

February 12, 2025

Michael Kennedy, Manager
Permit Review Branch
Division for Air Quality
Department for Environmental Protection
300 Sower Blvd – 2nd Floor
Frankfort, KY 40601

Re: Permit Renewal Application – V-20-010

Mr. Kennedy:

Attached are Akebono Brake – Glasgow's application materials for renewal of our Title V permit (AI# 15685). Some items to note in this application:

- 502(b).10 change submitted on 12.12.23 to Re-route of Aftermarket 1 EP 30 to EP46
- Removal of all Mod 1 equipment
- Mixer 2 Removed

I've also attached a summary of our maximum emission potentials based on these updates. Feel free to contact me at 270-590-9034 or Brandon.petz@akebono-usa.com if you have any questions or need additional information.

Sincerely,

A handwritten signature in black ink, appearing to read 'Brandon Petz'.

Brandon Petz
HSE Manager

Division for Air Quality

300 Sower Boulevard
Frankfort, KY 40601
(502) 564-3999

DEP7007AI

Administrative Information

- ___ Section AI.1: Source Information
___ Section AI.2: Applicant Information
___ Section AI.3: Owner Information
___ Section AI.4: Type of Application
___ Section AI.5: Other Required Information
___ Section AI.6: Signature Block
___ Section AI.7: Notes, Comments, and Explanations

Additional Documentation

___ Additional Documentation attached

Source Name:

Akebono Brake Corporation Glasgow Plant

KY EIS (AFS) #:

21- 009-00067

Permit #:

V-20-010

Agency Interest (AI) ID:

15685

Date:

1.27.25

Section AI.1: Source Information

Physical Location
Address:

1765 Cleveland Ave

City:

Glasgow

County:

Barren

Zip Code:

42141

Street or
P.O. Box:

1765 Cleveland Ave

Mailing Address:

Glasgow

City:

Glasgow

State:

KY

Zip Code:

42141

Standard Coordinates for Source Physical Location

Longitude:

36.996261

(decimal degrees)

Latitude:

-85.959136

(decimal degrees)

Primary (NAICS) Category:

Motor Vehicle Brake System
Manufacturing

Primary NAICS #:

336340

Classification (SIC) Category:		Motor Vehicle Parts and Accessories		Primary SIC #: 3714	
Briefly discuss the type of business conducted at this site:					
Manufacture Brake Components					
Description of Area Surrounding Source:	☒ Rural Area ☐ Urban Area	☐ Industrial Park ☐ Industrial Area	☒ Residential Area ☐ Commercial Area	Is any part of the source located on federal land? ☐ Yes ☒ No	Number of Employees: 520
Approximate distance to nearest residence or commercial property:	1000ft	Property Area:	50 Acres	Is this source portable?	☐ Yes ☒ No
What other environmental permits or registrations does this source currently hold or need to obtain in Kentucky?					
NPDES/KPDES:	☒ Currently Hold ☐ Need	☐ N/A			
Solid Waste:	☐ Currently Hold ☐ Need	☒ N/A			
RCRA:	☒ Currently Hold ☐ Need	☐ N/A			
UST:	☐ Currently Hold ☐ Need	☒ N/A			
Type of Regulated Waste Activity:	☐ Mixed Waste Generator ☐ U.S. Importer of Hazardous Waste	☒ Generator ☐ Transporter	☐ Recycler ☐ Treatment/Storage/Disposal Facility	☐ Other: _____ ☐ N/A	

Section AI.2: Applicant Information**Applicant Name:** Akebono Brake Corporation**Title:** (if individual)**Mailing Address:** Street or P.O. Box: 1765 Cleveland Ave

City: Glasgow State: KY Zip Code: 42141

Email: (if individual)**Phone:** 270-678-1765**Technical Contact****Name:** Brandon Petz**Title:** HSE Manager**Mailing Address:** Street or P.O. Box: 1765 Cleveland Ave

City: Glasgow State: KY Zip Code: 42141

Email: brandon.petz@akebono-usa.com**Phone:** 270-590-9034**Air Permit Contact for Source****Name:** Brandon Petz**Title:** HSE Manager**Mailing Address:** Street or P.O. Box: 1765 Cleveland Ave

City: Glasgow State: KY Zip Code: 42141

Email: brandon.petz@akebono-usa.com**Phone:** 270-590-9034

Section AI.3: Owner Information

☒ Owner same as applicant

Name: _____
Title: _____
Mailing Address: _____
Street or P.O. Box: _____
City: _____ **State:** _____ **Zip Code:** _____
Email: _____
Phone: _____

List names of owners and officers of the company who have an interest in the company of 5% or more.

Name	Position
_____	_____
_____	_____
_____	_____

Section AI.4: Type of Application**Current Status:**
☒ Title V ☐ Conditional Major ☐ State-Origin ☐ General Permit ☐ Registration ☐ None
Requested Action:*(check all that apply)*
☐ Name Change ☐ Initial Registration ☐ Significant Revision ☐ Administrative Permit Amendment
☒ Renewal Permit ☐ Revised Registration ☐ Minor Revision ☐ Initial Source-wide Operating Permit
☐ 502(b)(10)Change ☐ Extension Request ☐ Addition of New Facility ☐ Portable Plant Relocation Notice
☐ Revision ☐ Off Permit Change ☐ Landfill Alternate Compliance Submittal ☐ Modification of Existing Facilities
☐ Ownership Change ☐ Closure
Requested Status:
☒ Title V ☐ Conditional Major ☐ State-Origin ☐ PSD ☐ NSR ☐ Other: _____
Is the source requesting a limitation of potential emissions?
☐ Yes ☒ No
Pollutant:**Requested Limit:****Requested Limit:**

☐ Particulate Matter	_____	Pollutant:	☐ Single HAP	_____
☐ Volatile Organic Compounds (VOC)	_____		☐ Combined HAPs	_____
☐ Carbon Monoxide	_____		☐ Air Toxics (40 CFR 68, Subpart F)	_____
☐ Nitrogen Oxides	_____		☐ Carbon Dioxide	_____
☐ Sulfur Dioxide	_____		☐ Greenhouse Gases (GHG)	_____
☐ Lead	_____		☐ Other	_____

For New Construction:**Proposed Start Date of Construction:***(MM/YYYY)***Proposed Operation Start-Up Date:** *(MM/YYYY)***For Modifications:****Proposed Start Date of Modification:***(MM/YYYY)***Proposed Operation Start-Up Date:** *(MM/YYYY)*Applicant is seeking coverage under a permit shield. ☒ Yes ☐ No

Identify any non-applicable requirements for which permit shield is sought on a separate attachment to the application.

Section AI.5 Other Required Information

Indicate the documents attached as part of this application:

- | | |
|--|--|
| ☒ DEP7007A Indirect Heat Exchangers and Turbines | ☐ DEP7007CC Compliance Certification |
| ☒ DEP7007B Manufacturing or Processing Operations | ☒ DEP7007DD Insignificant Activities |
| ☐ DEP7007C Incinerators and Waste Burners | ☒ DEP7007EE Internal Combustion Engines |
| ☐ DEP7007F Episode Standby Plan | ☐ DEP7007FF Secondary Aluminum Processing |
| ☐ DEP7007J Volatile Liquid Storage | ☒ DEP7007GG Control Equipment |
| ☒ DEP7007K Surface Coating or Printing Operations | ☐ DEP7007HH Haul Roads |
| ☐ DEP7007L Mineral Processes | ☐ Confidentiality Claim |
| ☐ DEP7007M Metal Cleaning Degreasers | ☐ Ownership Change Form |
| ☒ DEP7007N Source Emissions Profile | ☐ Secretary of State Certificate |
| ☐ DEP7007P Perchloroethylene Dry Cleaning Systems | ☐ Flowcharts or diagrams depicting process |
| ☐ DEP7007R Emission Offset Credit | ☐ Digital Line Graphs (DLG) files of buildings, roads, etc. |
| ☐ DEP7007S Service Stations | ☒ Site Map |
| ☒ DEP7007T Metal Plating and Surface Treatment Operations | ☐ Map or drawing depicting location of facility |
| ☒ DEP7007V Applicable Requirements and Compliance Activities | ☐ Safety Data Sheet (SDS) |
| ☐ DEP7007Y Good Engineering Practice and Stack Height Determination | ☐ Emergency Response Plan |
| ☐ DEP7007AA Compliance Schedule for Non-complying Emission Units | ☒ Other: _____ |
| ☐ DEP7007BB Certified Progress Report | PTE Calculations Spreadsheet |

Section AI.6: Signature Block

I, the undersigned, hereby certify under penalty of law, that I am a responsible official*, and that I have personally examined, and am familiar with, the information submitted in this document and all its attachments. Based on my inquiry of those individuals with primary responsibility for obtaining the information, I certify that the information is on knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false or incomplete information, including the possibility of fine or imprisonment.

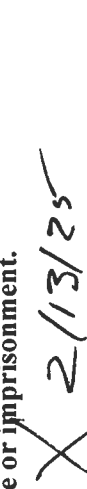


Authorized Signature

Brad Burd

Type or Printed Name of Signatory

*Responsible official as defined by 401 KAR 52:001.



Date

Plant Manager

Title of Signatory

DEP7007A

Indirect Heat Exchangers and Turbines

Section A.1: General Information

Section A.2: Operating and Fuel Information

Section A.3: Notes, Comments, and Explanations

Additional Documentation

____ Complete DEP7007AI, DEP7007N, DEP7007V, and DEP7007GG.

Manufacturer's specifications

Source Name:

KY FIS (AFS) #: 21-00900067

V-20-010

Agency Interest (AI) ID:

Date: 1/27/2025

Akebono Brake - Glasgow Plant

Section A.1: General Information

[illegible]

Indirect Heat Exchangers and Turbines

____ Complete DEP7007AI, DEP7007N, DEP7007V, and DEP7007GG.

Manufacturer's specifications

Section A.2: Operating and Fuel Information

Section A.3: Notes, Comments, and Explanations

Division for Air Quality

300 Sower Boulevard

Frankfort, KY 40601

(502) 564-3999

Akebono Brake - Glasgow Plant

21-00900067

V-20-010

Permit #:

15685

1/27/2025

Section A.1: General Information

[illegible]

Section A.2: Operating and Fuel Information

Emission Unit #	If multipurpose unit, identify the percentage of use by purpose				Rated Capacity Heat Input (MMBtu/hr)	Rated Capacity Power Output		Describe Operating Scenario (only if this unit will be used in different configurations)	Classify Fuel as Primary or Secondary	Identify Fuel Type: Coal, Natural Gas, Wood, Biomass, Landfill/Digester Gas, Fuel Oil # (specify 1-6), or Other	Heat Content (HHV)		Maximum Operating Hours	Ash Content (%)	Sulfur Content (%)
	Space Heat	Process Heat	Power	Emergency		(Specify units: hp, MW, or lb steam/hr)	(Specify units: Btu/lb, Btu/gal, or Btu/scf)								
21		100%			4.5				Primary	Natural Gas			24/7/365		
33		100%			4.5				Primary	Natural Gas			24/7/365		
34		100%			4.5				Primary	Natural Gas			24/7/365		

Division for Air Quality 300 Sower Boulevard Frankfort, KY 40601 (502) 564-3999	DEP7007B Manufacturing or Processing Operations ___ Section B.1: Process Information ___ Section B.2: Materials and Fuel Information ___ Section B.3: Notes, Comments, and Explanations	Additional Documentation ___ Complete DEP7007AI, DEP7007N, DEP7007V, and DEP7007GG. ___ Attach a flow diagram ___ Attach SDS
Source Name: Akebono Brake - Glasgow Plant		
KY EIS (AFS) #: 21- 00900067		
Permit #: V-20-010		
Agency Interest (AI) ID: 15685		
Date: 1/27/2025		

Section B.1: Process Information

Emission Unit #	Emission Unit Name	Describe Emission Unit	Process ID	Process Name	Manufacturer	Model No.	Proposed/Actual Date of Construction Commencement (MM/YYYY)	Is the Process Continuous or Batch?	Number of Batches per 24 Hours (if applicable)	Hours per Batch (if applicable)
04	1 Slitters/Grinders	Mods 2		Grinding	Comec		07/2006	C		
06	4 Mixing/Blending	Mixers 11, 31, 41, 51		Mixing			1/1/1995, 10/1/1996, and 6/1/2007	B		
16	1 Slitter/Grinder	Mod 3		Grinding	Comec		05/2007	C		
27	1 Slitter/Grinder	Mod 5		Grinding	Comec		05/2007	C		
29	2 Mixing/Blending	Mixers 61, 71		Mixing			1/1/2015 and 10/1/2017	B		
30	1 Slitters/Grinders	Aftermarket 2		Grinding			9/1/2008	C		
38	1 Slitter/Grinder	Mod 7		Grinding	Comec		10/1/2011	C		
39	1 Slitter/Grinder	Mod 6		Grinding	Comec		6/5/2011	C		
46	2 Slitter/Grinder	Aftermarket 1 and Mod 8		Grinding	Comec		9/1/2008 and 4/1/2015	C		
52	1 Slitter/Grinder	Aftermarket 3		Grinding			5/1/2017	C		

Section B.2: Materials and Fuel Information

**Maximum yearly fuel usage rate only applies if applicant request operating restrictions through federally enforceable limitations.*

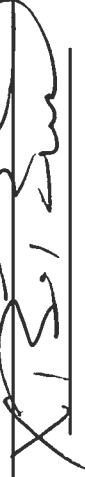
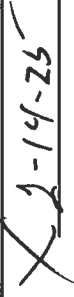
Emission Unit #	Emission Unit Name	Name of Raw Materials Input	Maximum Quantity of Each Raw Material Input		Total Process Weight Rate for Emission Unit (tons/hr)	Name of Finished Materials	Maximum Quantity of Each Finished Material Output		Fuel Type	Maximum Fuel Usage Rate		Sulfur Content (%)	Ash Content (%)
			(Specify Units/hr)	(Specify Units/hr)			(Specify Units/hr)	(Specify Units/hr)		(Specify Units)	(Specify Units)		
04	2 Slitters/Grinders	Brake Pads	4800	pads/hr		Brake Pads	4800	pads/hr	N/A				
06	4 Mixing/Blending Systems	Raw Friction Material	1.918	tons/hr		Friction Material Mix	1.918	tons/hr	N/A				
16	1 Slitter/Grinder	Brake Pads	2400	pads/hr		Brake Pads	2400	pads/hr	N/A				
27	1 Slitter/Grinder	Brake Pads	2400	pads/hr		Brake Pads	2400	pads/hr	N/A				
29	2 Mixing/Blending Systems	Raw Friction Material	0.477	tons/hr		Friction Material Mix	0.477	tons/hr	N/A				
30	1 Slitters/Grinders	Brake Pads	4800	pads/hr		Brake Pads	4800	pads/hr	N/A				
38	1 Slitter/Grinder	Brake Pads	2400	pads/hr		Brake Pads	2400	pads/hr	N/A				
39	1 Slitter/Grinder	Brake Pads	2400	pads/hr		Brake Pads	2400	pads/hr	N/A				
46	2 Slitter/Grinder	Brake Pads	4800	pads/hr		Brake Pads	4800	pads/hr	N/A				
52	1 Slitter/Grinder	Brake Pads	720	pads/hr		Brake Pads	720	pads/hr	N/A				

DEP7007DD Insignificant Activities ___ Section DD.1: Table of Insignificant Activities ___ Section DD.2: Signature Block ___ Section DD.3: Notes, Comments, and Explanations				
Division for Air Quality 300 Sower Boulevard Frankfort, KY 40601 (502) 564-3999				
Source Name: <u>Akebono Brake - Glasgow Plant</u>				
KY EIS (AFS) #: <u>21-00900067</u>				
Permit #: <u>V-20-010</u>				
Agency Interest: <u>15685</u>				
Date: <u>2.12.25</u>				
Section DD.1: Table of Insignificant Activities				
*Identify each activity with a unique Insignificant Activity number (1A #); for example: 1, 2, 3... etc.				
Insignificant Activity #	Description of Activity including Rated Capacity	Serial Number or Other Unique Identifier	Applicable Regulation(s)	Calculated Emissions
1	30 After Cure Ovens: 8@1.98; 4@1.20; 12@0.956; 1@0.795; 1@0.317; 2@0.794; 1@0.956; 1@1.187 mmBTU/hr	Mods 2, 3, 5, 6, 7, 8 and AM Lines 1, 2, 3	401 KAR 63:020	
2	5 ST Cure Ovens: 2@1.5; 3@1.0 mmBTU/hr	Surface Treat 11, 21, 31, 41, 51	N/A	
3	12 Scorchers: 4@0.794; 8@4.756 mmBTU/hr	Mods 2, 3, 5, 6, 7, 8	N/A	
4	3 Powder Adhesive Booths, 100% reclaim - no emissions	Surface Treat 31, 41, 51	401 KAR 59:010	N/A

Insignificant Activity #	Description of Activity including Rated Capacity	Serial Number or Other Unique Identifier	Applicable Regulation(s)	Calculated Emissions
5	Hot Pressing Operations	Mods 2, 3, 5, 6, 7, 8 and AM Lines 1, 2, 3	N/A	
6	18 Air Make-Up Units (2@3.2, 2@3.5, 1@6.3, 1@0.54, 6@6.6, 2@2.93, 4@9.9 mmBTU/hr)	MAUs	N/A	
8	9 Powder Paint Lines - No emissions	Powder Painters - Closed Loop	401 KAR 59:010	N/A
9	Inkjet Printers	Inkjet Printers	N/A	

Section DD.2: Signature Block

I, THE UNDERSIGNED, HEREBY CERTIFY UNDER PENALTY OF LAW, THAT I AM A RESPONSIBLE OFFICIAL, AND THAT I HAVE PERSONALLY EXAMINED, AND AM FAMILIAR WITH, THE INFORMATION SUBMITTED IN THIS DOCUMENT AND ALL ITS ATTACHMENTS. BASED ON MY INQUIRY OF THOSE INDIVIDUALS WITH PRIMARY RESPONSIBILITY FOR OBTAINING THE INFORMATION, I CERTIFY THAT THE INFORMATION IS ON KNOWLEDGE AND BELIEF, TRUE, ACCURATE, AND COMPLETE. I AM AWARE THAT THERE ARE SIGNIFICANT PENALTIES FOR SUBMITTING FALSE OR INCOMPLETE INFORMATION, INCLUDING THE POSSIBILITY OF FINE OR IMPRISONMENT.

By: 	Authorized Signature	Date  2-14-25
	Brad Burd	Plant Manager
Type/Print Name of Signatory		Title of Signatory

DEP7007EE Internal Combustion Engines ___ Section EE.1: General Information ___ Section EE.2: Operating Information ___ Section EE.3: Design Information ___ Section EE.4: Fuel Information ___ Section EE.5: Emission Factor Information ___ Section EE.6: Notes, Comments, and Explanations		Additional Documentation ___ Complete DEP7007AI, DEP7007N, DEP7007V, and DEP7007GG ___ Attach EPA certification of the engine	
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Division for Air Quality 300 Sower Boulevard Frankfort, KY 40601 (502) 564-3999		Source Name: Akebono Brake - Glasgow Plant KY EIS (AFS) #: 21- 00900067 Permit #: V-20-010 Agency Interest (AI) ID: 15685 Date: 2.12.25	
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Section EE.1: General Information										
Emission Unit #	Emission Unit Name	Control Device ID	Stack ID	Manufacturer	Model Number	Model Year	Date of Manufacture	Proposed/Actual Date of Construction Commencement (MM/YYYY)	Date Reconstructed/Modified	List Applicable Regulations
23	Emergency Generator - Plant			Caterpillar	3406C	2000		09/2003		401 KAR 63:002, 40 CFR 63 Subpart ZZZZ
49	Emergency Generator - Guard Shack			Kohler John Deere Eng	30REOZJB 3029TF270D	2007	Aug-07	01/2013		401 KAR 63:002, 40 CFR 63 Subpart ZZZZ, 40 CFR 60 Subpart IIII

Alternate Operating Scenarios

[illegible]

Section EE.3: Design Information

[illegible]

Section EE.4: Fuel Information

[illegible]

Section EE.5: Emission Factor Information

Emission factors expressed here are based on the potential to emit.

