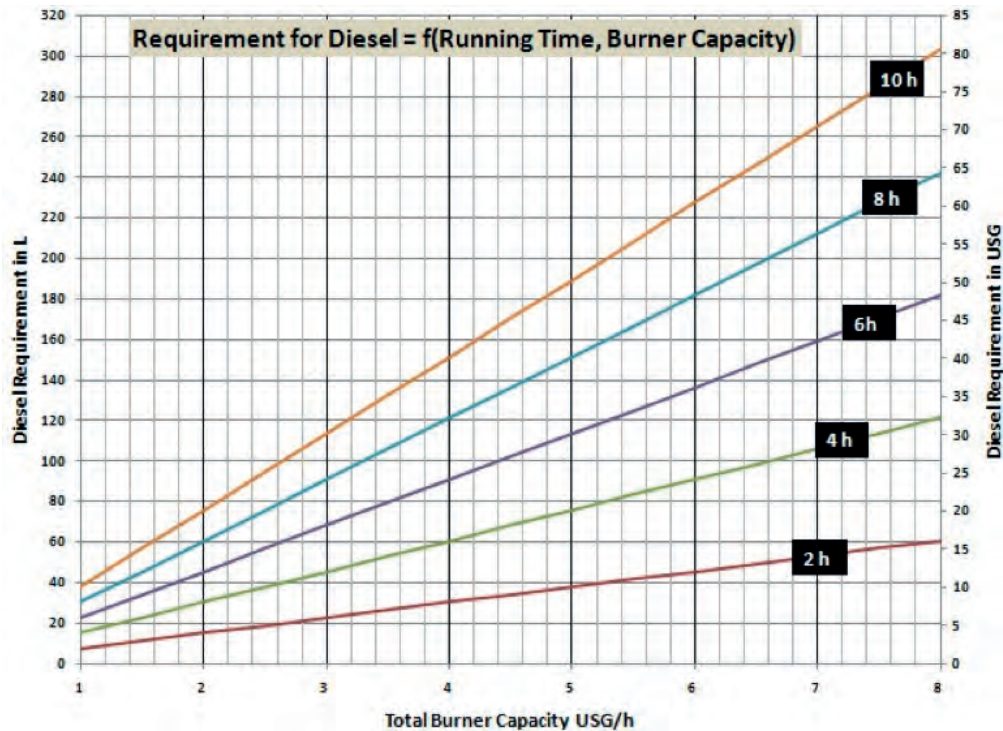


FIGURE 10. REQUIREMENT FOR DIESEL



1. **KETEK MANUFACTURING** 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 KETEK MANUFACTURING.
2. The obligation of KETEK MANUFACTURING 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 KETEK MANUFACTURING 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 KETEK MANUFACTURING indemnified against any such claim. In no event shall KETEK MANUFACTURING 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 KETEK MANUFACTURING 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 KETEK MANUFACTURING under this Warranty shall cease and determine if:
 - (a) The Purchaser shall not have paid in full all invoices as submitted by KETEK MANUFACTURING, or affiliated companies on or before their due dates:
 - (b) Representatives of KETEK MANUFACTURING, are denied full and free right of access to the units:
 - (c) The Purchaser permits persons other than the agents of KETEK MANUFACTURING or those approved or authorized by KETEK MANUFACTURING 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 KETEK MANUFACTURING 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 KETEK MANUFACTURING 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 KETEK MANUFACTURING 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 KETEK MANUFACTURING 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 KETEK MANUFACTURING regular billing rates on usual credit terms.
9. The liability of KETEK MANUFACTURING 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: _____

CY-50-CA