Emission Unit #	Fuel	Pollutant	Emission Factor	Emission Factor Units	Source of Emission Factor
23	Diesel				
49	Diesel				

Section EE.6: Notes, Comments, and Explanations

DEP7007GG

Control Equipment

Division for Air Quality

300 Sower Boulevard
Frankfort, KY 40601
(502) 564-3999

Additional Documentation

Complete Sections GG.1 through GG.12, as applicable
Attach manufacturer's specifications for each control device
Complete DEP7007AI

Source Name: Akebono Brake - Glasgow Plant

KY EIS (AFS) #: 21- 00900067

Permit #: V-20-010

Agency Interest (AI) ID: 15685

Date: 2.12.25

Section GG.1: General Information - Control Equipment

Control Device ID #	Control Device Name	Cost	Manufacturer	Model Name/ Serial #	Date Installed	Inlet Gas Stream Data For All Control Devices						Inlet Gas Stream Data For Condensers, Adsorbers, Afterburners, Incinerators, Oxidizers Only			Equipment Operational Data For All Control Devices		
						Temperature (°F)	Flowrate (scfm at 68°F)	Average Particle Diameter (µm)	Particle Density (lb/ft³) or Specific Gravity	Gas Density (lb/ft³)	Gas Moisture Content (%)	Gas Composition	Fan Type	Pressure Drop Range (in. H ₂ O)	Pollutants Collected/Controlled	Pollutant Removal (%)	
	Dust Collector 1		RL Flowers & Associates	Flowaire Pulse Jet HEWI-12-187 3525			28000							4-5	PM	99.9	
	Dust Collector 2		RL Flowers & Associates	Flowaire Pulse Jet HEWI-12-187 3525			28000							4-5	PM	99.9	
	Dust Collector 3		RL Flowers & Associates	Flowaire Pulse Jet HEWI-12-187 3525			28000							4-5	PM	99.9	
	Dust Collector 4		Donaldson Torit				28000							4-5	PM	99.9	
	Dust Collector 5		Fisher-Klosterman	HEWI-12-110-2073			15000							4-5	PM	99.9	
	Dust Collector 6		Donaldson Torit	Pulse Jet 243MBW12			28000							4-5	PM	99.9	
	Dust Collector 7		Fisher-Klosterman	Flowaire Pulse Jet HEWI-12-187 3525			28000							4-5	PM	99.9	
	Dust Collector 8		Schenck Process	MCF Power Saver 144MCF1120			83000							4-5	PM	99.9	
	Oxidizer		VMB Systems	VMB Model M6	1/1/1995							Natural Gas		1.5-2	VOC	85.03	
	Scrubber		Viron	VHS-3648											Acid/Trichromate	90	

Section GG.2: Flare Source Information						
Control Device ID #	Identify all Emission Units and Control Devices that Feed to Flare	Type of Flare (e.g. steam-assisted, air-assisted, nonassisted)	Process Gas Flowrate (acfm)	Net Heating Value of Stream(s) (Btu/scf)	Removal Efficiency (%)	Flare Rated Capacity (MMBtu/hr)

Section GG.5: Scrubber

[illegible]

Section GG.6: Filter

Control Device ID #	Identify all Emission Units and Control Devices that Feed to Filter	Identify Type of Filter Unit: Baghouse, Cartridge Collector, or Other (specify)	Identify Type of Filtering Material: Fabric, Paper, Synthetic, or Other (specify)	Total Filter Area (ft^2)	Effective Air-to-Filter Ratio ($acfm/ft^2$)	Continuous Monitoring Instrumentation (e.g. COMS, BLDs, none)	Additional Materials Introduced into the Control System (e.g. lime, carbon)		Identify Cleaning Method: Shaker, Pulse Air, Reverse Air, Pulse Jet, or Other (specify)	Identify Gas Cooling Method: Ductwork, Heat Exchanger, Bleed-in Air, Water Spray, or Other (specify)	For Ductwork:		For Bleed-in Air:	For Water Spray:
							Material	Injection Rate (lb/hr)			Length (ft)	Diameter (ft)		
	EP4	Baghouse 1	Synthetic	3525		none			Pulse Jet					N/A
	EP6	Baghouse 2	Synthetic			none			Pulse Jet					N/A
	EP16	Baghouse 3	Synthetic	3525		none			Pulse Jet					N/A
	EP27	Baghouse 4	Synthetic			none			Pulse Jet					N/A
	EP29	Baghouse 5	Synthetic			none			Pulse Jet					N/A
	EP30, EP39	Baghouse 6	Synthetic	3525		none			Pulse Jet					N/A
	EP38	Baghouse 7	Synthetic	4677		none			Pulse Jet					N/A
	EP46, EP52	Baghouse 8	Synthetic			none								N/A
	EP02, EP03	Dry Filter	Paper			none								N/A

Section GG.7: Afterburner/Incinerator/Oxidizer

[illegible]

DEP7007K**Surface Coating or Printing Operations****Division for Air Quality**

300 Sower Boulevard
Frankfort, KY 40601
(502) 564-3999

Additional Documentat

___ Complete DEP7007AI, DEP700
DEP7007V, and DEP7007GG.

___ Attach SDS or Technical Sheets f
Coating/Printing Materials

___ Attach a flow diagram

- ___ Section K.1: Process Information
___ Section K.2: Coating Operations
___ Section K.3: Other Operations
___ Section K.4: Coatings/Printing Materials as Applied
___ Section K.5: HAP-containing Coatings/Printing Materials
___ Section K.6: Notes, Comments, and Explanations

Source Name:

Akebono Brake - Glasgow Plant

KY EIS (AFS) #:

21- 00900067

Permit #:

V-20-010

Agency Interest (AI) ID:

15685

Date:

2.12.2025

Section K.1: Process Information**Emission Unit #:**

02 and 03

Emission Unit Name:

2 Primer Spray Booths and 2 Adhesive Spray Booths

Coating/Printing Line Name:

Surface Treat 11 and 21

Proposed/Actual Date of**Construction: (MM/YYYY)**

1/1/1995

**List Applicable
Regulations:**

401 KAR 59:010
401 KAR 59:225
401 KAR 63:020

**Describe Overall
Process:**

Spray application of liquid primer and adhesive/hardener onto one side of steel backing plates for disc brakes

**Describe
Coatings/Printing
Materials:**

Liquid Primer, Liquid Adhesive and Liquid Hardener - all EthylAlcohol-based

Identify the Material that is Coated/Printed:

☒ Metal ☐ Vinyl ☐ Plastics ☐ Wood ☐ Foil ☐ Paper ☐ Other Substrate

Provide detailed description of material coated/printed:

Steel backing plate of brake pad

Provide approximate dimensions and range of sizes of parts being coated or printed:

Largest surface area pressure plate = 16.2 cm²
Smallest surface area pressure plate = 4.2 cm²

Identify the Type of Operation:

☒ Continuous ☐ Batch ☐ Other:

Describe Surface Preparation/Pretreatment Steps:

Phosphate wash

For Coating Operations:

☒ Spray ☐ Flow ☐ Dip tank ☐ Electrodeposition
☐ Brush ☐ Powder ☐ Roller Coat ☐ Other:

For Printing Operations:

(Select all that apply)

☐ Web ☐ Rotogravure ☐ Heatset ☐ Lithographic ☐ Other:
☐ Sheetfed ☐ Letterpress ☐ Non-heatset ☐ Flexographic

Describe Final Product:

Adhesive-coated metal backing plate of brake pad

Check the category that most closely describes this unit:

☐ Large Appliance Coating ☐ Auto or Light-Duty Truck Coating ☐ Metal Furniture Coating ☐ Metal Coil Coating
☐ Beverage Can Coating ☒ Miscellaneous Metal Parts Coating ☐ Magnet Wire Insulation Coating ☐ Flat Wood Panel Coating
☐ Fabric, Vinyl, or Paper Coating ☐ Boat Manufacturing/ Ship Repair ☐ Pressure Sensitive Tape and Label Coating ☐ Magnet Tape Coating
☐ Publication Rotogravure Printing ☐ Coating of Plastic Parts for Business Machines ☐ Flexible Vinyl and Urethane Coating and Printing
☐ Graphic Arts using Rotogravure and Flexographic Printing ☐ Other:

[illegible]

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Section K.2: Coating Operations

K.2A: For Spray Coating

Gun/Booth ID	Describe Function	Type	Mode	Maximum Design Application Rate (gal/hr or lb/hr)		Describe how maximum rate was determined
05, 06	2 Primer Spray Booths	☐ Conventional Air Gun ☐ Airless ☐ Electrostatic ☐ Aerosol Spray Can ☐ HVLP ☐ LVLP ☒ Other	☐ Manual ☒ Automatic	45	lb/hr	☐ Testing ☒ Equipment Specification Sheet ☐ Estimation
07, 08	2 Adhesive Spray Booths	☐ Conventional Air Gun ☐ Airless ☐ Electrostatic ☐ Aerosol Spray Can ☐ HVLP ☐ LVLP ☒ Other	☐ Manual ☒ Automatic	19.4	lb/hr	☐ Testing ☒ Equipment Specification Sheet ☐ Estimation
		☐ Conventional Air Gun ☐ Airless ☐ Electrostatic ☐ Aerosol Spray Can ☐ HVLP ☐ LVLP ☐ Other	☐ Manual ☐ Automatic			☐ Testing ☐ Equipment Specification Sheet ☐ Estimation

If spray guns are used simultaneously, describe:

K.2B: For Brush Coating

Describe Function:

Maximum Coating Application Rate:
(gal/hr)

K.2C: For Roller Coating

Roller Coat ID	Describe Function	Maximum Coating Application Rate (gal/hr)	Describe how maximum rate was determined
			☐ Testing ☐ Equipment Specification Sheet ☐ Estimation
			☐ Testing ☐ Equipment Specification Sheet ☐ Estimation
			☐ Testing ☐ Equipment Specification Sheet ☐ Estimation

K.2D: For Powder Coating

Powder Coat ID	Describe Function	Maximum Coating Application Rate (gal/hr or lb/hr)		Describe how maximum rate was determined
				☐ Testing ☐ Estimation ☐ Equipment Specification Sheet
				☐ Testing ☐ Estimation ☐ Equipment Specification Sheet
				☐ Testing ☐ Estimation ☐ Equipment Specification Sheet
				☐ Testing ☐ Estimation ☐ Equipment Specification Sheet

If powder coating material is recycled, describe:

K.2E: For Flow Coating

Flow Coat ID	Describe Function	Maximum Coating Application Rate (gal/hr or lb/hr)		Describe how maximum rate was determined
				☐ Testing ☐ Estimation ☐ Equipment Specification Sheet
				☐ Testing ☐ Estimation ☐ Equipment Specification Sheet
				☐ Testing ☐ Estimation ☐ Equipment Specification Sheet
				☐ Testing ☐ Estimation ☐ Equipment Specification Sheet

K.2F: For Dip Tank/Electrodeposition Coating

Tank ID	Describe Function	Maximum Make-up Rate (gal/hr or lb/hr)		Describe how maximum rate was determined
				☐ Testing ☐ Estimation ☐ Equipment Specification Sheet
				☐ Testing ☐ Estimation ☐ Equipment Specification Sheet
				☐ Testing ☐ Estimation ☐ Equipment Specification Sheet
				☐ Testing ☐ Estimation ☐ Equipment Specification Sheet

Section K.3: Other Operations

K.3A: For Finishing

Describe Finishing Processes:
Complete Form DEP7007B as applicable

K.3B: For Curing/Drying

Describe Curing/Drying Processes:	Description	Rated Capacity (MMBtu/hr)	Fuel	Control Device/Stack ID
2 Curing Ovens	Surface Treat Cure Ovens 11, 21	2 @ 1.5 each	Natural Gas	Insignificant Activity - EP 05 and 14

K.3C: For Purge

Type: Ethyl Alcohol
Daily Usage: 0.5 gal/day

K.3D: For Clean-up

Type: ☒ Manual ☐ Automatic
Daily Usage: 0.5 hrs/day
Operating Hours: Lines flushed at end of each shift (7 am, 3 pm, 11 pm)

K.3E: For Other Equipment

Describe Processes:

Section K.4: Coatings/Printing Materials As Applied

Include SDS or Technical Sheets for all coating/printing materials used.

[illegible]

*Emission factor for particulate matter (PM) should not include transfer efficiency.

Section K.5: Hazardous Air Pollutant-containing Coatings/Printing Materials

List each individual hazardous air pollutant (HAP) contained in each material.

[illegible]

Section K.6: Notes, Comments, and Explanations	
K.2: Low volume/High pressure spray guns; Cannot reach maximum design application rate due to the viscosity of the liquids being sprayed	

Division for Air Quality

300 Sower Boulevard
Frankfort, KY 40601
(502) 564-3999

DEP7007N

Source Emissions Profile

Section N.1: Emission Summary
Section N.2: Stack Information
Section N.3: Fugitive Information
Section N.4: Notes, Comments, and Explanations

Additional Documentation

Complete DEP7007AI

Source Name:

Akebono Brake - Glasgow Plant

KY EIS (AFS) #:

21- 00900067

Permit #:

V-20-010

Agency Interest (AI) ID:

15685

Date:

2.12.2025

N.1: Emission Summary

Emission Unit #	Emission Unit Name	Process ID	Process Name	Control Device Name	Control Device ID	Stack ID	Maximum Design Capacity (SC Units hour)	Pollutant	Uncontrolled Emission Factor (lb SC Units)	Emission Factor Source (e.g. AP-42, Stack Test, Mass Balance)	Capture Efficiency (%)	Control Efficiency (%)	Hourly Emissions		Annual Emissions	
													Uncontrolled Potential (lb/hr)	Controlled Potential (lb/hr)	Uncontrolled Potential (tons/yr)	Controlled Potential (tons/yr)
02	Primer Spray Booths			oxidizer			0.0225 tons/hr	VOC		mass balance		85.03%	45	6.7365	197.1	29.50587
03	Adhesive Spray Booths			oxidizer			0.0097 tons/hr	VOC		mass balance		85.03%	19.4	2.90418	84.972	12.7203084
04	Grinders (Mod 2)			dust collector			4800 parts/hr	PM		mass balance		99.90%	211.2	0.2112	925.056	0.925056
06	4 Mixing Systems			dust collector			1.918 tons/hr	PM		mass balance		99.90%	3836	3.836	16801.68	16.80168
16	Grinder (Mod 3)			dust collector			2400 parts/hr	PM		mass balance		99.90%	105.6	0.1056	462.528	0.462528
21	Boiler						4.5 mmBTU/hr									
23	Emergency Generator						459 HP									

DEP7007N

Division for Air Quality

300 Sower Boulevard
Frankfort, KY 40601
(502) 564-3999

Source Emissions Profile

Section N.1: Emission Summary
Section N.2: Stack Information
Section N.3: Fugitive Information
Section N.4: Notes, Comments, and Explanations

Additional Documentation

Complete DEP7007AI

Source Name: **Akebono Brake - Glasgow Plant**

KY EIS (AFS) #: **21- 00900067**

Permit #: **V-14-023 R1**

Agency Interest (AI) ID: **15685**

Date: **10/31/2019**

N.1: Emission Summary

Emission Unit #	Emission Unit Name	Process ID	Process Name	Control Device Name	Control Device ID	Stack ID	Maximum Design Capacity (SCF Units hour)	Pollutant	Uncontrolled Emission Factor (lb SCF Units)	Emission Factor Source (e.g. AP-42, Stack Test, Mass Balance)	Capture Efficiency (%)	Control Efficiency (%)	Hourly Emissions		Annual Emissions	
													Uncontrolled Potential (lb/hr)	Controlled Potential (lb/hr)	Uncontrolled Potential (tons/yr)	Controlled Potential (tons/yr)
27	Grinder (51)			dust collector			2400 parts/hr	PM		mass balance		99.90%	105.6	0.1056	462.528	0.462528
29	2 Mixers (61 & 71)			dust collector			0.477 tons/hr	PM		mass balance		99.90%	954	0.954	4178.52	4.17852
30	Grinders (AM 2)			dust collector			4800 parts/hr	PM		mass balance		99.90%	211.2	0.2112	925.056	0.925056
33	Boiler						4.5 mmBTU/hr									
34	Boiler						4.5 mmBTU/hr									
38	Grinder (71)			dust collector			2400 parts/hr	PM		mass balance		99.90%	105.6	0.1056	462.528	0.462528
39	Grinder (61)			dust collector			2400 parts/hr	PM		mass balance		99.90%	105.6	0.1056	462.528	0.462528
46	Grinder (AM 1 and 81)			dust collector			4800 parts/hr	PM		mass balance		99.90%	211.2	0.2112	925.056	0.925056
49	Emergency Generator						64 HP									
52	Grinder (AM3)			dust collector			720 parts/hr	PM		mass balance		99.90%	31.68	0.03168	138.7584	0.1387584

Section N.2: Stack Information

UTM Zone:

Stack ID	Identify all Emission Units (with Process ID) and Control Devices that Feed to Stack	Stack Physical Data			Stack UTM Coordinates		Stack Gas Stream Data		
		Equivalent Diameter (ft)	Height (ft)	Base Elevation (ft)	Northing (m)	Easting (m)	Flowrate (acfm)	Temperature (° F)	Exit Velocity (ft/sec)
	02 - Primer Spray Booth 03 - Adhesive Spray Booth	2.1	42				13,415	750	64.58
	04 - Grinders (Mod 2)	2.4	25				28,000	70	103.7
	06 - 4 Mixing Systems	2.4	25				28,000	70	103.7
	16 - Grinder (Mod 3)	2.52	25				28,000	70	93.57
	21 - Boiler	1.33	39				1809	209	21.69
	23 - Emergency Generator (Plant)			15				70	
	27 - Grinder (Mod 5)	2.52	25				28,000	70	93.57

Section N.2: Stack Information

UTM Zone:

Stack ID	Identify all Emission Units (with Process ID) and Control Devices that Feed to Stack	Stack Physical Data			Stack UTM Coordinates		Stack Gas Stream Data		
		Equivalent Diameter (ft)	Height (ft)	Base Elevation (ft)	Northing (m)	Easting (m)	Flowrate (acfm)	Temperature (°F)	Exit Velocity (ft/sec)
	29 - 2 Mixers (61, 71)	2.4	25				13,500	70	49.74
	30 - Grinders (AM 2)	2.4	25				28,000	70	103.16
	33 - Boiler	0.58	39				250	100	15.77
	34 - Boiler	0.58	39				250	100	15.77
	38 - Grinder 71	5	25				28,000	70	23.77
	39 - Grinder 61	5	25				28,000	70	23.77
	46 - Grinder AM 1 and 81	5	25				28,000	70	23.77
	49 - Emergency Generator (Guard Shack)								
	52 - Grinder (AM3)	5	30				83,000	70	81.75

Division for Air Quality 300 Sower Boulevard Frankfort, KY 40601 (502) 564-3999 DEP7007V Applicable Requirements and Compliance Activities ___ Section V.1: Emission and Operating Limitation(s) ___ Section V.2: Monitoring Requirements ___ Section V.3: Recordkeeping Requirements ___ Section V.4: Reporting Requirements ___ Section V.5: Testing Requirements ___ Section V.6: Notes, Comments, and Explanations Additional Documentation ___ Complete DEP7007AI							
Source Name: Akebono Brake - Glasgow Plant							
KY EIS (AFS) #: 21- 00900067							
Permit #: V-20-010							
Agency Interest (AI) ID: 15685							
Date: 2.12.2025							
Section V.1: Emission and Operating Limitation(s)							
Emission Unit #	Emission Unit Description	Applicable Regulation or Requirement	Pollutant	Emission Limit (if applicable)	Voluntary Emission Limit or Exemption (if applicable)	Operating Requirement or Limitation (if applicable)	Method of Determining Compliance with the Emission and Operating Requirement(s)
04, 16, 27, 30, 38, 39, 46, 52	Grinders	401 KAR 59:010 401 KAR 63:020 40 CFR 64	PM	2.34 lb/hr, ≤ 20% opacity		operate dust collector	CAM Plan, visible emission monitoring
06, 29	Mixers	401 KAR 59:010 401 KAR 63:020 40 CFR 64	PM	2.34 lb/hr, ≤ 20% opacity		operate dust collector	CAM Plan, visible emission monitoring
02, 03	Primer and Adhesive Spray Booths	401 KAR 59:010 401 KAR 59:225 401 KAR 63:020	PM, VOC	2.34 lb/hr, ≤ 20% opacity, ≤ 15% VOC		operate oxidizer	visible emission monitoring, material balance, temperature and flowrate monitoring

Division for Air Quality 300 Sower Boulevard Frankfort, KY 40601 (502) 564-3999 DEP7007V Applicable Requirements and Compliance Activities ___ Section V.1: Emission and Operating Limitation(s) ___ Section V.2: Monitoring Requirements ___ Section V.3: Recordkeeping Requirements ___ Section V.4: Reporting Requirements ___ Section V.5: Testing Requirements ___ Section V.6: Notes, Comments, and Explanations Additional Documentation ___ Complete DEP7007AI							
Source Name: Akebono Brake - Glasgow Plant KY EIS (AFS) #: 21- 00900067 Permit #: V-20-010 Agency Interest (AI) ID: 15685 Date: 2.12.2025							
Section V.1: Emission and Operating Limitation(s)							
Emission Unit #	Emission Unit Description	Applicable Regulation or Requirement	Pollutant	Emission Limit (if applicable)	Voluntary Emission Limit or Exemption (if applicable)	Operating Requirement or Limitation (if applicable)	Method of Determining Compliance with the Emission and Operating Requirement(s)
21, 33, 34	Boilers	401 KAR 59:015 401 KAR 63:020	PM, sulfur dioxide	0.522 lb/mmBTU, 20% opacity.		natural gas only	
23	Emergency Generator	401 KAR 63:002 40 CFR Part 63 Subpart ZZZZ		N/A		annual PM, nonroad diesel fuel, <100 hrs non-emergency	follow manufacturer's O&M instructions
49	Emergency Generator	401 KAR 63:002 40 CFR Part 63 Subpart ZZZZ, 40 CFR 60 Subpart IIII		N/A		nonroad diesel fuel, <100 hrs non-emergency	follow manufacturer's O&M instructions

Section V.2: Monitoring Requirements

Emission Unit #	Emission Unit Description	Pollutant	Applicable Regulation or Requirement	Parameter Monitored	Description of Monitoring
04, 16, 27, 30, 38, 39, 46, 52	Grinders	PM			monthly processing rate monthly hours of operation daily baghouse pressure drop weekly visible emissions
06, 29	Mixers	PM			monthly processing rate monthly hours of operation daily baghouse pressure drop weekly visible emissions
02, 03	Primer and Adhesive Spray Booths	PM, VOC	401 KAR 59:225 Section 4(8)		daily coating usage monthly hours of operation weekly visible emissions continuous combustion chamber temperature daily volumetric flow rate
21, 33, 34	Boilers	PM, Sulfur Dioxide	401 KAR 52:020 Section 10		monthly natural gas usage
23	Emergency Generator		40 CFR 63.6655(f) 401 KAR 52:020, Section 10		monthly hours of operation monthly amount of diesel fuel usage
49	Emergency Generator				monthly hours of operation monthly amount of diesel fuel usage

Section V.3: Recordkeeping Requirements

Emission Unit #	Emission Unit Description	Pollutant	Applicable Regulation or Requirement	Parameter Recorded	Description of Recordkeeping
04, 16, 27, 30, 38, 39, 46, 52	Grinders	PM			monthly processing rate monthly hours of operation daily baghouse pressure drop weekly visible emissions monthly emission calculations list of certified VE evaluators and dates of certification
06, 29	Mixers	PM			monthly processing rate monthly hours of operation daily baghouse pressure drop weekly visible emissions monthly emission calculations list of certified VE evaluators and dates of certification
02, 03	Primer and Adhesive Spray Booths	PM, VOC			daily coating usage monthly hours of operation weekly visible emissions combustion chamber temperature daily volumetric flow rate oxidizer performance test and capture efficiency monthly emission calculations list of certified VE evaluators and dates of certification
21, 33, 34	Boilers	PM, Sulfur Dioxide			monthly natural gas usage
23	Emergency Generator		40 CFR 60.6655(a)		maintenance records monthly hours of operation monthly fuel usage
49	Emergency Generator				maintenance records monthly hours of operation monthly fuel usage manufacturing instructions sulfur content and Cetane index of fuel

Section V.4: Reporting Requirements

Emission Unit #	Emission Unit Description	Pollutant	Applicable Regulation or Requirement	Parameter Reported	Description of Reporting
04, 16, 27, 30, 38, 39, 46, 52	Grinders	PM			opacity or PM emission limit exceedances to DAQ
06, 29	Mixers	PM			opacity or PM emission limit exceedances to DAQ
02, 03	Primer and Adhesive Spray Booths	PM, VOC			deviation from oxidizer's minimum temperature and flowrate requirements
21, 33, 34	Boilers	PM, Sulfur Dioxide			general reporting requirements
23	Emergency Generator		40 CFR 63.6640(e) 40 CFR 63.6650(h)		abnormalities only
49	Emergency Generator				monthly hours of operation on semi-annual report operation limit exceedances

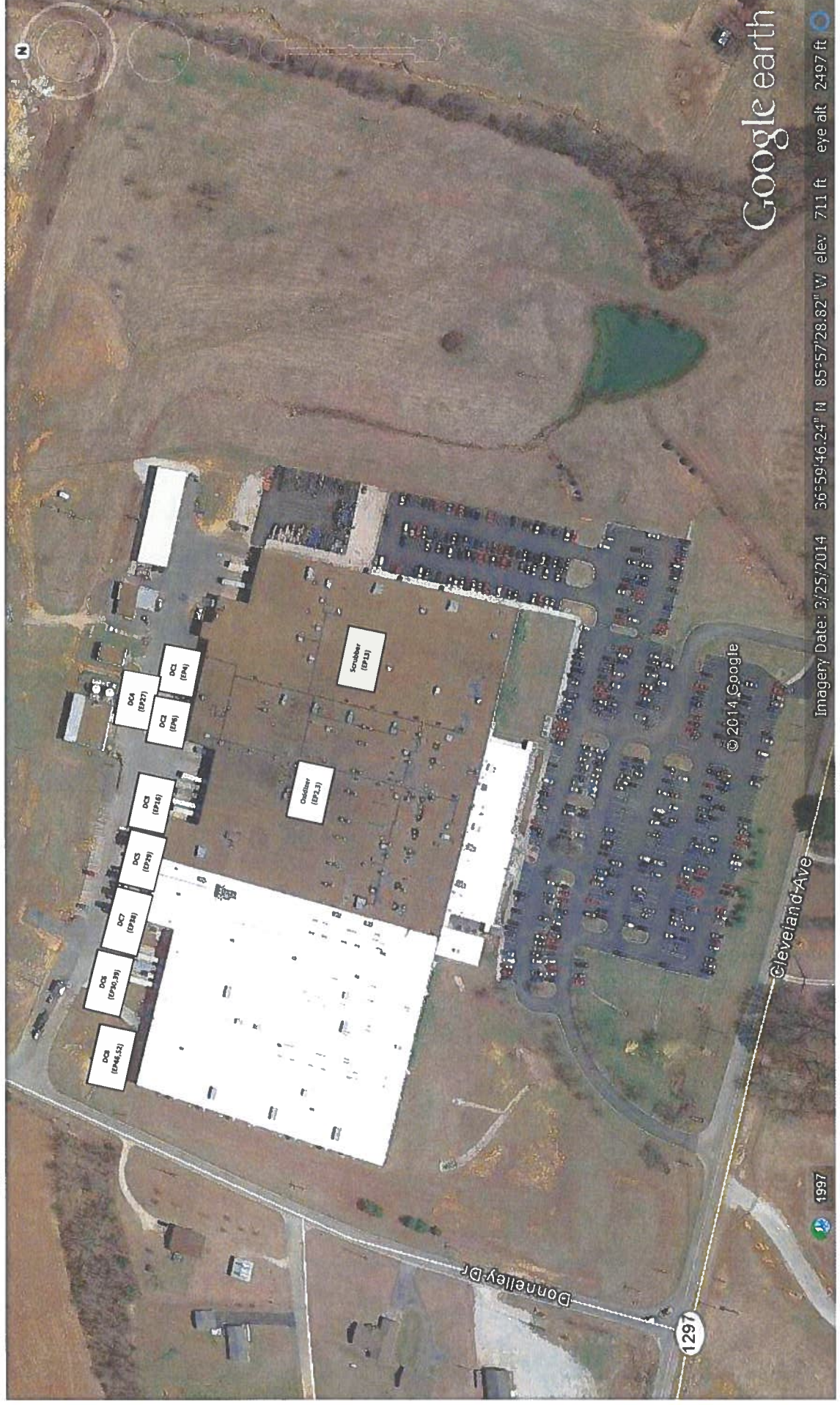
Section V.5: Testing Requirements

Emission Unit #	Emission Unit Description	Pollutant	Applicable Regulation or Requirement	Parameter Tested	Description of Testing
04, 16, 27, 30, 38, 39, 46, 52	Grinders	PM	401 KAR 50:045 401 KAR 50:015		
06, 29	Mixers	PM	401 KAR 50:065 401 KAR 50:015		
02, 03	Primer and Adhesive Spray Booths	PM, VOC			capture efficiency - initial compliance demonstration VOC destruction efficiency - every 5 years temperature and pressure
21, 33, 34	Boilers	PM, Sulfur Dioxide	401 KAR 50:215 401 KAR 50:015		
23	Emergency Generator		401 KAR 50:235 401 KAR 50:015		
49	Emergency Generator		401 KAR 50:495 401 KAR 50:015		

Akebono Brake
1765 Cleveland Ave.

Glasgow, KY

Location Map Showing Control Devices



ABG Title V Renewal - FEB 2025 Max Potential

Emission Point	Significant Activity	Description	Contaminant	BASIS - Mass Balance - Jun 2013 thru May 2014 Usage: 55494 KG. Peds produced 3697049 = 0.0015 KG/ Pad, Plus 3% Seige = 5289 KG E016 @ 0.001576 KG/Pad									
2	NO	Primer Booths - 2 units (ST 11 & 21)	VOC	17410.1508 LB/VYR	4000000 Pcs/Yr	0.001576 KG/PC	2.205 LB/KG	12 Booths	0.835 % VOC	15.0% Oxidizer 85%			
			Toluene	729.7665 LB/VYR	4000000 Pcs/Yr	0.001576 KG/PC	2.205 LB/KG	12 Booths	0.035 % Toluene	15.0% Oxidizer 85%			
			PM 10	2293.3528 LB/VYR	4000000 Pcs/Yr	0.001576 KG/PC	2.205 LB/KG	12 Booths	0.163 % Solid	10% Filter 90%			
			PM	2293.3528 LB/VYR	4000000 Pcs/Yr	0.001576 KG/PC	2.205 LB/KG	12 Booths	0.163 % Solid	10% Filter 90%			
3	NO	Adhesive Booths - 2 units (ST 11 & 21)	VOC	6298.784413 LB/VYR	4000000 Pcs/Yr	0.0011756 lbs E016/pc	0.134228188 Gal/LB	3.96 LB VOC/Gal	0.0005566 lbs E016/pc	0.137551582 Gal/LB			
			PM 10	2729.610339 LB/VYR	4000000 Pcs/Yr	0.0011756 lbs E016/pc	0.134228188 Gal/LB	3.49 LB Solid/Gal	0.0005566 lbs E016/pc	0.137551582 Gal/LB			
			PM	2729.610339 LB/VYR	4000000 Pcs/Yr	0.0011756 lbs E016/pc	0.134228188 Gal/LB	3.49 LB Solid/Gal	0.0005566 lbs E016/pc	0.137551582 Gal/LB			
			PM 10	1850.112 LB/VYR	2400 Pcs/HR	2 Units	0.044 Lb/Pad	8760 Hrs/Yr	0.10% Baghouse Efficiency 99.9%				
4	NO	2 - Convec Grinders (Mods 1&2)	PM	1850.112 LB/VYR	2400 Pcs/HR	2 Units	0.044 Lb/Pad	8760 Hrs/Yr	0.10% Baghouse Efficiency 99.9%				
			PM	1850.112 LB/VYR	2400 Pcs/HR	2 Units	0.044 Lb/Pad	8760 Hrs/Yr	0.10% Baghouse Efficiency 99.9%				
			PM	99.864 LB PM/YR	1500000 BTU/HR	0.001 hr/BTU	0.0000076 LB PM/HR	8760 HR/YR					
			SO2	24.966 LB PM/YR	1500000 BTU/HR	0.001 hr/BTU	0.0000019 LB PM/HR	8760 HR/YR					
5	YES	ST Cure Oven 11 - 1.5 mmBTU/hr	PM	7.884 LB SO2/YR	1500000 BTU/HR	0.001 hr/BTU	0.0000006 LB SO2/HR	8760 HR/YR					
			Nor	1314 LB Nox/Yr	1500000 BTU/HR	0.001 hr/BTU	0.0001 LB Nox/HR	8760 HR/YR					
			CO	1103.76 LB CO/YR	1500000 BTU/HR	0.001 hr/BTU	0.000084 LB CO/HR	8760 HR/YR					
			VOC	72.27 LB VOC/YR	1500000 BTU/HR	0.001 hr/BTU	0.0000355 LB VOC/HR	8760 HR/YR					
6	NO	4 Mixing Systems (Mixers 11, 31, 41)	BASIS - Mass Balance - Assuming 422.5 grams/pad (ABC's Largest)				422.5 grams/pad	0.002204624 lbs/gram	0.10% Baghouse Efficiency 99.9%				
			PM 10	36988.74645 LB/VYR	39710768 Pcs/Yr	1 System	422.5 grams/pad	0.002204624 lbs/gram	0.10% Baghouse Efficiency 99.9%				
			PM	36988.74645 LB/VYR	39710768 Pcs/Yr	1 System	422.5 grams/pad	0.002204624 lbs/gram	0.10% Baghouse Efficiency 99.9%				
			PM	211.445376 LB PM/YR	794000 BTU/HR	0.001 hr/BTU	0.0000076 LB PM/HR	8760 HR/YR	4 UNITS				
7	YES	4 - Scorifiers (0.794 mmBTU/hr each) (Mods 1&2)	PM 10	52.861344 LB PM/YR	794000 BTU/HR	0.001 hr/BTU	0.0000019 LB PM/HR	8760 HR/YR	4 UNITS				
			SO2	16.693056 LB SO2/YR	794000 BTU/HR	0.001 hr/BTU	0.0000006 LB SO2/HR	8760 HR/YR	4 UNITS				
			Nor	2782.176 LB Nox/Yr	794000 BTU/HR	0.001 hr/BTU	0.0001 LB Nox/HR	8760 HR/YR	4 UNITS				
			VOC	2337.02784 LB CO/YR	794000 BTU/HR	0.001 hr/BTU	0.000084 LB CO/HR	8760 HR/YR	4 UNITS				
9	YES	18 Make-Up Air Units (2-3.2 mmBTU/hr, 2-3.5 mmBTU/hr, 1-6.3 mmBTU/hr each) 1-54 mmBTU/hr, 6-6 mmBTU/hr, 2-2.83 mmBTU/hr, 4-9 mmBTU/hr)	PM	2804.1812 LB PM/YR	105300000 BTU/HR	0.001 hr/BTU	0.0000076 LB PM/HR	8760 HR/YR	0.4 EST RUNTIME				
			PM 10	701.04328 LB PM/YR	105300000 BTU/HR	0.001 hr/BTU	0.0000019 LB PM/HR	8760 HR/YR	0.4 EST RUNTIME				
			SO2	221.38272 LB SO2/YR	105300000 BTU/HR	0.001 hr/BTU	0.0000006 LB SO2/HR	8760 HR/YR	0.4 EST RUNTIME				
			Nor	36897.12 LB Nox/Yr	105300000 BTU/HR	0.001 hr/BTU	0.0001 LB Nox/HR	8760 HR/YR	0.4 EST RUNTIME				
10	YES	4-Aftercure Ovens - 1.98 mmBTU/hr each (Mod 2)	CO	30593.5008 LB CO/YR	105300000 BTU/HR	0.001 hr/BTU	0.000084 LB CO/HR	8760 HR/YR	0.4 EST RUNTIME				
			VOC	2029.3416 LB VOC/YR	105300000 BTU/HR	0.001 hr/BTU	0.0000355 LB VOC/HR	8760 HR/YR	0.4 EST RUNTIME				
			PM	527.28192 LB PM/YR	1980000 BTU/HR	0.001 hr/BTU	0.0000076 LB PM/HR	8760 HR/YR	4 UNITS				
			PM 10	131.82048 LB PM/YR	1980000 BTU/HR	0.001 hr/BTU	0.0000019 LB PM/HR	8760 HR/YR	4 UNITS				
14	YES	ST Cure Oven 21 - 1.5 mmBTU/hr	SO2	41.62752 LB SO2/YR	1980000 BTU/HR	0.001 hr/BTU	0.0000006 LB SO2/HR	8760 HR/YR	4 UNITS				
			Nor	6937.92 LB Nox/Yr	1980000 BTU/HR	0.001 hr/BTU	0.0001 LB Nox/HR	8760 HR/YR	4 UNITS				
			CO	5827.8528 LB CO/YR	1980000 BTU/HR	0.001 hr/BTU	0.000084 LB CO/HR	8760 HR/YR	4 UNITS				
			FORMALDEHYDE	38.83974359 LB/YR	10950000 psc/Yr	0.000114155 fVr/HR	1170 psc/Yr	0.00415 LB/HR	8760 HR/YR				
15A	YES	4-Aftercure Ovens - 1.98 mmBTU/hr each (Mod 3)	Phenol	16.14147321 lb/y	10950000 psc/Yr	0.000114155 fVr/HR	560 psc/Yr	0.0008255 LB/HR	8760 HR/YR				
			VOC	6248.321429 LB/YR	10950000 psc/Yr	0.000114155 fVr/HR	560 psc/Yr	0.0008255 LB/HR	8760 HR/YR				
			BASIS: Formaldehyde emissions based on Stack Test performed at ABC in July 2016 (Formaldehyde @ 1170 psch/r = 0.00415 lbs/hr). VOC emissions based on Stack Test performed at another AKEBONO facility (VOC @ 560 psch/r = 0.3196 lbs/hr). Other emissions Calculated uses AP-42										
			PM	527.28192 LB PM/YR	1980000 BTU/HR	0.001 hr/BTU	0.0000076 LB PM/HR	8760 HR/YR	4 UNITS				
15B	YES	4-Aftercure Ovens - 1.98 mmBTU/hr each (Mod 4)	PM 10	131.82048 LB PM/YR	1980000 BTU/HR	0.001 hr/BTU	0.0000019 LB PM/HR	8760 HR/YR	4 UNITS				
			SO2	41.62752 LB SO2/YR	1980000 BTU/HR	0.001 hr/BTU	0.0000006 LB SO2/HR	8760 HR/YR	4 UNITS				
			Nor	6937.92 LB Nox/Yr	1980000 BTU/HR	0.001 hr/BTU	0.0001 LB Nox/HR	8760 HR/YR	4 UNITS				
			CO	5827.8528 LB CO/YR	1980000 BTU/HR	0.001 hr/BTU	0.000084 LB CO/HR	8760 HR/YR	4 UNITS				
16	NO	1 - Grinder (Mod 3)	FORMALDEHYDE	38.83974359 LB/YR	10950000 psc/Yr	0.000114155 fVr/HR	1170 psc/Yr	0.00415 LB/HR	8760 HR/YR				
			Phenol	16.14147321 lb/y	10950000 psc/Yr	0.000114155 fVr/HR	560 psc/Yr	0.0008255 LB/HR	8760 HR/YR				
			VOC	6248.321429 LB/YR	10950000 psc/Yr	0.000114155 fVr/HR	560 psc/Yr	0.0008255 LB/HR	8760 HR/YR				
			BASIS - Mass Balance - Assuming 0.044 lb/pad is removed during process										

Emission Point	Insignificant Activity	Description	Contaminant	PM	925.056 LB/YR	2400 Pcs/HR	1 Units	0.044 LB/Pcd	8760 Hrs/YR	0.10% Baghouse Efficiency 99.9%
17	YES	2 - Scorchers (0.794 mmBtu/hr each) (Mod 3)	PM	BASIS - AP-42						
			PM		105.722688	794000 BTU/HR	0.001 P/BTU	0.0000076 LB PM/HR	8760 HRS/YR	2 UNITS
			PM10		26.430672	794000 BTU/HR	0.001 P/BTU	0.0000019 LB PM10/HR	8760 HRS/YR	2 UNITS
			SO2		8.346528	794000 BTU/HR	0.001 P/BTU	0.0000006 LB SO2/HR	8760 HRS/YR	2 UNITS
			Nox		1391.088	794000 BTU/HR	0.001 P/BTU	0.0001 LB NOx/HR	8760 HRS/YR	2 UNITS
			CO		1168.51392	794000 BTU/HR	0.001 P/BTU	0.000084 LB CO/HR	8760 HRS/YR	2 UNITS
18	YES	11 Powder Coat Painting Lines	VOC		76.50884	794000 BTU/HR	0.001 P/BTU	0.0000055 LB VOC/HR	8760 HRS/YR	2 UNITS
			Closed loop system - No Emissions							

Emission Point	Insignificant Activity	Description	Contaminant
21	YES	Natural Gas Boiler (4.5 mmBTU/hr)	BASIS - AP-42
			PM
			PM10
			SO2
			Nox
			CO
23	YES	Emergency Generator - plant	VOC
			NA - Only as minimum back-up
			BASIS - Formaldehyde emissions based on Stack Test performed at ABG in July 2016 (Formaldehyde @ 1170 psf/hr = 0.00415 lbs/hr). VOC emissions based on Stack Test performed at another AKEBONO facility (VOC @ 560 psf/hr = 0.3196 lbs/hr). Other emissions Calculated uses AP-42
			PM
			SO2
			Nox
24	YES	4-Acturecure Ovens - 1.20 mmBTU/hr each (Mod 5)	CO
			FORMALDEHYDE
			Phenol
			VOC
			BASIS - AP-42
			PM
25	YES	Mod 5 Fibermat Scorchers (2 @ 4.7616 mmBTU/hr)	SO2
			Nox
			CO
			VOC
			BASIS - Mass Balance - Assuming 0.044 lb/pad is removed during process
			PM10
27	NO	1 Slitter/Gninder (Mod 5)	PM
			BASIS - AP-42
			PM
			SO2
			Nox
			CO
28	YES	ST Cure Oven 31 - 1.0 mmBTU/hr	PM
			SO2
			Nox
			CO
			VOC
			BASIS - Mass Balance - Assuming 422.5 grams/pad (ABG's Largest)
29	NO	2 Mixing Systems (Miers 61 & 71)	PM
			PM10
			BASIS - Mass Balance - Assuming 0.044 lb/pad is removed during process
			PM10
			PM
			SO2
30	NO	AM Line 2 Grinding	PM
			PM10
			BASIS - Formaldehyde emissions based on Stack Test performed at another AKEBONO facility (VOC @ 560 psf/hr = 0.0009 lbs/hr). VOC emissions based on Stack Test performed at another AKEBONO facility (VOC @ 560 psf/hr = 0.0009 lbs/hr). Other emissions Calculated uses AP-42
			PM
			PM10
			SO2
31	YES	AM Line 1 Cure Ovens 1 & 2 - (1@ 79.5029 & 1@ 317329 mmBTU/hr	Nox
			CO
			FORMALDEHYDE
			Phenol
			VOC
			BASIS - Formaldehyde emissions based on Stack Test performed at ABG in July 2016 (Formaldehyde @ 150 psf/hr = 0.0009 lbs/hr). VOC emissions based on Stack Test performed at another AKEBONO facility (VOC @ 560 psf/hr = 0.3196 lbs/hr). Other emissions Calculated uses AP-42
32	YES	AM Line 2 Cure Ovens 1 & 2 - 79.864 mmBTU/hr each	PM
			PM10
			SO2
			Nox
			CO
			FORMALDEHYDE
33	YES	Natural Gas Boiler (4.5 mmBTU/hr)	PM
			PM10
			SO2
			Nox
			CO
			VOC
34	YES	Natural Gas Boiler (4.5 mmBTU/hr)	PM
			PM10
			SO2
			Nox
			CO
			VOC
35	YES	ST 31 Powder Adhesive Booth	PM
			PM10
			SO2
			Nox
			CO
			VOC

Emission Point	Significant Activity	Description	Contaminant	0 [Lb/Yr	12000000 [Pcs/Yr	1 Units	0.00135962 [Lb/Plate
			Cresol				

Emission Point	Significant Activity	Description	Contaminant							
48	YES	Mod 8 Scorchers (81 and 82 @ 4.76 MMbtu/hr ea)	BASIS - AP-42	PM	634.0165632 LB PM/YR	4761600 BTU/HR	0.001 lb/8TU	0.00000076 LB PM/YR	8760 LB/YR	2 UNITS
			PM 10	158.5041408 LB PM/YR	4761600 BTU/HR	0.001 lb/8TU	0.00000019 LB PM/YR	8760 LB/YR	2 UNITS	
			SO2	50.0539392 LB SO2/YR	4761600 BTU/HR	0.001 lb/8TU	0.00000006 LB SO2/YR	8760 LB/YR	2 UNITS	
			Nox	8342.3232 LB NOx/YR	4761600 BTU/HR	0.001 lb/8TU	0.0001 LB NOx/YR	8760 LB/YR	2 UNITS	
			CO	7007.551488 LB CO/YR	4761600 BTU/HR	0.001 lb/8TU	0.000084 LB CO/YR	8760 LB/YR	2 UNITS	
			VOC	458.827776 LB VOC/YR	4761600 BTU/HR	0.001 lb/8TU	0.0000055 LB VOC/YR	8760 LB/YR	2 UNITS	
49	YES	Emergency Generator - guard shack	NA - Only as minimum back-up							
			BASIS- Formaldehyde emissions based on Stack Test performed at ASIG Test performed at another AKEBONO facility (VOC @ 560 pcs/hr = 0.0009 lbs/hr), VOC emissions based on Stack Test performed at another AKEBONO facility (VOC @ 560 pcs/hr = 0.0009 lbs/hr). Other emissions Calculated using AP-42.							
51	YES	AM Line 3 Cure Ovens - 1 @ 0.956 mmBTU/hr; 1 @ 1.1874 mmBTU/hr	PM	142.6989984 LB PM/YR	2143400 BTU/HR	0.001 lb/8TU	0.00000076 LB PM/YR	8760 LB/YR	1 UNITS	
			PM 10	35.8747496 LB PM/YR	2143400 BTU/HR	0.001 lb/8TU	0.00000019 LB PM/YR	8760 LB/YR	1 UNITS	
			SO2	11.2657104 LB SO2/YR	2143400 BTU/HR	0.001 lb/8TU	0.00000006 LB SO2/YR	8760 LB/YR	1 UNITS	
			Nox	1877.6164 LB NOx/YR	2143400 BTU/HR	0.001 lb/8TU	0.0001 LB NOx/YR	8760 LB/YR	1 UNITS	
			CO	1577.199456 LB CO/YR	2143400 BTU/HR	0.001 lb/8TU	0.000084 LB CO/YR	8760 LB/YR	1 UNITS	
			FORMALDEHYDE	44.57088 LB/YR	7428480 pcs/Yr	0.000114153 YR/HR	150 pcs/Yr	0.0009 LB/HR	8760 LB/HR	
52	NO	AM Line 3 Grinding	Phenol	10.95037543 lb/Yr	7428480 pcs/Yr	0.000114153 YR/HR	0.0008235 LB/HR	8760 LB/HR	8760 LB/HR	
			VOC	4239.539657 LB/YR	7428480 pcs/Yr	0.000114153 YR/HR	560 pcs/Yr	0.0008235 LB/HR	8760 LB/HR	
			BASIS - Mass Balance - Assuming 0.044 lb/pad is removed during process							
			PM	277.5168 LB/YR	720 Pcs/HR	1 Units	0.044 lb/Pad	8760 Hrs/Yr	0.10% Baghouse Efficiency 99.9%	
			PM 10	277.5168 LB/YR	720 Pcs/HR	1 Units	0.044 lb/Pad	8760 Hrs/Yr	0.10% Baghouse Efficiency 99.9%	

TOTAL INSIGNIFICANT ACTIVITY EMISSIONS									
PM	9943.25 LB/YR PTE								
PM 10	2485.81 LB/YR PTE								
SO2	784.99 LB/YR PTE								
Nox	130832.25 LB/YR PTE								
CO	109899.09 LB/YR PTE								
Formaldehyde	493.78 LB/YR PTE								
Phenol	147.71 LB/YR PTE								
VOC	6221.25 LB/YR PTE								
HCL	0.00 LB/YR PTE								
Sodium Hydroxide	0.00 LB/YR PTE								
Ammonium Chloride	0.00 LB/YR PTE								
Fluoride	0.00 LB/YR PTE								
Chromium Compounds	0.00 LB/YR PTE								
Toluene	0.00 LB/YR PTE								
Cresol	0.00 LB/YR PTE								
Nitric	0.00 LB/YR PTE								
PLANTWIDE EMISSION POTENTIAL TOTALS (Including Insig. Activities)									
PM	75353.68 LB/YR PTE								
PM 10	67896.24 LB/YR PTE								
SO2	784.99 LB/YR PTE								
Nox	130832.25 LB/YR PTE								
CO	109899.09 LB/YR PTE								
Formaldehyde	493.78 LB/YR PTE								
Phenol	147.71 LB/YR PTE								
VOC	85930.19 LB/YR PTE								
HCL	0.00 LB/YR PTE								
Sodium Hydroxide	0.00 LB/YR PTE								
Ammonium Chloride	0.00 LB/YR PTE								
Fluoride	0.00 LB/YR PTE								
Chromium Compounds	0.00 LB/YR PTE								
Toluene	726.77 LB/YR PTE								
Cresol	0.00 LB/YR PTE								
Nitric	0.00 LB/YR PTE								



Installation and Operating Service Manual

FORCED DRAFT STEAM BOILERS

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Installation Instructions

Forced Draft Steam Boilers

Section

1

Note: Please read the entire instruction manual before attempting installation.

Insurance and local or state regulatory codes may contain additional or more stringent requirements than those contained in this manual. Installation must conform to these codes and any other authority having jurisdiction.

1.1 BOILER FOUNDATION

Before uncrating, the boiler location should be prepared. The boiler should set upon a good level concrete floor. If the boiler is not level or the floor is not in good condition, a concrete foundation should be built, the dimensions being larger than the outside dimensions of the boiler base.

DO NOT INSTALL BOILER ON COMBUSTIBLE FLOORING.

IMPORTANT

If the boiler is installed directly on a concrete floor where it is important that the floor be kept cool (such as an upper floor or mezzanine or when sitting over wiring conduits) set the boiler up on insulating tile or steel framework so that air may circulate underneath.

1.2 CLEARANCES

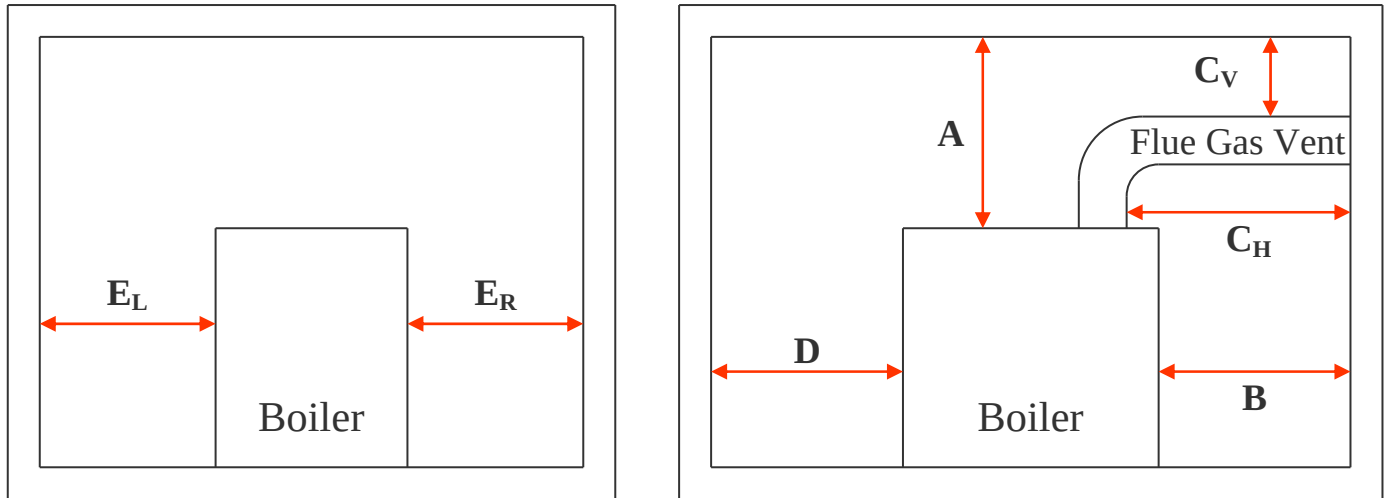
See Table 1.2 for minimum clearances to wall, ceilings, or obstructions. The clearances in Table 1.2 are intended as a general recommendation only. Local codes must be applied to specific installations and the minimum clearances established accordingly. Provisions must also be made for service, accessibility and clearance for piping and electrical connections. Do not obstruct combustion air and ventilation openings with piping or any other construction. All boilers must be installed in a space that is large compared to the boiler.

NOTE

ADHERE TO ALL APPLICABLE LOCAL CODES REGARDING BOILER INSTALLATION AND CLEARANCES.

Illustration 1.2 and Table 1.2 Minimum Clearances

NOTE: These boilers are intended to be installed in a room that is large compared to the size of the boiler. They are not intended for alcove installation and are suitable for installation on non-combustible flooring only.



DIM.	Description	AB, HEAB, CLM, HECLM, DR Series		RV, EB & HERV Series		RW Series	
		Water/ Steam to 50#	Steam over 50#	Water/Steam to 50#	Steam over 50#	Water/Steam to 50#	Steam over 50#
A	Clearance above top of boiler	18"	24"	18"	24"	18"	24"
B	Front of boiler – burner end	48"	48"	48"	48"	48"	48"
C_H	From chimney or vent collector measured horizontally	18"	24"	18"	24"	18"	24"
C_V	From chimney or vent collector measured vertically	18"	24"	18"	24"	18"	24"
D	Rear of boiler opposite burner end	18"	24"	18"	24"	18"	24"
E_L	Left Side – Tube access side on standard construction	24"	24"	32"	32"	32"	32"
E_R	Right Side	18"	24"	18"	24"	32"	32"

These clearances are general minimum clearances. Local codes may dictate larger clearances.

1.3 UNCRATING THE BOILER

Uncrate the boiler near its permanent location. Leave it on the bottom crating until ready to place it permanently. Leave the plastic shroud on the boiler until all piping work is complete, cutting holes in the plastic for access to connections.

Remove the bolts attaching the boiler to the crate at the underside of the bottom crating. Lift or slide the boiler off of the bottom crating into position. Be careful not to tip the boiler up on one corner or side, which could cause damage to jacket.

1.4 BOILER CONNECTIONS

1.4.1 GENERAL

Do not run any pipes along the access panel side of the boiler. Maintain clearances as shown on the dimensional drawing for servicing of the boiler tubes. Provide at least 36" from the gas train and burner, unless a larger dimension is indicated on the dimensional. All piping should be designed and installed to avoid any loadings on the boiler connections or piping.

1.4.2 STEAM SUPPLY CONNECTION

A steam shut-off valve must be installed between each boiler and the steam main. This valve must be of the outside screw and yoke design to allow indication from a distance whether the valve is open or closed.

1.4.3 FEEDWATER CONNECTION

Install a check valve and a globe valve between the feed pump and the boiler. It is also recommended to install a globe valve between the feed pump and the receiver tank. This valve can then be adjusted to bypass access pump capacity to better control the boiler feed rate.

BOILER MUST CONTROL FEED WATER

The water feed to the boiler must be controlled by the boiler-mounted water level control. It is unacceptable to use gravity return or to let the water feed be controlled by a condensate/receiver/condensate pump system. The water feed to the boiler must be controlled:

- by a feed pump control which is mounted on the boiler. This control is to activate the feed pump on a boiler feed system. It will be necessary to supply such a system if not already installed
- by an automatic water feeder mounted on the boiler. This is used only on systems requiring 100% make-up, such as humidification, steam process, etc.

NOTE

It is not recommended to provide the make-up for a closed steam heating system to the boiler by means of a water feeder. It is preferred that system make-up be connected to the condensate return tank of a boiler feed system. A boiler feed system may be used in conjunction with an existing condensate receiver system by allowing the receiver system to pump condensate into the boiler feed system tank.

1.4.4 SAFETY RELIEF VALVE(S)

A connection is provided in the top of the boiler for the relief valve. The relief valve discharge piping must be the same size as the relief valve discharge opening. Avoid over-tightening as this can distort valve seats. All piping from relief valve must be independently supported with no weight carried by the valve.

1.4.5 BLOWDOWN CONNECTION

Blowdown valve(s) must be full size of the connection on the boiler. Steam boilers 15 psig and below require at least one blowdown valve. Higher-pressure boilers require two blowdown valves with one or both valves being slow opening type. Each water column and float type low water cut-off must be equipped with a blowdown valve.

1.5 GAS SUPPLY CONNECTION

The installation must conform completely to the requirements of the authority having jurisdiction, or in the absence of such, requirements shall conform in the U.S. to the current National Fuel Gas Code, ANSI Z223.1-, or in Canada to the current Installation Code for Gas Burning Appliances and Equipment (CAN/CGA B149.1), or Oil Burning Equipment (CSA B139), and applicable regional regulations for the class; which should be followed carefully in all cases.

Drip leg must be installed on gas supply piping.

Consult the local gas utility company for inspection and authorization of all gas supply piping and flue connections.

The regulator vent line must be vented to outside of building on any boiler equipment with electric gas pilot ignition.

1.5.1 DRIP LEG

A drip leg, or sediment trap, must be installed in the gas supply line. See Fig. 1.5A. The gas line must be connected to a supply main at least as large as the gas train connection at the boiler. This connection should be made with a union so that the boiler gas train components and burner may be easily removed for service.

1.5.2 GAS PIPING LEAK TEST

After completion of the gas piping hookup, the installation must be checked for leaks, using a soap and water solution. Disconnect the boiler and gas train from the gas supply piping during any pressure testing of the gas supply system.

1.5.3 VENTING OF GAS TRAIN COMPONENTS

Gas pressure regulator - The regulator must be vented to the outside air, using minimum 1/4" tubing or pipe. The vent line should terminate in a downward direction to be free of restriction.

Diaphragm gas valves - The vent line off of these gas valves must be vented to outdoors, the same as the regulator.

Normally open vent valves - These valves must be piped to outdoors using pipe no smaller than that of the valve.

Gas pressure switches - Vent these switches to outdoors using a minimum of 1/4" tubing or piping.

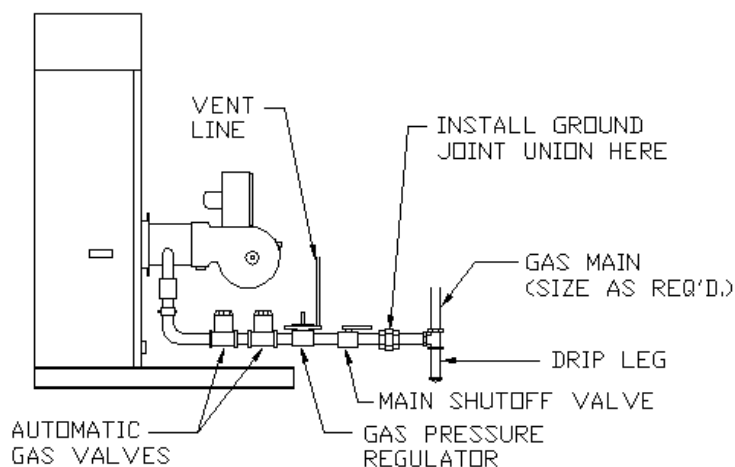


FIGURE 1.5A: GAS BURNER CONNECTION -

NOTE: USE PIPE COMPOUND THAT IS RESISTANT TO THE ACTION OF LIQUID PETROLEUM GAS. DO NOT USE TEFLON TAPE.

1.6 ELECTRICAL CONNECTION

IMPORTANT:

All electrical connections must conform to the National Electrical Code and to all other applicable State and Local Codes. Forced draft boilers may require a high voltage connection. See boiler wiring diagram and equipment list for details.

Equipment Grounding - The boiler must be grounded in accordance with the American National Standard Electrical Code, ANSI/NFPA #70.

1.7 COMBUSTION AIR SUPPLY

IMPORTANT:

Positive means for supplying an ample amount of outside air, allowing complete combustion of the gas, must be provided.

Movable combustion air dampers, automatic or manually adjustable, must be electrically interlocked with the boiler to prevent boiler operation if the dampers are closed.

Combustion air openings must never be blocked or obstructed in any manner.

The boiler room must be at a positive or neutral pressure relative to the outdoors. A negative in the boiler room will result in downdraft problems and incomplete combustion due to the lack of air.

WARNING!

Failure to provide an adequate air supply will result in boiler damage and hazardous conditions in the building (fire and asphyxiation hazard as well as equipment damage).

COMBUSTION AIR:

Complete combustion of natural or propane gas requires approximately ten cubic foot of air (at sea level and 70 Deg F) for each 1,000 Btu of boiler input. In reality additional air is required to achieve complete combustion. Air is also required for the proper operation of the appliance draft diverter or barometric damper. The combustion air opening recommendations below are designed to provide the air needed for atmospheric gas fired boilers that are equipped with either draft diverters or barometric damper. Combustion air openings for boilers which are equipped with forced draft burners may be reduced to 70% of that required for atmospheric gas fired boilers. This is because the forced draft boiler is not equipped with a draft diverter (so no air is required for draft control).

COMBUSTION AIR OPENINGS - AREA REQUIRED:

OPENINGS DIRECTLY THROUGH OUTSIDE WALL -

One opening within 12 inches of the ceiling plus one opening within 12 inches of the floor. **Each** opening must have a minimum free area of 1 square inch per 4,000 Btu of total input of all air using appliances in the room.

Example: A boiler room having two boilers with 500,000 Btu input would require two openings through an outside wall, and each opening must have at least 250 square inches of free area.

OPENINGS THROUGH VERTICAL DUCTS -

One duct in the ceiling plus one duct terminating within 12 inches of the floor. **Each** opening must have a minimum free area of 1 square inch per 4,000 Btu of total input of all air-using appliances in the room.

Example: A boiler room having four boilers with 250,000 Btu input would require two ducts, one in ceiling and one terminating near the floor, and each opening must have at least 250 square inches of free area.

OPENINGS THROUGH HORIZONTAL DUCTS -

One duct opening within 12 inches of the ceiling plus one duct opening within 12 inches of the floor. **Each** opening must have a minimum free area of 1 square inch per 2,000 Btu of total input for all equipment in the room. NOTE: No rectangular duct may have a dimension of less than 4 inches.

Example: A boiler room having 1 million Btu total input would require two ducts, one in ceiling and one near the floor, each opening having at least 500 square inches of free area.

VENTILATION AIR:

In addition to air needed for combustion, sufficient air must be supplied for ventilation, including air required for comfort and proper working conditions for personnel in the boiler room. In colder climates, provision should also be made to heat the boiler room, if necessary, for personnel comfort.

CAUTION

Protection from combustion air contamination:

Where corrosive or flammable process fumes are present in the vicinity of the boiler room or the air stream for the combustion air supply, it is essential that suitable means be provided for their safe disposal. The boiler room and the combustion air supply must not be exposed to the fumes. Such fumes include, but are not limited to, carbon monoxide, hydrogen sulfide, ammonia, chlorine, and halogenated hydrocarbons.

NOTE: Halogenated hydrocarbons are particularly injurious and corrosive after exposure to high temperatures.

1.8 CHIMNEY, FLUE PIPE & DRAFT CONTROL

1.8.1 GENERAL

CODE COMPLIANCE

The installation must conform to the requirements of NFPA 54, the National Gas Code (ANSI Z223.1), Part 7, "Venting of Equipment", or to the applicable requirements of all local building codes. For factory-built and listed chimney systems (such as type B vent), consult the system manufacturer's instructions for correct installation procedures. Gas vents may be of any of the construction types listed in this manual. No portion of a venting system may extend into or pass through any circulating air duct or plenum.

MINIMUM SAFE PERFORMANCE

Venting systems must be designed to develop positive flow adequate to remove flue gases to the outside atmosphere. Guidelines are provided in this manual and in the National Fuel Gas Code, NFPA 54, for sizing and design of flue gas venting system. For additional reference to good practice in vent design, refer to the "Chimney, Gas Vent, and Fireplace Design" chapter of the ASHRAE Equipment Handbook.

OUTSIDE VENTS AND CHIMNEYS

Outside uninsulated single wall pipe is not recommended for use in cold climates for venting gas-fired appliances since temperature differentials may cause corrosion in such pipe, as well as poor draft on start ups. When local experience indicates that condensate may be a problem, provisions should be made to drain off the condensate in the gas vent or chimney.

ESTIMATING FLUE GAS FLOW RATE (ACFM)

Flue gas volumetric flow rate in SCFM (standard cubic feet per minute) and ACFM (actual cubic feet per minute) can be estimated by using the information in 1.8.1A. Divide the Total Input of appliances connected to the chimney or vent by 1000. Then multiply this result times the factor listed in the SCFM and ACFM table. The ACFM data is required for determining stack exit velocity and induced draft fan requirements.

ESTIMATING STACK EXIT VELOCITY

First, determine the ACFM for the stack as described above. Multiply the total ACFM times the Velocity Factor from the Velocity Table in Table 1.8.1B for the stack diameter used. The result is the Stack Exit Velocity in feet per second.

ESTIMATING STACK EMISSIONS

Table 1.8.1C lists approximate emissions of NO_x (oxides of nitrogen) and CO (carbon monoxide). The table lists both the concentration, in parts per million (ppm), and the flow rate, in pounds per hour (PPH), of each compound: Divide the total input of appliances connected to the chimney or vent by 1,000,000. Then multiply this result times the value listed in the table for PPH emissions.

MANUAL REFERENCES

See Figure 1.8.1 for a graphics listing of applicable sections of this manual for each section of the vent system.

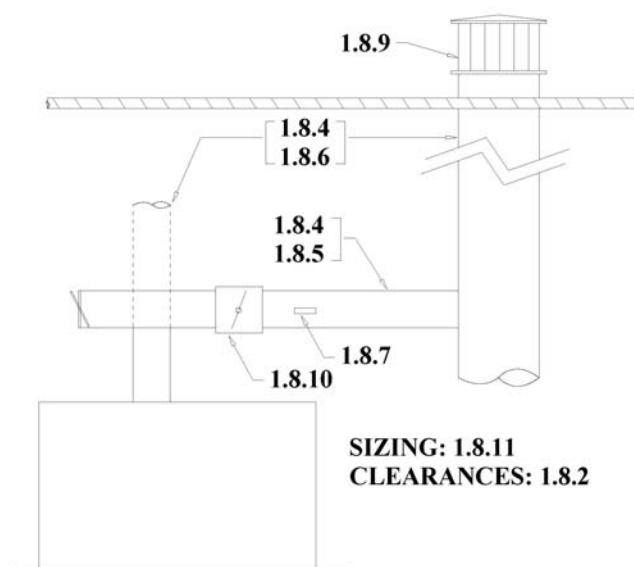


FIGURE 1.8.1: VENT DESIGN INSTRUCTIONS - REFERENCE

TABLE 1.8.1A: ESTIMATING FLUE GAS VOLUMETRIC FLOW RATE

Approximate Flue Gas VOLUMETRIC FLOW RATE (Per 1000 Btu/hr Input) (Multiply factor listed times boiler input in MBH)			
BOILER TYPE	SCFM Per 1000 Btu/hr INPUT	ACFM Per 1000 Btu/hr INPUT	APPROXIMATE FLUE GAS TEMPERATURE AT FULL INPUT
Water & 15# Steam			
Gas Fired	0.230	0.402	450 Deg F.
Oil Fired	0.230	0.402	450 Deg F.
150# Steam			
Gas Fired	0.230	0.425	500 Deg F.
Oil Fired	0.230	0.425	500 Deg F.

TABLE 1.8.1B: STACK EXIT VELOCITY

Estimated STACK EXIT VELOCITY Calculation (Multiply total ACFM times the velocity factor below velocity in feet per second)					
STACK INSIDE DIAMETER (Inches)	VELOCITY FACTOR	STACK INSIDE DIAMETER (Inches)	VELOCITY FACTOR	STACK INSIDE DIAMETER (Inches)	VELOCITY FACTOR
6	0.0849	18	0.00943	34	0.00264
7	0.0624	20	0.00764	36	0.00236
8	0.0477	22	0.00631	38	0.00212
10	0.0306	24	0.00531	40	0.00191
12	0.0212	26	0.00390	48	0.00133
14	0.0156	28	0.00340	60	0.00085
16	0.0119	32	0.00298		

TABLE 1.8.1C: ESTIMATING FLUE GAS EMISSIONS

Estimated Emissions (Volumetric Flow Rate Per Million Btu/hr Input)										
(Multiply PPH listed times boiler input divided by 1,000,000)										
BOILER TYPE	PARTICULATES		NOx		CO		SOx		Hydrocarbons	
	PPH per MMBH	PPM	PPH per MMBH	PPM	PPH per MMBH	PPM	PPH per MMBH	PPM	PPH per MMBH	PPM
Gas Fired	N/A	N/A	0.049	50	0.194	200	N/A	N/A	0.010	10
Oil Fired	0.020	20	0.068	70	0.018	18	0.286	290	0.004	4

1.8.2 CLEARANCES

The vent system and draft control devices must be installed so as to achieve the clearances to surfaces outlined in Table 1.2, Minimum Clearances chart, in this manual. See also Table 1.8.9 for vent clearances. All clearances must comply with the National Fuel Gas Code NFPA54, and with all local and state building codes. The clearances described in this manual are intended to be general guidelines only, additional requirements may occur because of local building design regulations.

1.8.3 BOILER ROOM PRESSURIZATION

The boiler room must be supplied with adequate air for combustion and for proper operation of draft control devices (barometric dampers or draft diverters) as outlined in "Combustion Air Supply", Section 1.7 of this manual

WARNING

THE BOILER ROOM MUST BE MAINTAINED AT A POSITIVE OR NEUTRAL PRESSURE (RELATIVE TO OUTDOORS) AT ALL TIMES. EXHAUST FANS OR CONNECTIONS FROM THE BOILER ROOM TO ZONES OF NEGATIVE PRESSURE (AIR DUCTS, NEGATIVE PRESSURE ROOMS, ETC.) WILL CAUSE NEGATIVE PRESSURE IN THE BOILER ROOM. SUCH CONDITIONS WILL CAUSE HAZARDOUS OPERATION OF THE BOILER AND INTRODUCTION OF COMBUSTION PRODUCTS INTO THE BUILDING AIR.

IF THE BOILER ROOM MUST BE UNDER A NEGATIVE PRESSURE AT ANY TIME, AN INDUCED DRAFT FAN WILL BE REQUIRED. FURTHER, THE BOILER MUST BE PROVIDED WITH A BAROMETRIC DRAFT CONTROL - THE FAN MUST BE INTERLOCKED WITH THE BOILER AND A DRAFT PROVING SWITCH MUST BE INSTALLED TO PREVENT OPERATION OF THE BOILER IF THE FAN SHOULD FAIL TO OPERATE.

IT ALSO MAY BE ADVISABLE TO INSTALL AN AUTOMATIC VENT DAMPER IN THE VENT SYSTEM TO PREVENT BACKFLOW THROUGH THE VENT SYSTEM DURING BOILER OFF CYCLES. SEE FOLLOWING SECTION ON AUTOMATIC VENT DAMPERS.

1.8.4 ACCEPTABLE VENT TYPES

LISTED GAS VENTS

Listed gas vents must be applied only on those applications for which they are listed. Type B gas vents are **NOT** listed for use on forced draft appliance vent systems. Installation of these vents must comply with the vent listing, with the vent manufacturer's instructions and with complete adherence to the codes and clearances as outlined previously.

PRESSURIZED VENT SYSTEMS

Some Bryan Boilers (unless specifically fitted for the application) are not suitable for operation on a pressurized vent system. Refer to Section 2 of this manual for the allowable range of vent pressure for each series. The DR, AB, EB, RV and RW series boilers are designed for pressurized vent systems. All others require a neutral pressure.

SINGLE-WALL METAL PIPE

Single-wall metal pipe must be of galvanized sheet or other approved noncombustible corrosion resistant material, with minimum thickness per Table 1.8.4 from the National Fuel Gas Code NFPA 54. Single-wall metal pipe should be insulated to prevent excessive heat in the boiler room and to avoid ignition and spillage problems as well as corrosion from excessive condensation.

MASONRY, METAL AND FACTORY BUILT CHIMNEYS

Installation of factory built vents and chimneys must comply with the vent listing, with the vent manufacturer's instructions and with adherence to the codes and clearances as outlined herein. Masonry or metal chimneys must be built and installed in accordance with nationally recognized building codes or standards.

MASONRY CHIMNEYS FOR RESIDENTIAL APPLICATIONS MUST BE LINED WITH FIRE-CLAY FLUE LINING (KX C315) OR THE EQUIVALENT WITH THICKNESS NOT LESS THAN 5/16 INCH OR WITH A LINER OF OTHER APPROVED MATERIAL THAT WILL RESIST CORROSION, SOFTENING OR CRACKING FROM FLUE GASES AT TEMPERATURES UP TO 1,800°F.

EXISTING CHIMNEYS SHOULD BE INSPECTED FOR UNSAFE CONDITIONS; SUCH AS DETERIORATED MASONRY AND EXCESSIVE SOOT OR OTHER BLOCKAGE OR POTENTIAL BLOCKAGE. SEE ALSO SECTION 1.8.6.

EXISTING CHIMNEYS MUST BE PROPERLY SIZED FOR THE FLUE GAS LOADING TO BE USED. THAT IS, IF AN EXISTING CHIMNEY IS USED FOR A SMALLER TOTAL INPUT THAN ITS ORIGINAL DESIGN, A LINER OR VENT IS REQUIRED. THE USE OF A PROPERLY SIZED GAS VENT OR LINER WILL PREVENT DETERIORATION OF THE CHIMNEY DUE TO THE EXCESSIVE CONDENSATION THAT RESULTS ON OVERSIZED SYSTEMS.

WARNING

UNDER NO CIRCUMSTANCES SHOULD THE FLUE PIPE BE CONNECTED TO THE CHIMNEY OF AN OPEN FIREPLACE

TABLE 1.8.4A WATER BOILER & STEAM BOILERS TO 50 PSIG		TABLE 1.8.4B (STEAM BOILERS OVER 50 PSIG)	
Diameter of Connector, Inches	Minimum Thickness, Inch (Gauge)	Diameter of Connector, Inches	Minimum Thickness, Inch (Gauge)
6 to 10	0.023 (24)	14 and less	0.053 (16)
10 to 12	0.029 (22)	14 to 16	0.067 (14)
12 to 16	0.034 (20)	16 to 18	0.093 (12)
16 +	0.056 (16)	18 +	0.123 (10)

1.8.5 VENT CONNECTORS (HORIZONTAL RUNS)

CONSTRUCTION

Vent connectors may be of any of the acceptable constructions listed in this manual.

AVOID UNNECESSARY BENDS

The vent connector must be installed so as to avoid turns or other construction features which create excessive resistance to flow of flue gases.

JOINTS

Vent connectors must be firmly attached to draft diverter outlets or boiler flue collars by sheet metal screws or other approved means. Vent connectors of Type B vent material must be assembled in accordance with the vent manufacturer's instructions. Joints between sections of connector piping must be fastened using sheet metal screws or other approved means.

SLOPE OF VENT CONNECTOR

The vent connector must be installed without any dips or sags and must slope upward at least 1/4 inch per foot.

LENGTH OF VENT CONNECTOR

The vent connector must be as short as possible and the boiler close as practical to the chimney or vent.

The horizontal run of an uninsulated vent connector to a natural draft chimney or vent servicing a single appliance must not be more than 75% of the height of the chimney or vent above the vent connector.

The horizontal run of an insulated vent connector to a natural draft chimney or vent servicing a single appliance must not exceed 100% of the height of the chimney or vent above the vent connector.

SUPPORT OF VENT CONNECTOR

The vent connector must be supported in accordance with the vent manufacturer's instructions and listing and with all applicable codes. Support should also be independent of the boiler or the draft diverter (when used). The vent connector must be: supported for the design and weight of the materials employed, maintain clearances, prevent physical damage and separation of joints, and to prevent sagging of the vent connector. Supports should usually be overhead hangers, and of load bearing capacity appropriate for the weight involved.

LOCATION

When the vent connector used for an appliance having a draft hood must be located in or pass through a crawl space or other area difficult to access or which may be cold, that portion of the vent connector must be of listed double wall Type B gas vent material, or of material having equivalent insulation qualities. Single wall metal pipe used as a vent connector must not pass through any floor or ceiling.

CHIMNEY CONNECTION

In entering a passageway in a masonry or metal chimney, the vent connector must be installed above the extreme bottom to avoid stoppage. Means must be employed which will prevent the vent connector from protruding so far as to restrict the space between its end and the opposite wall of the chimney. A thimble or slip joint may be used to facilitate removal of the vent connector. The vent connector must be firmly attached to or inserted into the thimble or slip joint to prevent the vent connector from falling out.

DAMPERS

Manually operated dampers must not be placed in the vent connector. This does not exclude the use of fixed baffles, locking quadrant dampers that are welded in a fixed position or automatic vent damper (when properly installed and interlocked with the boiler gas controls).

USE OF THIMBLES

Vent connectors made of single wall metal pipe must not pass through any combustible wall unless they are guarded at the point of passage by ventilated metal thimbles 6" larger in diameter than the vent connector. This may be done only on water boilers and steam boilers rated for operation at no higher than 50 psig.

SINGLE WALL METAL VENT PIPE USED TO VENT STEAM BOILERS OPERATING OVER 50 PSIG MUST NOT PASS THROUGH WALLS OR PARTITIONS CONSTRUCTED OF COMBUSTIBLE MATERIAL.

1.8.6 CHIMNEY & VENT CONSTRUCTION (VERTICAL SECTION)

INSTALLATION OF FACTORY BUILT SYSTEMS

Listed gas vents and factory built chimneys must be installed in accordance with their listings and the manufacturer's instructions. Vents and venting systems passing through roofs must extend through the roof flashing, roof thimble or roof jack.

INSTALLATION OF MASONRY OR METAL CHIMNEYS

Masonry or metal chimneys must be built in accordance with nationally recognized building codes and standards.

INSTALLATION OF SINGLE WALL GAS VENTS

Single wall metal pipe may be used only for runs directly from the space in which the appliance is located through the roof or exterior wall to the outer air. A pipe passing through a roof must extend without interruption through the roof flashing, roof jack, or thimble. Single wall metal pipe must not originate in any unoccupied attic or concealed space. Additionally it must not pass through any attic, inside wall, concealed space or through any floor. Minimum clearance must be maintained between the single wall metal pipe and any combustible surface as outlined in Table 1.8.6.

Table 1.8.6

EQUIPMENT TYPE	MINIMUM REQUIRED DISTANCE FROM COMBUSTIBLE MATERIAL		
	Listed Vent	Single Wall Metal Pipe	Factory Built Chimney
Water and 15 psig Steam Boilers	Not permitted	18"	as listed
All Steam Boilers over 15 psig	Not permitted	36"	as listed

When a single wall metal pipe passes through an exterior wall constructed of combustible material, it must be guarded at the point of passage by a ventilated thimble as described under "Use of Thimbles" in Section 1.8.5 of this manual.

Alternatively, a non-ventilating thimble not less than 18" above and 6" below the roof (with the annular space open at the bottom and closed at the top) may be used.

INSPECTIONS OF CHIMNEYS

Before connection of a vent connector to a chimney, the chimney passageway must be examined to ascertain that it is clear and free of obstructions. Cleanouts must be constructed such that they will remain tightly closed when not in use. Tee fittings used as cleanouts or condensate drains must have tight fitting caps to prevent entrance of air into the chimney at such points. When an existing masonry chimney is unlined and local experience indicates that vent gas condensate may be a problem, an approved liner or another vent must be installed. When inspection reveals that an existing chimney is not safe for the intended application, it must be rebuilt to conform to nationally recognized standards, relined with a suitable liner, or replaced with a gas vent or chimney suitable for the appliances to be attached.

SUPPORT OF CHIMNEYS AND VENTS

All portions of chimneys must be adequately supported for the design and weight of the materials employed. Listed factory built chimneys must be supported and spaced in accordance with their listings and the chimney or gas vent manufacturer's recommendation. THE GAS VENT OR CHIMNEY MUST BE SUPPORTED INDEPENDENTLY OF THE BOILER TOP.

1.8.7 MARKING OF GAS VENTS

In those localities where solid and liquid fuels are used extensively, gas vents must be plainly and permanently identified by a label reading: "This gas vent is for appliances which burn gas only. Do not connect to incinerators or solid or liquid fuel burning appliances."

This label must be attached to the wall or ceiling at a point near where the gas vent connector enters the wall, ceiling or chimney. The authority having jurisdiction must determine whether their area constitutes such a locality.

1.8.8 VENTING MULTIPLE APPLIANCES ON A COMMON VENT

COMMON GAS VENT

When two or more openings (for vent connectors) are provided in a chimney or gas vent, the opening should be at different levels. They should never be opposite one another.

When two vent connectors enter the same gas vent or chimney, the smaller of the two should enter at the highest position possible.

PRESSURIZED VENTS OR VENT CONNECTORS

DO NOT CONNECT THE FLUE OF AN APPLIANCE VENTED BY NATURAL DRAFT TO A VENT SYSTEM THAT OPERATES UNDER A POSITIVE PRESSURE.

SOLID FUEL APPLIANCE VENTS

Gas appliances must not be vented to a vent or a chimney that serves a solid fuel-burning appliance.

1.8.9 VENT AND CHIMNEY TERMINATIONS

HEIGHT ABOVE ROOF AND OBSTACLE

WATER BOILERS AND LOW PRESSURE STEAM BOILERS:

No less than 3 feet above the roof and no less than 2 feet above any parapet or obstacle closer than 10 feet from the vent outlet (Reference NFPA 211).

HIGH PRESSURE (OVER 15 PSIG) STEAM BOILERS:

No less than 10 feet higher than any portion of any building within a distance of 25 feet from the vent (Reference NFPA 211).

MINIMUM HEIGHT ABOVE DRAFT CONTROL

Chimneys and gas vents must extend at least 5 feet above the highest connected draft diverter outlet, barometric draft control or any appliance flue outlet.

CLEARANCE FROM AIR INLETS

The vent or chimney must terminate no less than 3 feet above any forced air inlet within a distance of 10 feet. It must terminate no less than 1 foot above, or 4 feet below, or 4 feet horizontally from, any door, window or gravity air inlet into a building.

CLEARANCE FROM PUBLIC WALKWAYS

The vent exit of a mechanical draft system must be at least 7 feet above grade when located next to public walkways.

PROTECTION OF BUILDING MATERIALS FROM POSSIBLE CORROSION OR DISCOLORATION FROM FLUE PRODUCTS

The products of combustion from gas or oil contain potentially corrosive gases and high temperatures. For this reason, the chimney or vent exit must be designed to prevent exposure of the building materials to the flue products. Failure to do so may result in deterioration or discoloration of building materials.

VENT SUPPORT

The gas vent or chimney must be securely positioned and supported. Guy wires or other reliable means must be used to prevent movement of the vent.

PROTECTION AGAINST BLOCKAGE OR OBSTRUCTION

The chimney or vent exit design must prevent any possibility of blockage by snow or by any other obstruction.

POWER VENTED EXHAUST SYSTEMS

When these are used, such mechanical exhaust devices must be electrically interlocked with all appliances on the vent system. The circuit must prevent the operation of any appliance on the system if the hood or exhaust system is not in operation.

STACK CAPS

Every gas vent must be supplied with an approved vent cap that will prevent the entrance of rain or other precipitation into the vent. Failure to provide such a cap may cause severe boiler corrosion or combustion problems or both.

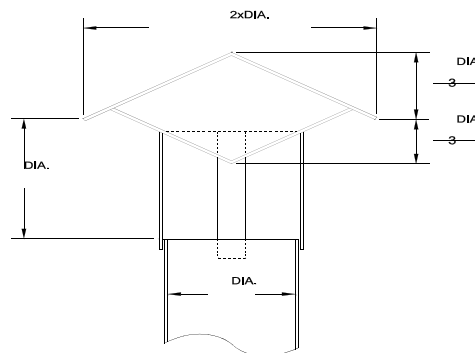
Listed gas vents must be terminated with a listed cap, approved for use with the particular gas vent.

Listed vent caps or roof assemblies must have a rated venting capacity no less than the vent.

Single wall vents must terminate in an approved cap which does not obstruct the exit. The preferred type of cap for natural draft vented atmospheric boilers is the Briedert Cap. This is because of the protection this cap provides against wind generated downdrafts.

Where there is no concern of high winds or turbulence at the vent exit, a low resistance conical cap may be used. See Fig. 1.8.9 for typical dimensions. The diameter of this type cap should be twice the vent diameter. The cap must be securely positioned on the vent such as to provide a clearance of one vent diameter above the vent exit

Figure 1.8.9



1.8.10 AUTOMATIC VENT DAMPERS

ONE APPLIANCE ONLY

An automatic vent must be installed such that it serves only one appliance vent - that to which is properly interlocked.

LISTING REQUIREMENTS

Automatic vent dampers, if used, must be of a listed type.

INSTALLATION

The damper installation must comply with the National Fuel Gas Code, NFPA 54. The installation must also comply with the automatic vent damper listing, the damper manufacturer's instructions and all applicable local or state building codes.

AUTOMATIC VENT DAMPERS MUST BE INSTALLED ONLY BY QUALIFIED SERVICE
TECHNICIANS. FAILURE TO PROPERLY INSTALL A VENT DAMPER WILL CREATE A
SEVERE HAZARD.

PERFORMANCE TEST

The damper must be tested after installation to assure its proper and safe operation.

AUTOMATIC VENT DAMPERS MUST BE IN THE OPEN POSITION AT ANY TIME THE
APPLIANCE MAIN GAS VALVE IS ENERGIZED

1.8.11 SIZING OF CHIMNEY AND VENT

The flue system calculations, which follow in Section 1.8.12, are applicable to double-wall or insulated single wall breechings (vent connectors) and stacks (vents). Do not apply these calculations to uninsulated vent systems.

HIGH ALTITUDES

At altitudes of 2000 feet and higher, atmospheric boilers must be derated. The amount of derate required by the National Fuel Gas Code is 4% per 1000 feet above sea level. Boilers that are shipped from the factory prepared for these altitudes have the gas orifices properly sized for this derate. The altitude and gas Btu content for which the boilers have been constructed is listed on the Equipment List/Submittal Data in the boiler manual. The boilers will also be provided with a label indicating that they have been prepared for high altitude. If a boiler is to be installed at an altitude other than that for which it was factory built, orifices must be replaced to properly adjust the gas input. Consult the factory or the local Bryan Representative for the proper parts. For the purpose of vent system sizing, assume full input and determine sizing as if at sea level. The derate factor of 4% per 1000 feet above sea level accounts for the increased volume per Btu/hr of flue products at high altitude.

INDUCED DRAFT FANS

Occasionally, the characteristics of an installation are such that a natural draft vent system will not suffice. In such cases, induced draft may be used. The vent system is then sized with an available "pumping" action equal to the total theoretical draft plus the static pressure capability of the induced draft fan. This will result in a smaller diameter vent than for a natural draft system. Sizing of induced draft fans should be done using the recommendations of the fan manufacturer and the ASHRAE Handbook.

MULTIPLE APPLIANCE INSTALLATIONS

Bryan recommends that boilers and other gas appliances be individually vented when possible. See figure 1.8.11A. Individual venting provides better draft control and fuel efficiency, and is less likely to cause condensation in the system. When individual venting is not possible, boilers may be vented to a common breeching (vent connector). See Fig. 1.8.11B for recommended design of such a system. Note that connections of individual boiler or appliance vents into the common breeching should be done with 45 Deg F elbows and not by "bullheading" directly into the vent connector at 90 Deg F angles. "Bullhead" connections generally cause excessive turbulence and poor draft conditions. On vent connectors serving multiple appliances, the diameter of the piping should be increased at each appliance's entrance so as to provide a relatively constant flue gas

velocity through the vent system. Using a constant diameter breeching will often result in poor draft at the outermost appliances.

Fig. 1.8.11A

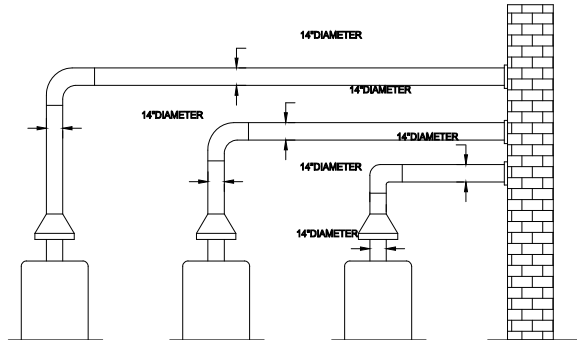
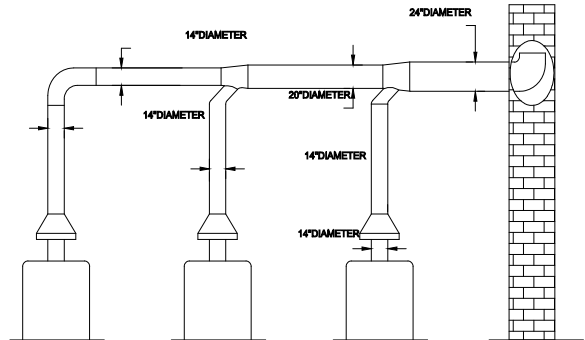


Fig. 1.8.11B



1.8.12 QUICK SELECTION FOR VENT SIZING

FIG. 1.8.11: SUGGESTED APPLIANCE VENTING PROCEDURE

CHARTS

GENERAL

These charts were generated using the procedure described in Chapter 26 of the ASHRAE Equipment Handbook. The results are consistent with those of the National Fuel Gas Code. The responsibility for assurance of such compliance is that of the system designer and/or the system installer. All sizing and installation must be checked against such local requirements. The sizing herein is applicable to vent systems utilizing double wall listed Type B vent as well as single wall insulated vent with insulation equivalent to double wall insulating value.

This sizing procedure is not applicable to vent systems utilizing single wall uninsulated vents or vent connectors. The sizing information given herein is intended as a general recommendation only. Vent sizing and installation must comply with local codes.

RECTANGULAR VENTS

Vent systems may be rectangular as well as circular. Table 1.8.12F has been provided to give the circular equivalent of a rectangular duct. These equivalent values account for the higher pressure drop per cross sectional area for rectangular ducts.

STEP 1: EQUIVALENT INPUT - DRAFT CONTROL FACTOR

Determine the boiler (system) Draft Control Factor, F_1 , from Table 1.8.12A.

Determine the boiler (or total system) input in MBH. This is done by dividing the boiler (or total system) input in Btu/hr by 1000.

Multiply the total input times factor F_1 .

The equivalent input, I , (without altitude correction) is then: $I = MBH \times F_1$ eq. 12A

TABLE 1.8.12A: DRAFT CONTROL FACTOR F_1 Multiply factor times input in MBH	
Boiler Type	Factor, F_1
Atmospheric with Draft Hood	1.000
Atmospheric with Barometric	0.741
Forced Draft Gas or Oil	0.602

STEP 2: EQUIVALENT INPUT - ALTITUDE FACTOR

Determine the boiler (system) Altitude Correction Factor, F_2 , from Table 1.8.12B.

Multiply the boiler (or total system) input times factors, F_2 and F_1 for the equivalent input.

Table 1.8.12B ALTITUDE CORRECTION FACTOR, F_2 (Multiple factor times sea level Input, MBH)			
Altitude (ft)	Factor, F_2	Altitude (ft)	Factor, F_2
0 to 1999	1.00		
2000	1.075	6000	1.247
2500	1.096	6500	1.272
3000	1.116	7000	1.296
3500	1.136	7500	1.322
4000	1.157	8000	1.346
4500	1.180	8500	1.373
5000	1.202	9000	1.399
5500	1.25	10000	1.453

The altitude correction factor, F_2 for atmospheric boilers is equal to 1, because their inputs are already derated for altitude.

The equivalent input, I , with corrections for altitude is: $I = MBH \times F_1 \times F_2$ eq. 12B

STEP 3: SELECT TRIAL DIAMETER

Determine the NET STACK HEIGHT for the vent. (The net stack height is the vertical distance from the top of the atmospheric boiler draft control to the top of the stack. On forced draft boilers it is the distance from the boiler flue connection to the top of the stack.)

Find the vent of TRIAL STACK DIAMETER. Enter Table 1.8.12C at the Net Stack Height column equal to the system net stack height. Then proceed down the column to the input which is just larger than the Equivalent Input of the system. Read the Trial Stack Diameter in the left hand column.

NOTE: This is only a trial diameter. Proceed to Step 4 to calculate the system k-factor to determine the actual stack diameter required.

STEP 4: CALCULATE SYSTEM K-FACTOR

The system "k-factor" accounts for the pressure drop through fittings and vent piping. It is calculated by adding up the individual k-factors for each of the fittings plus the k-factor for the vent pipe(s).

From Table 1.8.15D find the k-factors for each of the elbows, tee fittings, draft regulators, etc. in the system. Then calculate the vent piping k-factor from the formula:

$$k_{\text{piping}} = 0.4 \times L/D \quad \text{eq. 12C}$$

L = total length of piping in feet

D = diameter of piping in inches

Add all the k-factors together to determine the total system k-factor:

$$k_{\text{total}} = k_{\text{piping}} + k_{\text{fittings}} \quad \text{eq. 12D}$$

NOTE: On multiple appliance systems, multiply the k-factor times 1.5. This is required only on atmospheric boiler vent systems, not on forced draft systems.

<u>Table 1.8.12D: Vent Fitting k-Factors</u>			
Vertical Draft Hood Barometric Draft Control	1.50 0.50	Low Resistance Stack Cap	
Round Elbow, 90 Deg Round Elbow, 45Deg	0.75 0.30	Converging Exit Cone	$(D1/D2)^4 - 1$ (D1 is larger than D2)
Tee or 90 Deg Breeching Y Breeching	1.25 0.75	Tapered Reducer	$1 - (D2/D1)^4$ (D1 is larger than D2)

STEP 5: CORRECT EQUIVALENT INPUT FOR SYSTEM K-FACTOR

The capacities listed in Table 1.8.12C are based on a system k-factor equal to 7.5. For any other k-factor, the vent capacity must be adjusted. This is accomplished by adjusting the equivalent input for the system using a k-factor correction factor, designated F3.

Refer to Table 1.8.12E for the equivalent input correction factor that applies to the k-factor calculated in Step 4. This factor is designated as F3. Multiply the equivalent input calculated in Step 2 times factor F3 from Table 1.8.12E. This step will yield a new equivalent input, I:

$$I = MBH \times F1 \times F2 \times F3 \quad \text{eq. 12E}$$

Using this adjusted equivalent input, check the stack diameter by following Steps 2 thru 3 again. If the stack diameter remains the same, the sizing is complete. If not, redo Steps 4 thru 5 etc. until an acceptable result is achieved.

Stack Diam. (in.)	Table 1.8.12C: Approximate Stack Capacities (MBH) (Based on Atmospheric Boiler with Draft Hood)																			
	5	7	10	12	15	20	25	30	35	40	45	50	60	70	80	90	100	125	150	200
6	100	120	140	150	170	200	220	250	270	280	300	320	350	380	400	430	450	510	550	640
7	130	160	190	210	240	270	310	340	360	390	410	430	480	510	550	580	620	690	760	870
8	180	210	250	280	310	360	400	440	480	510	540	570	620	670	720	760	810	900	990	1140
9	220	270	320	350	390	450	510	560	600	640	680	720	790	850	910	970	1020	1140	1250	1450
10	280	330	400	430	490	560	630	690	750	800	850	890	980	1060	1130	1200	1260	1410	1550	1790
12	400	480	570	630	700	810	910	1000	1080	1150	1220	1290	1410	1520	1630	1730	1820	2040	2330	2580
14	550	650	780	860	960	1110	1240	1360	1470	1570	1660	1750	1920	2070	2220	2350	2480	2770	3040	3510
16	720	850	1020	1120	1250	1450	1620	1770	1920	2050	2170	2290	2510	2710	2900	3070	3240	3620	3970	4590
18	910	1080	1290	1420	1590	1830	2050	2250	2430	2590	2750	2900	3180	3430	3670	3890	4100	4590	5030	5810
20	1130	1340	1600	1750	1960	2260	2530	2770	3000	3200	3400	3580	3920	4240	4530	4810	5070	5670	6210	7170
22	1370	1620	1940	2120	2370	2740	3060	3360	3630	3880	4110	4340	4750	5130	5480	5820	6130	6860	7510	8680
24	1630	1930	2300	2530	2820	3260	3650	4000	4320	4610	4900	5160	5650	6110	6530	6920	7300	8160	8940	10330
26	1910	2260	2710	2960	3320	3830	4280	4690	5070	5420	5750	6060	6640	7170	7660	8130	8570	9580	10490	12120
28	2220	2630	3140	3440	3850	4440	4970	5440	5880	6280	6660	7030	7700	8310	8890	9430	9940	11110	12170	14060
30	2550	3010	3600	3950	4420	5100	5700	6250	6750	7210	7650	8070	8840	9540	10200	10820	11410	12760	13970	16140
32	2900	3430	4100	4490	5020	5800	6490	7110	7680	8210	8710	9180	10050	10860	11610	12310	12980	14510	15900	18360
34	3270	3870	4630	5070	5670	6550	7320	8020	8670	9270	9830	10360	11350	12260	13110	13900	14650	16390	17950	20730
36	3670	4340	5190	5670	6360	7350	8210	9000	9720	10390	11020	11620	12730	13750	14700	15590	16430	18370	20120	23240
48	6530	7730	9230	10120	11310	13060	14600	16000	17280	18470	19600	20660	22630	24400	26130	27710	29210	32660	35780	41320
54	8260	9780	11690	12810	14320	16530	18480	20250	21870	23380	24800	26140	28640	30930	33070	35080	36970	41340	45290	52290
60	10200	12070	14430	15810	17680	20410	22820	25000	27000	28870	30620	32280	35360	38190	40830	43310	45650	51040	55910	64560
72	14700	17390	20780	22770	25460	29400	32870	36000	38890	41570	44100	46480	50920	55000	58800	62360	65740	73500	80510	92970

Table 1.8.12E: K-Factor Equivalent Input Correction Factor F_3

K- Factor F_3	K- Factor F_3	K- Factor F_3	K- Factor F_3	K- Factor F_3
1.00 0.37	5.50 0.86	10.00 1.15	14.50 1.39	19.00 1.59
1.50 0.45	6.00 0.89	10.50 1.18	15.00 1.41	19.50 1.61
2.00 0.52	6.50 0.93	11.00 1.21	15.50 1.44	20.00 1.63
2.50 0.58	7.00 0.97	11.50 1.24	16.00 1.46	20.50 1.65
3.00 0.63	7.50 1.00	12.00 1.26	16.50 1.48	21.00 1.67
3.50 0.68	8.00 1.03	12.50 1.29	17.0 1.51	21.50 1.69
4.00 0.73	8.50 1.06	13.00 1.32	17.50 1.53	22.00 1.71
4.50 0.77	9.00 1.10	13.50 1.34	18.00 1.55	22.50 1.73
5.00 0.82	9.50 1.13	14.00 1.37	18.50 1.57	23.00 1.75

Table 1.8.12F: CIRCULAR EQUIVALENTS OF RECTANGULAR BREECHINGS & STACKS

WIDTH (IN)	HEIGHT (INCHES)																	
	6	8	10	12	14	16	18	20	22	24	26	28	30	36	42	48	54	60
6	7	8	8	9	10	10	11	11	12	12	13	13	14	15	16	17	17	18
8	8	9	10	11	11	12	13	13	14	15	15	16	16	15	19	20	21	21
10	8	10	11	12	13	14	15	15	16	17	17	18	18	17	21	22	23	24
12	9	11	12	13	14	15	16	17	18	18	19	20	20	20	23	25	26	27
14	10	11	13	14	15	16	17	18	19	20	21	21	22	22	26	27	29	30
16	10	12	14	15	16	17	19	20	20	21	22	23	24	24	28	29	31	32
18	11	13	15	16	17	19	20	21	23	23	24	24	25	26	29	31	33	34
20	11	13	15	17	18	20	21	22	24	24	25	26	27	27	31	33	35	37
22	12	14	16	18	19	20	22	23	25	25	26	27	28	29	33	35	37	39
24	12	15	17	18	20	21	23	24	26	26	27	28	29	31	34	37	39	40
26	13	15	17	19	21	22	24	25	27	27	28	29	31	32	36	38	40	42
28	13	16	18	20	21	23	24	26	28	28	29	31	32	35	37	40	42	44
30	14	16	18	20	22	24	25	27	31	29	31	32	33	36	39	41	44	46
36	15	17	20	22	24	26	27	29	33	32	33	35	36	39	42	45	48	50
42	16	19	21	23	26	28	29	31	35	34	36	37	39	42	46	49	52	55
48	17	20	22	25	27	29	31	33	37	37	38	40	41	45	49	52	56	59
54	17	21	23	26	29	31	33	35	39	39	40	42	44	48	52	56	59	62
60	18	21	24	27	30	32	34	37	39	40	42	44	46	50	55	59	62	66

1.8.13 SPECIAL APPLICATIONS

FLUE GAS ECONOMIZERS

When applying flue gas economizers, care must be taken to assure that:

1. Proper draft must be maintained. This requires that the gas side pressure drop be considered and that the economizer exchanger must be designed so as to allow cleaning.
2. The vent system materials must be considered regarding resistance from corrosion that might result from the lower flue gas temperature.
3. In general, it is recommended that the boiler manufacturer be consulted when a flue gas economizer is to be added.

HIGH EFFICIENCY APPLIANCES

High efficiency appliances require special consideration in vent design because of the reduced stack gas temperatures. Under no circumstances can a condensing type appliance be vented into the same vent system with other appliances. The vent system for such appliances must be provided by or specified specifically by the manufacturer of the condensing appliance.

High efficiency non-condensing appliances should generally be installed only on vent systems that are resistant to corrosion from flue gas condensate. This generally requires stainless steel vent construction.

1.9 BURNERS AND GAS TRAINS

GENERAL

Refer to separate manual on the forced draft burner for start-up and adjustment procedures. Do not attempt to start burner when excess oil has accumulated, or when the combustion chamber is full of gas, or if chamber is very hot.

FUEL CONNECTIONS

Gas supply connections must comply with the National Fuel Gas Code (NFPA 54). Oil Supply connections must comply with (NFPA 31). Any additional local or state codes must also be adhered to. Oil supply lines must be sized for the circulation rate of the burner pump.

This is referred to as the suction gear capacity of the pump. If a transfer pump is used, it must have a pumping capacity no less than the total suction gear capacity of all burner pumps on the system. Refer to Burner Manual for the suction gear capacity of standard oil pumps. Two-pipe oil systems are recommended in all cases, although a one-pipe system might be acceptable on smaller boilers (under 6 gph). Two-pipe systems tend to have fewer problems with air entrainment in the oil. Air in the oil will cause nuisance problems and delayed ignition.

1.10 PROCEDURES TO BE FOLLOWED BEFORE PLACING BOILER IN OPERATION

1.10.1 HYDROSTATIC TEST OF BOILERS AND SYSTEM

After completing the boiler and burner installation, the boiler connections, fittings, attachments and adjacent piping must be inspected for leaks by filling the unit with water. The pressure should be gradually increased to a pressure just below the setting of boiler safety relief valve(s).

Remove the boiler tube access panels (see dimensional drawing in this manual). Inspect the tube to header joints to be certain that all tube fittings are sealed. This is necessary because, although the boiler is hydrostatically tested at the factory, minor leaks in fittings and at attachments can develop from shipping vibration or from installation procedures. It is often necessary to retighten such fittings after installation and after the boiler has been operated for some time. Replace tube access panels before proceeding to start boiler.

1.10.2 TEST OF GAS PIPING

Reference gas system test under Section 1.5, "Gas Connection", in this manual.

Section

2

START-UP AND OPERATION FORCED DRAFT STEAM

WARNING:

IMPROPER SERVICING AND START-UP OF THIS EQUIPMENT MAY CREATE A POTENTIAL HAZARD TO EQUIPMENT AND TO OPERATORS OR PERSONS IN THE BUILDING.

SERVICING AND START-UP MUST BE DONE ONLY BY FULLY TRAINED AND QUALIFIED PERSONNEL.

CAUTION:

BEFORE DISCONNECTING OR OPENING ANY FUEL LINE, OR BEFORE CLEANING OR REPLACING PARTS OF ANY KIND TAKE THE FOLLOWING PRECAUTIONS:

Turn **OFF** the main fuel shutoff valves, including the pilot gas cock if applicable. If the burner is a multiple fuel type, shut **OFF** all fuel supplies.

Turn **OFF** all electrical disconnects to the burner, boiler and any other equipment or systems electrically interlocked with the burner or boiler.

All cover plates, enclosures, and guards must be in place at all times except during maintenance and servicing.

2.1 FIRING RATE ADJUSTMENT

Proper procedures must be followed carefully before putting the boiler in operation. Failure to do so will present severe hazards to equipment, operating personnel and building occupants.

Refer to Burner Manufacture's Installation Operation Manual for firing rate adjustment.

2.2 FIRING RATE ADJUSTMENT – GAS METER READINGS

2.2.1 CHECKING BURNER INPUT

The burner input rate can be checked by taking readings from the gas meter. Please note checking the rate with a meter is the only way to be sure of input. Manifold readings are only an approximate value and may vary from unit to unit.

In order to obtain accurate data, there must be no other appliances using gas from the same meter while the burner input rate is being checked. The test hand on the meter should be timed for several revolutions. The input rate in cubic feet per hour is calculated from this timing. The method is described in the Lighting Instructions. If the meter is not calibrated for gas temperature and pressure, correction factors must be applied to determine correct rate in SCFH (standard cubic feet per hour). Consult the National Fuel Gas Code (ANSI Z223.1, NFPA 54) or the local gas utility for further information. Refer to Table 2.2A for correction factors for the gas pressure at the meter. Refer to Table 2.2B for the gas temperature correction factors.

Table 2.2A - Pressure Correction		Table 2.2B - Temperature Correction	
Gas Pressure at Meter	Correction Factor	Gas Temp. at Meter	Correction Factor
7" w.c.	1.017	40 Deg F	0.920
14" w.c.	1.034	50 Deg F	0.902
21" w.c.	1.051	60 Deg F	0.885
1 psig	1.061	70 Deg F	0.868
2 psig	1.136	80 Deg F	0.852
5 psig	1.340	90 Deg F	0.836

2.3 SAFETY SHUT-OFF DEVICES (FLAME SUPERVISION)

Refer to Burner Manufacture's Installation Operation Manual for Flame Supervision device instructions.

2.4 LIMIT CIRCUIT CUT-OUT TEST

2.4.1 PROTECTIVE DEVICES

All operating and limit controls, and low water cutoffs must be tested for proper operation.

2.4.2 OPERATING CONTROL

The pressure in the boiler is regulated by the Boiler Operator. This is a pressure control which senses the steam pressure and turns the boiler on and off accordingly. This control must be operationally tested. Adjust the pressure setting on the control to a pressure less than the boiler pressure (as shown on the boiler pressure gauge). The control should turn the boiler off. Restore the control setting to normal. The boiler should cycle on.

2.4.3 HIGH LIMIT CONTROL

At least one additional pressure control is provided as the high limit control. It is set at a pressure above the operator to act as a back-up should the operator fail. The high limit control must be operationally tested. With the boiler operating, decrease the pressure setting of the limit control below the current pressure of the boiler. The boiler should cycle off. Restore the high limit control setting to normal (pushing the reset button if it is a manual reset type). The boiler should now cycle on.

2.4.4 LOW WATER CUT-OFF(S)

Most boilers are supplied with a float-operated primary low water cut-off (and pump control or water feeder combination) or electric probe type auxiliary control. These water level controls are intended to sense (and control) the level of the water in the boiler. It operates to shut off the boiler if the water level drops below its sensing level. The low water cut-off controls must be operationally tested by manually lowering the boiler water level (by opening the boiler blowdown valve for probe controls, and by opening the control blowdown valve for float type controls). The boiler should cycle off when the water level drops below the control point of the low water cut-off. When the water level is restored, the boiler should cycle back on. Depress the manual reset button of devices that require manual reset in order to restore the boiler to operation. Carefully read the enclosed literature on the low water cut-off controls, particularly installing, operating and servicing.

2.4.5 COMBINATION LOW WATER CUT-OFF & FEEDER

The low water cut-off/feeder supplied with some boilers serves as a low water cut-off (see above) and also causes make-up water to be added to the boiler, should the water level drop below its control point. This type of control must be operationally tested as described in Section 2.4.1 and also to assure that the make-up water is introduced as needed. Carefully read the enclosed literature on the Low Water Cut-off controls, particularly installing, operating and servicing.

2.4.6 OTHER CONTROLS

Additional controls, as required for the particular installation, may also be provided. Refer to the literature on these devices included in the Boiler Manual. All such devices must be operationally tested to assure reliable operation of the boiler and system.

2.5 RECOMMENDED DRAFT AND COMBUSTION READINGS

FORCED DRAFT GAS FIRED BOILERS					
BOILER SERIES	DRAFT AT BOILER OUTLET (i.w.c.)	CO ₂ @ HIGH FIRE	O ₂ @ HIGH FIRE	CO (ppm)	SMOKE NO.
AB	+0.25 TO -0.06	9.0 TO 10.0 %	4.8 TO 3.0 %	< 400	0
CLM	0.0 TO -0.04	8.5 TO 10.0 %	5.8 TO 3.0 %	< 400	0
DR	+0.10 TO -0.06	9.0 TO 10.0 %	4.8 TO 3.0 %	< 400	0
EB	+0.10 TO -0.10	9.0 TO 10.0 %	4.8 TO 3.0 %	< 400	0
RV & RW	+0.50 TO -0.10	9.0 TO 10.0 %	4.8 TO 3.0 %	< 400	0

FORCED DRAFT OIL FIRED BOILERS					
BOILER SERIES	DRAFT AT BOILER OUTLET (i.w.c.)	CO ₂ @ HIGH FIRE	O ₂ @ HIGH FIRE	CO (ppm)	SMOKE NO.
AB	+0.25 TO -0.06	11.5 TO 12.5 %	5.6 TO 4.2 %	< 400	0
CLM	0.0 TO -0.04	10.0 TO 12.0 %	7.6 TO 5.0 %	< 400	0
DR	+0.10 TO -0.06	10.0 TO 12.0 %	7.6 TO 5.0 %	< 400	0
EB	+0.10 TO -0.10	11.5 TO 12.5 %	5.6 TO 4.2 %	< 400	0
RV & RW	+0.50 TO -0.10	11.5 TO 12.5 %	5.6 TO 4.2 %	< 400	0

NOTE: THE VALUES FOR CO₂ AND O₂ ARE SHOWN FOR HIGH FIRE ONLY. THE VALUES FOR LOW FIRE OR MID RANGE WILL GENERALLY BE LOWER, PARTICULARLY FOR ATMOSPHERIC GAS-FIRED BOILERS. DRAFT SHOULD BE MEASURED APPROXIMATELY 24" FROM TOP OF BOILER, BEFORE ANY DRAFT CONTROL.

2.5.1 DRAFT ADJUSTMENT - FORCED DRAFT BOILERS

Draft adjustments are generally not necessary on forced draft boilers. The draft must be measured as part of the start-up procedure. The measured draft at the boiler flue should fall within the recommended range specified in the appropriate table.

On some installations, the draft may be excessive due to a high chimney. In these cases, the draft should be adjusted to within the recommended range specified in the appropriate table above.

This may be done using a barometric damper, a restrictor, or a locking quadrant damper. Such devices must be installed and adjusted by a qualified technician.

2.5.2 COMBUSTION

Refer to the separate burner manual for the procedures for burner adjustments. The burner must be adjusted for a smooth lightoff. Combustion parameters should be within the appropriate range specified in the above table. In no case should the level of CO or the smoke spot reading be allowed to exceed the recommended limit.

2.6 OPERATING INSTRUCTIONS

2.6.1 FAMILIARIZATION WITH MANUAL(S)

The user of the boiler must familiarize himself with this manual (and the burner manual for those units which are forced draft) to be sure he is prepared to operate and maintain the boiler properly. The operating instructions should be kept adjacent to the boiler.

READ THE MANUAL BEFORE ATTEMPTING A START UP.

2.7 MAINTENANCE SCHEDULE

2.7.1 POSTING SCHEDULE

Post a maintenance schedule in accordance with the recommendations in this manual. A copy of a typical schedule is included in this manual.

CARE AND MAINTENANCE STEAM BOILERS

CAUTION:

- The boiler area should be kept free of combustible materials, gasoline and other flammable liquids.
- The boiler and venting system must be kept free of obstructions of the air louvers and draft hood relief openings.
- The following procedures must be conducted as outlined to assure safe operation of the boiler.
- All cover plates, enclosures, and guards must be in place at all times, except during maintenance and servicing.

3.1 REQUIRED PRECAUTIONS DURING TEMPORARY USE

A boiler is often utilized in new construction to assist in curing of building components or to provide temporary heat for the construction crew or for other purposes during the time the building is under construction. If precautions are not taken during this time to protect the boiler, a great deal of damage can occur before the ultimate owner takes over the building.

It is the mutual responsibility of the installing contractor and the boiler owner to consider the effect of temporary usage on the boiler warranty. The following should be observed so as to assure the longevity of the boiler.

OPERATOR SKILLS/RESPONSIBILITIES

During the temporary use period, a single individual must be assigned responsibility for the care and operation of the boiler. This person's responsibility must include, but not be limited to the following:

- Knowledge of burner/boiler operations
- Possession and understanding of boiler/burner operating instruction manual.
- Assurance that the boiler is fed with only treated water at all times and that chemical treatment and blowdown procedures are always followed.

Notification to the manufacturer (or manufacturer's agent) to provide start-up services if the boiler was purchased with start-up by a factory representative.

Adhere to all of the start-up procedures as noted in the boiler/burner manual.

Consideration of warranty should the boiler be used for temporary heat without adherence to the recommended start-up and operating procedures outlined in the instruction manuals.

3.2 CLEANING THE BOILER AND SYSTEM – NEW SYSTEMS

BOIL OUT PROCEDURE

The internal surfaces of a newly installed boiler will have oil, grease, or other protective coatings used in manufacturing. Such coatings must be removed since these coatings lower the heat transfer rate and could lead to overheating of a tube and reduce operating efficiency. Before boiling out procedures may begin, the burner must be ready for firing. The operator must be familiar with the procedure outlined in the boiler/burner operating instruction manuals.

In combination with system contamination, bacteria may cause objectionable odors, sometimes resembling natural gas. It is important to keep these fumes from air intake that would distribute them throughout the building. On steam humidification systems this is especially critical. Consult your local water treatment chemist for further information.

CAUTION

The boil out procedure outlined must be performed by, or under the direct supervision of, a qualified technician. The chemicals used present a hazard of burns and physical injury if mishandled. Always use suitable facemask, goggles, protective gloves and garments when handling caustic chemicals. Do not permit the chemical to come into contact with skin or clothing. Always follow the safety precautions on the container's label. Add chemicals slowly and in small amounts to prevent excessive heat and agitation. Do not add water to acid. Do not add water to dry chemicals. This will cause splattering and/or explosion and severe risk of personal injury.

Boiling out under pressure is not recommended. If boil out under pressure is required, competent assistance must be provided.

Your water consultant or water treatment company will be able to recommend a cleaning or boil out procedure. In the event that such service is unavailable or as yet not selected, the following may be used.

The boil out of the boiler and system is neither difficult nor expensive. The chemicals needed for cleaning are readily available. Tri-sodium phosphate, or sodium hydroxide (lye) are the most commonly used chemicals. Use only one type of solution in the system. The amount of chemical required will vary according to conditions, but an amount of one pound of chemical per fifty gallons of water is suggested.

Before introducing the solution into the boiler, an overflow pipe should be attached to the top of the boiler and routed to a safe point of discharge.

Remove all safety valves to ensure that none of the solution will come into contact with the valve seats. Use care in removing and reinstalling valves.

All valves in the piping to and from the system must be closed to prevent the chemical solution from getting into the system.

Gauge glasses must be protected from contact with the boil out chemicals.

Fill the boiler with clean softened water until the water level reaches the upper header. Then add the cleaning solution into the upper header. Add more clean water until the boiler is completely filled. The water used for this initial fill should be at room temperature and must be softened as noted.

After filling, fire the boiler intermittently (at low fire) at a frequency as necessary to hold the boiler solution at boiler point temperature. **DO NOT PRODUCE STEAM PRESSURE.** Boil the water, supervised at all times, for at least five hours.

After the five-hour boil out, begin to add a small amount of fresh softened water so as to create a slight overflow of the overflow pipe. This will carry out impurities that have accumulated at the water surface. Continue to apply heat and overflow until the water emitted from the overflow pipe clears. Then shut off burner.

Let the boiler cool to 120°F or less. Then drain the boiler. Use caution that the water is discharged with safety.

Remove the inspection/cleanout openings in the boiler upper and lower headers and wash the waterside surfaces thoroughly using high-pressure water stream.

Inspect the boiler's internal (waterside) surfaces thoroughly after the procedure. If the surfaces are not clean, repeat the boil out.

After boil out, close all openings. Install relief valves, gauge glasses and other components as necessary. Completely fill the boiler with fresh, softened, ambient temperature water. Fire the boiler at low fire until water temperature of at least 180°F is reached. This will drive off dissolved gases.

The boiler is now ready to operate.

3.3 SYSTEM CLEAN OUT

Many boilers have been ruined with system contaminants such as pipe dope, cutting oil, metal shavings or chips, and other debris that are left in the piping. If these contaminants are not removed they will end up in the boiler.

SYSTEM CLEANING PROCEDURE

For steam systems, the boiler will need to be connected to the header utilizing steam to purge the piping and thus push the debris out of the system. However, at this time, all condensate must be wasted until it runs clear and water analysis of the condensate indicates that it is free of contaminants. Steam trap strainers must be periodically opened and cleaned of any debris that accumulates.

During this system clean out, the boiler make-up water must be properly softened and treated. At the conclusion of the system clean out, the condensate must be reconnected.

For old or existing steam systems, the installation process may have jarred debris loose. Following the boil out of the new boiler, the condensate should be wasted until it is within proper guidelines. Check all steam trap strainers to assure their cleanliness. Refer to the succeeding section on replacement boiler installations.

3.4 REPLACEMENT BOILER INSTALLATIONS: PROTECTION AGAINST CORROSION & SEDIMENT

CLEAN OR REPLACE ALL SYSTEM PIPING AND HEATING UNITS

Arrange for chemical or mechanical cleaning of the entire system. A chemical treatment company should be consulted for the proper means of any chemical cleaning.

Replace any piping considered to be deteriorated beyond safe or cleanable condition.

Flush the system clean, being certain to isolate the boiler.

DO NOT FLUSH THE SYSTEM THROUGH THE BOILER.

NOTE:

For some old systems, there is a reluctance to clean the piping because of possible leaks occurring in badly corroded lines. Should the customer refuse cleaning, it is necessary to install filtration equipment. Install either a fibrous filter or a centrifugal filter in the boiler return piping. This will collect and remove sediment from the system. A booster pump may be required to overcome the additional pressure drop introduced in the line by the filter. When filling the system, provide chemical treatment as outlined in Section 3.3.

CAUTION

Failure to properly clean the system or to install mechanical sediment removal equipment can result in tube blockage and severe corrosion plus damage to pumps, controls, and air removal devices.

3.5 BOILER WATER TREATMENT

PURPOSE OF WATER TREATMENT

Water treatment is required for satisfactory operation of the boiler. It must be devised to prevent depositing of scale and corrosion from acids, oxygen and other such harmful elements that may be in the water supply. A qualified water treatment chemist should be consulted and the water systematically treated.

OBJECTIVES

The basic objectives of water treatment are:

- Prevent the accumulation of scale and deposits in the boiler.
- Remove dissolved gases from the water.
- Protect the boiler against corrosion.
- Maintain the highest possible boiler fuel efficiency.
- Decrease the amount of boiler down time from cleaning.

WATER SOFTENER

It is highly recommended that a zeolite water softener be used for all make-up to the boiler. It is intended that this be used in addition to the chemical treatment of the boiler. Water softening removes calcium and magnesium, the primary causes of hard boiler scale.

CONTINUOUS MONITORING REQUIRED

Water treatment should be checked and maintained whenever the boiler is operating. The boiler operator should be sure that the boiler is not operating for long periods without proper water treatment.

Water treatment may vary from season to season or over a period of time. Therefore, the water treatment procedure should be checked not less than four times a year and possibly more frequently as the local water conditions may indicate.

3.6 EXTERNAL "FIRE-SIDE" CLEANING

PURPOSE

Carbon (soot) is an insulator and is corrosive. The heating surface of a boiler must be kept free from soot accumulation to keep the boiler operating at its highest efficiency and to avoid damage from corrosion.

SOOT REMOVAL

If the yearly inspection of the boiler tube surfaces reveals a build-up of soot or rust (usually due to condensation), the tubes should be thoroughly brushed. (Tube cleaning brushes are available from Bryan Steam) To inspect and, if necessary, clean the tube surfaces and flue collector, first remove the tube access panels. Examine the exterior of the tubes for evidence of soot or rust. Using a flashlight, carefully look between the tubes. There should be an unobstructed opening between all tubes, and the top surfaces of the tube must be free from soot accumulation. Also inspect the interior of the flue collector. Brush or vacuum the soot from all surfaces. Be sure to cover the burner nozzle with a protective cover during cleaning to prevent soot from falling into it.

If the buildup of soot is appreciable, the flue gas venting system must be thoroughly inspected internally as well, and cleaned as necessary.

IMPORTANT

If either soot or condensation is apparent, a boiler service technician should be consulted. The presence of soot indicates poor combustion and possibly hazardous boiler operation. Failure to do so may result in fire, explosion potential, or asphyxiation. A combustion test and burner adjustments should be undertaken at once.

3.7 SUGGESTED MAINTENANCE SCHEDULE

DAILY

- Make visual inspection of gauges, monitors, and indicators and record readings in boiler log.
- Make visual check of instrument and equipment settings against factory recommended specifications.
- Check operation of float type low water cutoffs to ensure control is functioning. The lower piping connections of float type level controls should have a suitable blowdown valve piped into a proper drain. This valve should be opened periodically to allow any sludge accumulated in the control to be flushed out. Consult manufacturer's instructions.

WEEKLY

- On units equipped with firing rate control, verify it is functioning correctly by adjusting control and observing if input changes accordingly.
- Make visual inspection of pilot flame. Check pilot flame signal strength and main flame operation as specified in burner manual.
- Check pilot and main fuel valves for correct operation. Open limit switch - make audible and visual check - check valve position indicators and check fuel meters, if supplied.
- Confirm boiler area is free of combustible materials and that there is nothing obstructing air openings, relief openings, etc.
- Check combustion safety controls for flame failure and flame signal strength as specified in manufacturer's instructions in the burner manual.
- Check all limit controls as specified in Section 2.4 of this manual.
- Check float low water cutoff as described above.

MONTHLY

- Make visual inspection of linkage and proper operation of flue, vent, stack, or outlet dampers. Check draft as specified in Section 2 of this manual.
- Check float low water cutoff as described above.
- Check low draft, fan, air pressure and damper position interlocks as specified in burner manual.
- Check high and low gas pressure interlocks. Refer to manufacturer's instructions for correct procedure.

- Check high and low oil pressure interlocks. Refer to manufacturer's instructions for correct procedure.

ANNUALLY

- Perform leakage tests on pilot and main gas or main oil fuel valves as specified in manufacturer's instructions.
- Check operating control, high limit, low fire start control, and low water cutoff as specified in manufacturer's instructions.
- Check air atomizing interlock, fuel valve interlock switch, purge switch, burner position interlock, and fuel changeover control, as specified in burner manual.

The boiler should be checked at least yearly by the local gas utility company

The flue gas passages and the exterior surfaces of the boiler tubes should be inspected at least annually. Any accumulation of soot or debris should be thoroughly cleaned out.

If the yearly inspection of the boiler tube surfaces reveals a build-up of soot (carbon) or rust, the tubes surfaces should be thoroughly brushed. Failure to do so may result in fire or asphyxiation hazards.

The boiler pressure vessel and piping should be checked annually.

3.8 FLOAT-ACTUATED WATER LEVEL CONTROLS

Inspect float type water level controls for proper operation. Visually inspect sight glasses for evidence of scale forming residues. Refer to section 3.9 for gauge glass maintenance.

On closed steam heating systems, the float low water cutoff should be blown down by means of opening a blowdown valve on the lower connection of the cutoff once per day.

On humidification or process systems, the blowdown schedule should be based on recommendation from a water treatment and maintenance program specifically designed for the boiler.

At the annual inspection, all float type level controls should be disassembled, cleaned and inspected thoroughly. When reinstalled these controls must be given an operational test.

3.9 WATER GAUGE GLASSES

INSTALLATION

Check with the maintenance supervisor and engineer for the proper glass to be used. Compare the box and the glass label or marking to ascertain that the gauge glass ratings or temperature and pressure suitable for use on the boiler. Use new gaskets when replacing glass. The gaskets used should be the same type as those originally supplied with the boiler. Make certain that the gauge glass valves are properly aligned.

All bolts and nuts must be free running and well lubricated, preferably with a graphite type lubricant. Washers under nuts and bolt heads are desirable. DO NOT tighten while equipment is in operation.

MAINTENANCE

Inspect the gauge glass regularly for any signs of clouding or scratching. In new processes, the gauge glass should be inspected daily until the need for replacement becomes apparent. This will help establish the routine inspection cycle.

The gauge glass should be blown down daily so as to remove accumulated sediment from the valves.

INSPECTION

To examine for scratches, shine a bright concentrated light at about a 45 Deg angle. Anything that glistens brightly should be inspected closely. Any scratch which glistens and will catch a fingernail, or crescent-shaped or star-shaped mark is cause for replacement. This is because scratches, corrosion, chips, and surface damage weaken the glass. If inner surface appears cloudy or roughened, and will not respond to cleaning procedures, this is evidence of chemical attack. If severe, this is cause for replacement.

REPLACEMENT OF GLASS

Any glass that has been removed from its mounting in process boilers, regardless of the reason for removal, should be discarded and replaced with a new glass and gaskets. Used glasses may contain hidden damage and represent a safety hazard.

Be sure that the replacement glass is suitable for service conditions.

Protective shields to keep cold air, water, or falling objects from glass must be replaced.

3.10 IDLE BOILER CARE AND LAY-UP

GENERAL

Corrosion damage to boilers is often the result of improper lay-up during non-operating periods. Substantial damage can occur in only a few days if proper precautions are not taken. This damage is irreversible and will reduce boiler reliability, increase maintenance costs and eventually shorten the useful life of the boiler tubes.

Idle boilers are vulnerable to attack when air contacts untreated wet metal surfaces. To prevent corrosion, the boiler metal must be protected by either keeping the surfaces completely dry or excluding air from the boiler. Air exclusion is accomplished by either keeping the boiler completely full of water (short term lay-up) or filling the boiler with nitrogen gas (long-term lay-up). The nitrogen gas prevents air infiltration and does not react with the metal.

In addition to the corrosion damage that occurs, the metal particles that are released will form an insulating scale on the tubes when the boiler is returned to service. These corrosion products will accumulate on critical heat transfer areas of the boiler, increasing the potential for localized corrosion and overheating.

PRE-OPERATIONAL CLEANING AND LAY-UP

In operation, boiler water contains suspended solids that are held in suspension due to water circulation and the action of treatment chemicals. Unless care is exercised when draining the boiler, these suspended solids settle on the tube surfaces and will air dry to an adherent deposit, sometimes requiring chemical cleaning to remove. In addition, these deposits may be misleading regarding the effectiveness of the chemical treatment program.

PRE-SHUTDOWN PRECAUTIONS

For a period of three to seven days prior to shutdown, manual blowdown frequency should be increased. During this period, the lower conductivity limit should be below 3500 micro-mohs per centimeters. The feed of internal treatment must be increased to maintain a specific residual concentration. Continuous blowdown (when used) should be kept to a minimum so the reduction of solids is achieved by the increased manual blowdown.

WASHDOWN

As the boiler cannot be washed immediately, the heat in the boiler may cause baking of residual sludge. The boiler should not be drained until cooled enough to prevent this. However, never leave the boiler filled with water for any extended period of time without taking measures to prevent corrosion.

LAY-UP CONSIDERATIONS

There are two basic methods of steam boiler lay-up: Wet lay-up or Dry lay-up. The choice of which method should be used depends on:

- The possibility that the boiler may need to be placed operation on short notice.
- Disposal of lay-up solution
- Freezing potential

Wet Lay-Up is recommended for relatively short outages, such as seasonal lay-up. This method has the advantage of allowing the boiler to be brought on line with short notice. But it can pose problems if there is any likelihood of freezing.

Dry Lay-Up is recommended for longer periods of boiler shutdown or storage. But it is practical only if boiler can be drained hot (120° F to 170° F) or if external drying can be provided.

WET LAY-UP OF STEAM BOILERS – SHORT TERM

In the wet lay-up procedure, the boiler is to be filled with chemically treated water and sealed to prevent air in-leakage. Nitrogen gas under slight pressure can also be used to displace air and protect the boiler surfaces from corrosion. The following steps should be taken for wet lay-up of a boiler:

1a. Procedure for Operational Boiler:

At least thirty minutes before the boiler comes off line, add the following chemicals:

Sodium Sulfite – 0.5 lbs per 100 gallons water

Polymeric Sludge Dispersant – 0.1 lbs per 100 gallons water

Caustic Soda – 0.3 lbs per 100 gallons water

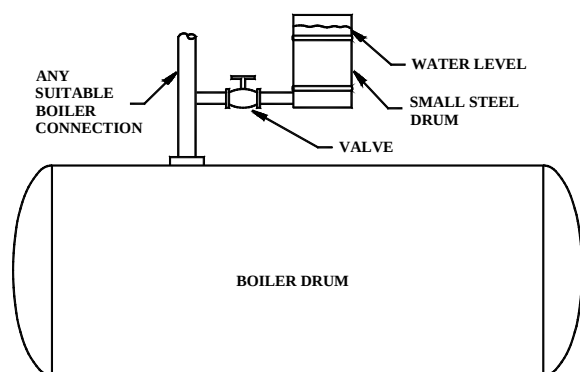
1b. Procedure for idle boiler:

if the boiler has never been on line or has been out of service for cleaning, select the highest quality water available to fill the boiler. Steam condensate, softened water, filtered fresh water, and boiler feedwater are generally acceptable for lay-up. Raw city water is not recommended and should not be used.

Prepare the chemical solution described in (1a) in a separate tank. Adhere to the safety precautions described in Section 3.2 of this manual. Add the concentrated lay-up solution to the boiler during the time it is being filled.

After the boiler is filled and the lay-up solution has been added, the boiler is to be operated for thirty minutes at low fire to circulate and mix the chemicals.

After filling, the boiler must be closed or blanketed tightly. The power supply to the boiler must be cut off. Vent all air from the top of the boiler to allow complete fill with the required solution. Nitrogen gas at 5 psig may be introduced through a suitable opening to prevent air in-leakage during the lay-up period. An alternative to the nitrogen gas (see safety precautions under dry lay-up) is to install a 55 gallon drum or auxiliary vessel as shown in Figure 3.11A. This is to be fitted with a cover and filled with properly treated water. This vessel or drum should be connected to an available opening in the top of the vessel. Its purpose is to create a hydrostatic head and to allow a ready visual check of water level loss or in-leakage during the lay-up period.



During lay-up, test the boiler weekly to assure the proper levels of sulfite and alkalinity. To do this, take a sample of the boiler water from the surface blowdown line or other high point. The test results should be:

- Sodium Sulfite 200 ppm minimum
- Phenolphthalein Alkalinity (as CaCO_3) 400 ppm minimum

Figure 3.11A: WET LAY-UP STATIC HEAD DRUM

If the tests indicate chemical concentration has decreased, chemical may be introduced to the boiler by putting it in the drum shown in Figure 3.11A. then lower the boiler water level to introduce it into the boiler. Then operate the boiler at low fire to circulate the water and mix the chemical. Then repeat Step 2. Pay attention to the maintenance of the valves being used to isolate the boiler to prevent leakage and resultant dilution of the lay-up solution.

ALTERNATE METHOD

An alternate wet lay-up method is to pipe clean continuous blowdown water from a properly treated boiler into any convenient bottom connection on the idle boiler, allowing the water to flow through the boiler and out the top (through any convenient top opening) to the sewer. This method will insure a continuous complete fill with warm, properly treated water. It also prevents in-leakage of air by keeping the boiler slightly pressurized. It may also provide enough heat to keep the fireside of the boiler dry and possibly produce adequate freeze protection.

DRY LAY-UP OF STEAM BOILERS – LONG TERM

The dry lay-up method recommended requires that the boiler be drained, dried as completely as is possible, all openings and valves closed. Nitrogen gas at 5 psig is introduced to the boiler to pressurize it and prevent air in-leakage. The success of the procedure depends on the thorough drying of the boiler metal surfaces after draining and the exclusion of air during the lay-up.

CAUTION

The use of nitrogen for blanketing is recommended in both the wet and dry lay-up procedures. Even though nitrogen in dilute quantities is non-toxic, it will not support life. Precautions must be taken before entering equipment filled with nitrogen for inspections or any other purposes. These precautions shall be as follows:

- disconnection of nitrogen supply line
- complete purging and venting of the equipment with fresh air
- testing oxygen levels inside before any attempt to enter
- all confined entry guidelines applicable to site must be followed
- Appropriate caution signs shall be posted around the equipment to alert personal that nitrogen blanketing is in use. A boiler laid up dry must be tagged with information that the unit is not to be operated until the boiler is properly refilled.

Drain the boiler before the steam pressure falls to zero. Then pressurize with 5 psig nitrogen gas through a suitable top opening during draining. The nitrogen pressure is to be maintained through draining and subsequent storage.

An alternate method is to completely dry a clean boiler (by blowing hot dry air through the boiler) and then purge the air from the boiler and pressurized with 5 psig nitrogen. Be aware that all metal surfaces that are not completely dry are vulnerable to corrosion, particularly if oxygen is present.

If a boiler has been down for repairs and is to be laid up, it should be operated to pressurize with steam and then drained and pressurized with nitrogen as in Step 1.

All connections must be blanked or tightly closed.

NOTE:

Operating boilers must be removed from service to minimize adherence of boiler water suspended solids on boiler metal surfaces. Refer to previous instructions for boiler washdown.

RETURNING IDLE BOILER TO SERVICE

- After wet lay-up

To start an idle boiler after wet lay-up, use the following procedure:

- ✓ If the boiler was pressurized with nitrogen, disconnect the nitrogen supply source and vent the boiler.
- ✓ Using the blowdown valve, drain the boiler partially and make up with feedwater so as to dilute the chemical residuals to operating concentration levels.
- ✓ After the boiler water concentrations and the water level are returned to proper operating conditions, the boiler can be started in the normal manner.

➤ After dry lay-up

To start an idle boiler after dry lay-up, use the following procedure:

- ✓ Disconnect the nitrogen supply source and vent the boiler in a safe manner – external to the building and away from air intakes. Then thoroughly purge the boiler of nitrogen with dry air.
- ✓ The boiler was to have been cleaned before the lay-up procedure. So it is necessary only to fill the boiler with properly treated water. Then proceed with start-up.

BOILER DATA GENERAL BY SERIES

Model	Input (MBH)	Output (MBH)	HP	# Tubes WTR/STM	Heating Surface WTR/STM (Sq. Ft.)	Flue Diameter		Steam PPH @ 212°F	Blowdown Size		Feed Connection	Steam Supply Size		Water Boiler Supply & Return	Capacity Gallons	
						Atmospheric	Forced Draft		15 PSI	150 PSI		15 PSI	150 PSI		Water	Steam
LM1200	12000	9600	286	220/216	1472	Qty. (2) - 28"	26"	9894	2" NPT	1" NPT	3" CPLG	12" FLG.	6" FLG.	8" FLG.	610	920
LM1350	13500	10800	322	248/244	1656	Qty. (2) - 30"	28"	11131	2" NPT	1" NPT	3" CPLG	12" FLG.	8" FLG.	8" FLG.	680	1030
LM1500	15000	12000	355	276/272	1841	Qty. (2) - 32"	28"	12368	2" NPT	1" NPT	3" CPLG	12" FLG.	8" FLG.	8" FLG.	750	1120
RV200	2000	1600	48	27	240		12"	1649	1½" NPT	1" NPT	2" NPT	6" FLG.	4" FLG.	4" FLG.	96	104
RV250	2500	2000	60	33	299		12"	2062	1½" NPT	1" NPT	2" NPT	6" FLG.	4" FLG.	4" FLG.	111	121
RV300	3000	2400	72	41	365		12"	2474	1½" NPT	1" NPT	2" NPT	6" FLG.	4" FLG.	4" FLG.	133	143
RV350	3500	2800	84	47	419		16"	2886	1½" NPT	1" NPT	2" NPT	6" FLG.	4" FLG.	4" FLG.	140	160
RV400	4000	3200	96	55	490		16"	3298	1½" NPT	1" NPT	2" NPT	8" FLG.	6" FLG.	6" FLG.	169	182
RV450	4500	3600	108	61	544		16"	3711	1½" NPT	1" NPT	2" NPT	8" FLG.	6" FLG.	6" FLG.	181	198
RV500	5000	4000	120	67	597		16"	4123	1½" NPT	1" NPT	2" NPT	8" FLG.	6" FLG.	6" FLG.	200	216
RV550	5500	4400	131	75	668		16"	4535	2" NPT	1" NPT	2" NPT	10" FLG.	6" FLG.	6" FLG.	216	237
RV600	6000	4800	143	81	722		16"	4947	2" NPT	1" NPT	2" NPT	10" FLG.	6" FLG.	6" FLG.	236	255
RV700	7000	5600	167	95	847		20"	5772	2" NPT	1" NPT	2" NPT	10" FLG.	6" FLG.	6" FLG.	278	294
RV800	8000	6400	191	109	972		20"	6596	2" NPT	1" NPT	2" NPT	10" FLG.	6" FLG.	6" FLG.	309	333
RVOS80	3360	2690	80	55	358		16"	2773	1½" NPT	1" NPT	2" NPT	8" FLG.	6" FLG.			182
RVOS100	4200	3360	100	55	358		16"	3463	1½" NPT	1" NPT	2" NPT	8" FLG.	6" FLG.			182
RVOS125	5250	4200	125	55	358		16"	4329	1½" NPT	1" NPT	2" NPT	8" FLG.	6" FLG.			182
RVOS150	6300	5040	150	55	358		16"	5195	1½" NPT	1" NPT	2" NPT	8" FLG.	6" FLG.			182
RW850	8500	6800	200	120	1118/1136		20"	7009	2" NPT	1" NPT	2" NPT	10" FLG.	6" FLG.	8" FLG.	472	780
RW1050	10500	8400	250	136	1266/1288		20"	8658	2" NPT	1" NPT	2" NPT	10" FLG.	6" FLG.	8" FLG.	522	860
RW1260	12600	10080	300	164	1527/1552		22"	10389	2" NPT	1" NPT	2" NPT	12" FLG.	6" FLG.	8" FLG.	608	1000
RW1500	15000	12000	350	192	1787/1818		22"	12368	2" NPT	1" NPT	2" NPT	12" FLG.	8" FLG.	8" FLG.	695	1140
RW1700	17000	13600	400	220	2048/2087		24"	14017	2" NPT	1" NPT	2" NPT	12" FLG.	8" FLG.	8" FLG.	781	1280
RW1900	19000	15200	450	248	2308/2347		26"	15666	2" NPT	1" NPT	2" NPT	12" FLG.	8" FLG.	10" FLG.	868	1415
RW2100	21000	16800	500	276	2569/2612		28"	17315	2" NPT	1" NPT	2" NPT	12" FLG.	8" FLG.	10" FLG.	955	1555
RW2100	25200	20160	600	276	2569/2612		28"	20778	2" NPT	1" NPT	2" NPT	12" FLG.	8" FLG.	10" FLG.	955	1555
TF150	1500	1350	40	27	678		8"							3" FLG.	54	
TF200	2000	1800	54	27	678		8"							3" FLG.	54	
TF250	2500	2250	67	39	782		8"							3" FLG.	77	
TF300	3000	2700	81	39	782		8"							3" FLG.	77	

Obsolete Models

Standard boiler models show outputs & HP @ nominal 80%.
High efficiency boiler models (HE & TF) show outputs & HP based on published ratings.



MODEL *FLX*
PACKAGED BOILER



1,500,000 to 12,000,000 Btu/hr
Hot Water and Steam
Fuel: Light Oil, Gas or Combination

Manual Part No. 750-177 R6

5/2014

MODEL FLX PACKAGED BOILER

Operation, Service, and Parts Manual

1,500,000 to 12,000,000 Btu/hr
Fuel: Light Oil, Gas or Combination



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DO NOT OPERATE, SERVICE, OR REPAIR THIS EQUIPMENT UNLESS YOU FULLY UNDERSTAND ALL APPLICABLE SECTIONS OF THIS MANUAL.

DO NOT ALLOW OTHERS TO OPERATE, SERVICE, OR REPAIR THIS EQUIPMENT UNLESS THEY FULLY UNDERSTAND ALL APPLICABLE SECTIONS OF THIS MANUAL.

FAILURE TO FOLLOW ALL APPLICABLE WARNINGS AND INSTRUCTIONS MAY RESULT IN SEVERE PERSONAL INJURY OR DEATH.

TO: Owners, Operators and/or Maintenance Personnel

This operating manual presents information that will help to properly operate and care for the equipment. Study its contents carefully. The unit will provide good service and continued operation if proper operating and maintenance instructions are followed. No attempt should be made to operate the unit until the principles of operation and all of the components are thoroughly understood. Failure to follow all applicable instructions and warnings may result in severe personal injury or death.

It is the responsibility of the owner to train and advise not only his or her personnel, but the contractors' personnel who are servicing, repairing or operating the equipment, in all safety aspects.

Cleaver-Brooks equipment is designed and engineered to give long life and excellent service on the job. The electrical and mechanical devices supplied as part of the unit were chosen because of their known ability to perform; however, proper operating techniques and maintenance procedures must be followed at all times. Although these components afford a high degree of protection and safety, operation of equipment is not to be considered free from all dangers and hazards inherent in handling and firing of fuel.

Any "automatic" features included in the design do not relieve the attendant of any responsibility. Such features merely free him of certain repetitive chores and give him more time to devote to the proper upkeep of equipment.

It is solely the operator's responsibility to properly operate and maintain the equipment. No amount of written instructions can replace intelligent thinking and reasoning and this manual is not intended to relieve the operating personnel of the responsibility for proper operation. On the other hand, a thorough understanding of this manual is required before attempting to operate, maintain, service, or repair this equipment.

Because of state, local, or other applicable codes, there are a variety of electric controls and safety devices which vary considerably from one boiler to another. This manual contains information designed to show how a basic burner operates.

Operating controls will normally function for long periods of time and we have found that some operators become lax in their daily or monthly testing, assuming that normal operation will continue indefinitely. Malfunctions of controls lead to uneconomical operation and damage and, in most cases, these conditions can be traced directly to carelessness and deficiencies in testing and maintenance.

It is recommended that a boiler room log or record be maintained. Recording of daily, weekly, monthly and yearly maintenance activities and recording of any unusual operation will serve as a valuable guide to any necessary investigation.

Most instances of major boiler damage are the result of operation with low water. We cannot emphasize too strongly the need for the operator to periodically check his low water controls and to follow good maintenance and testing practices. Cross-connecting piping to low water devices must be internally inspected periodically to guard against any stoppages which could obstruct the free flow of water to the low water devices. Float bowls of these controls must be inspected frequently to check for the presence of foreign substances that would impede float ball movement.

The waterside condition of the pressure vessel is of extreme importance. Waterside surfaces should be inspected frequently to check for the presence of any mud, sludge, scale or corrosion.

The services of a qualified water treating company or a water consultant to recommend the proper boiler water treating practices are essential.

The operation of this equipment by the owner and his or her operating personnel must comply with all requirements or regulations of his insurance company and/or other authority having jurisdiction. In the event of any conflict or inconsistency between such requirements and the warnings or instructions contained herein, please contact Cleaver-Brooks before proceeding.

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CHAPTER 1

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A. General

This manual covers Cleaver-Brooks Model FLX boilers in sizes ranging from 1,500,000 to 12,000,000 Btu/hr input.

Fuel Series

700 - Gas
100 - No.2 Oil
200 - Combination Gas & No.2 Oil

Design Pressure

160 psig hot water
15 psig steam
150 psig steam

CAUTION

The care taken in placing the boiler into initial service is vital to continuous, reliable operation. If the boiler is to be used for temporary heat (for example in new construction), properly treated water must be used. Failure to do so can be detrimental to the boiler.

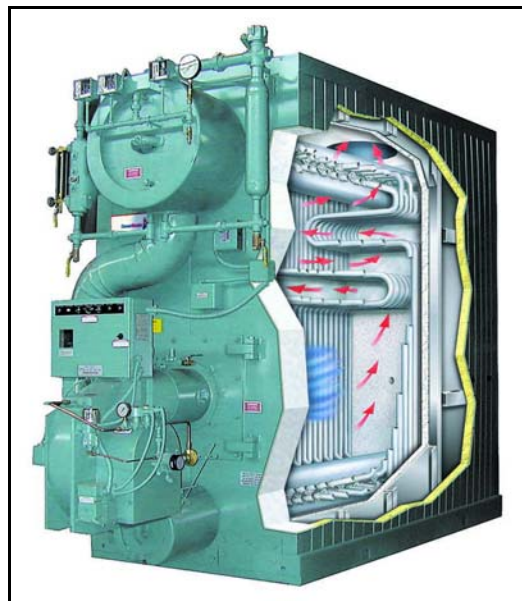


Figure 1-1: FLX cutaway view

B. The Boiler

The Cleaver-Brooks Model FLX is a five-pass steel boiler with flexible watertubes formed and arranged so as to direct the flow of combustion gases through the boiler. The pressure vessel conforms to Section I or IV of the ASME code. The pressure vessel consists of the formed tubes, the external downcomer, and the top and bottom drums to which they connect. The heated area of the pressure vessel is contained within a gas tight insulated casing that is composed of removable formed steel panels.

The boiler and related equipment installation are to be in compliance with the standards of the National Board of Fire Underwriters. Installation should also conform to state and local codes governing such equipment. Prior to installation, the proper authorities having jurisdiction are to be consulted, permits obtained, etc. All boilers comply, when equipped with optional equipment, to Industrial Risk Insurers (IRI), Factory Mutual (FM), or other insuring underwriters requirements.

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The Model FLX boiler is a packaged watertube boiler of welded steel construction and consists of a pressure vessel, burner, burner controls, forced draft fan, damper, refractory, and appropriate boiler trim.

Steam

Steam boilers are designed for low and high pressure applications. Low pressure boilers are limited to 15 psig design pressure, and are typically used for heating applications. High pressure boilers are limited to 150 psig design pressure, and are typically used for process steam applications.

Hot Water

Hot water is commonly used in heating applications with the boiler supplying water to the system at 180 °F to 220 °F. The operating pressure for hot water heating systems usually is 30 psig to 125 psig.

Steam and hot water boilers are defined according to design pressure and operating pressure. Design pressure is the maximum pressure used in the design of the boiler for the purpose of calculating the minimum permissible thickness or physical characteristics of the pressure vessel parts of the boiler. Typically, the safety valves are set at or below design pressure. Operating pressure is the pressure of the boiler at which it normally operates. The operating pressure usually is maintained at a suitable level below the setting of the pressure relieving valve(s) to prevent their frequent opening during normal operation.

The type of service that your boiler is required to provide has an important bearing on the amount of waterside care it will require.

CAUTION

Waterside care is of prime importance. For specific information or assistance with your water treatment requirements, contact your Cleaver-Brooks service and parts representative. Failure to follow these instructions could result in equipment damage.

Feedwater equipment should be ready for use upon installation of the boiler. Be sure that all valves, piping, boiler feed pumps, and receivers are installed in accordance with prevailing codes and practices.

The careful observance of water requirements for both steam and hot water boilers is essential. Constant attention to water requirements will pay dividends in the form of longer life, less down-time, and prevention of costly repairs.

Care taken in placing the pressure vessel into initial service is vital. The waterside of new boilers and new or remodeled steam or hot water systems may contain oil, grease or other foreign matter. A method of boiling out the vessel to remove accumulations is described in Chapter 3. The operator should be familiar with this chapter before attempting to place the unit into operation.

C. Construction

Steam boilers designed for 15 psig and hot water boilers designed for 250°F at 160 psi or less are constructed in accordance with Section IV, Heating Boilers, of ASME Code. Steam boilers designed for 150 psig are constructed in accordance with Section I, Power Boilers, of the ASME Code.

D. Steam Controls (All Fuels)

1. High Limit Pressure Control: Breaks a circuit to stop burner operation on a rise of pressure above a selected setting. It is adjusted to stop the burner at a preselected pressure above the operating limit control setting. The high limit pressure control is equipped with a manual reset.
2. Operating Limit Pressure Control: Breaks a circuit to stop burner operation on a rise of boiler pressure at a selected setting. It is adjusted to stop or start the burner at a preselected pressure setting.
3. Modulating Limit Pressure Control: Senses changing boiler pressures and transmits the information to the modulating motor to change the burner firing rate when the manual-automatic switch is set on “automatic.”
4. Low Water Cutoff and Pump Control: Float-operated control responds to the water level in the boiler. It performs two distinct functions:
 - Stops firing of the burner if water level lowers below the safe operating point. Energizes the low-water light in the control panel; also causes low-water alarm bell (optional equipment) to ring. Code requirements of some models require a manual reset type of low-water cutoff.
 - Starts and stops the feedwater pump (if used) to maintain water at the proper operating level.

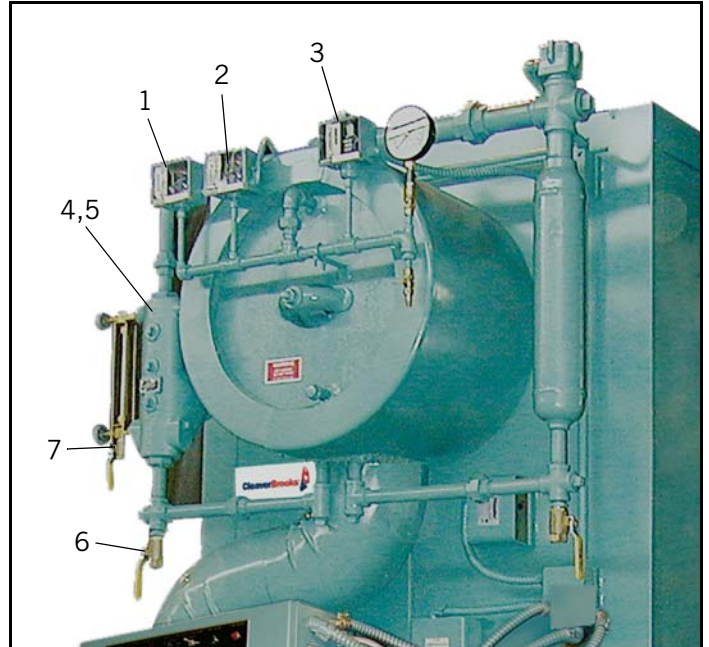


Figure 2-2: Steam Controls

⚠ CAUTION

Determine that the main and auxiliary low water cutoffs and pump control are level after installation and throughout the equipment's operating life. Failure to follow these instructions could result in equipment damage.

5. Water Column Assembly: Houses the low-water cutoff and pump control and includes the water gauge glass and gauge glass shutoff cocks.
6. Water Column Drain Valve: Provided so that the water column and its piping can be flushed regularly to assist in maintaining cross-connecting piping and in keeping the float bowl clean and free of sediment. A similar drain valve is furnished with auxiliary low-water cutoff for the same purpose.
7. Gauge Glass Drain Valve: Provided to flush the gauge glass.

8. **Safety Valve(s):** Prevent buildup over the design pressure of the pressure vessel. The size, rating and number of valves on a boiler is determined by the ASME Boiler Code. The safety valves and the discharge piping are to be installed to conform to the ASME code requirements. The installation of a valve is of primary importance to its service life. A valve must be mounted in a vertical position so that discharge piping and code-required drains can be properly piped to prevent buildup of back pressure and accumulation of foreign material around the valve seat area. Apply only a moderate amount of pipe compound to male threads and avoid overtightening, which can distort the seats. Use only flat-jawed wrenches on the flats provided. When installing a flange-connected valve, use a new gasket and draw the mounting bolts down evenly. Do not install or remove side outlet valves by using a pipe or wrench in the outlet.

⚠ WARNING

Only properly certified personnel such as the safety valve manufacturer's certified representative can adjust or repair the boiler safety valves. Failure to follow these instructions could result in serious personal injury or death

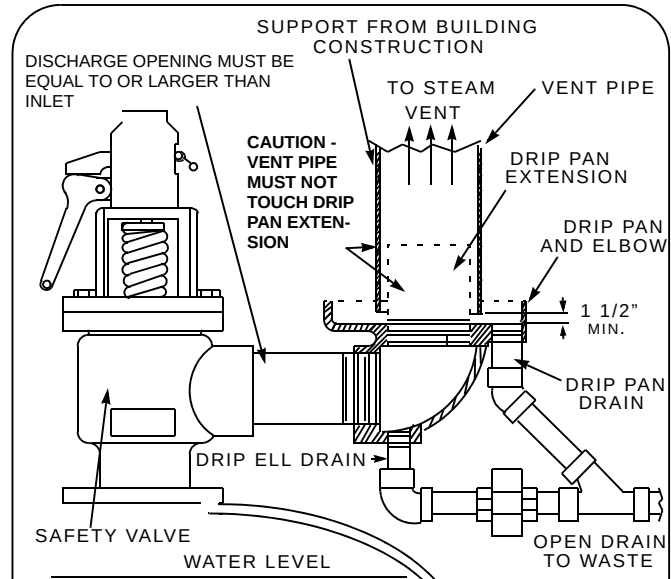


Figure 2-3: Recommended piping for steam relief valve (not furnished by Cleaver-Brooks)

E. Hot Water Controls (All Fuels)

1. **Water Temperature Gauge:** Indicates the boiler internal water pressure.
2. **Water Pressure Gauge:** Indicates the internal pressure of the boiler.
3. **High Limit Temperature Control:** Breaks a circuit to stop burner operation on a rise of temperature at a selected setting. It is adjusted to stop burner at a preselected temperature above the operating control setting. The high limit temperature control is equipped with a manual reset.
4. **Operating Limit Temperature Control:** Breaks a circuit to stop burner operation on a rise of boiler temperature at a selected setting. It is adjusted to stop or start the burner at a preselected operating temperature.
5. **Modulating Temperature Control:** Senses changing boiler water temperature and transmits the information to the modulating motor to change the burner firing rate when the manual-automatic switch is set on "automatic."
6. **Low Water Cutoff:** Breaks the circuit to stop burner operation if the water level in the boiler drops below safe operating point, activating low-water light and optional alarm bell if burner is so equipped.

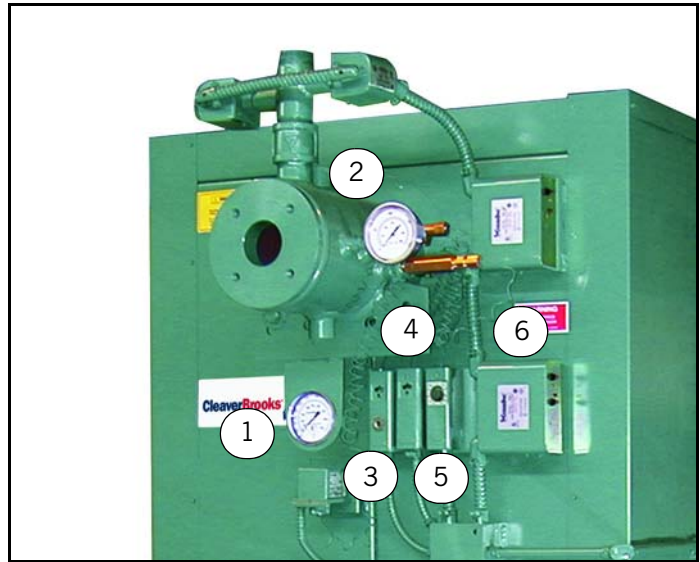


Figure 2-4: Hot Water Controls

7. Auxiliary Low Water Cutoff (Not Shown) (Optional): Breaks the circuit to stop burner operation if the water level in the boiler drops below the master low-water cutoff point.
8. Safety Valve(s): Prevent buildup over the design pressure of the pressure vessel. The size, rating and number of valves on a boiler is determined by the ASME Boiler Code. The safety valves and the discharge piping are to be installed to conform to the ASME code requirements. The installation of a valve is of primary importance to its service life. A valve must be mounted in a vertical position so that discharge piping and code-required drains can be properly piped to prevent buildup of back pressure and accumulation of foreign material around the valve seat area. Apply only a moderate amount of pipe compound to male threads and avoid overtightening, which can distort the seats. Use only flat-jawed wrenches on the flats provided. When installing a flange-connected valve, use a new gasket and draw the mounting bolts down evenly. Do not install or remove side outlet valves by using a pipe or wrench in the outlet.

 WARNING

Only properly certified personnel such as the relief valve manufacturer's certified representative can adjust or repair the boiler relief valves. Failure to follow these instructions could result in serious personal injury or death.

CHAPTER 2

Profire V Burner

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A. Introduction

V series burners are assembled, wired, and tested at the factory. They are listed by the Underwriters Laboratory (UL), CSD-1, NFPA-85, Factory Mutual (FM), including the National Electrical Code (NEC), and associated insurance underwriters. Where applicable, the Canadian Gas Association (CGA) B149 and the Canadian Standards Association (CSA) B140 codes shall prevail. Other regulatory agency control options are available.

CAUTION

ONLY FACTORY AUTHORIZED BURNER SERVICE PERSONNEL SHOULD START UP, ADJUST, OR SERVICE THIS EQUIPMENT.

DESCRIPTION

The V series burners are designed to operate with natural gas and light oil. The burners are designed for automatic, unattended operation except for periodic inspection and maintenance. The burner and control panel components require little attention except for occasional cleaning.

Model FLX boilers 150-1200 MBTU use the following size burners:

SIZE 1 - FLX 150-300 (Low-High-Low or Full Modulation)
SIZE 2 - FLX 350-550 (Low-High-Low or Full Modulation)
SIZE 3 - FLX 600 (Low-High-Low or Full Modulation)
SIZE 3 & 4 - FLX 700-1200 (Full Modulation)

OPERATING CONTROLS - PANEL

The burner control panel may be integral to the burner or remote, and contains: a flame safeguard programming control, motor relays (starters), and terminal strips mounted internally on a panel subbase. Lights, switches, and a control circuit breaker are mounted externally on the panel.

The following table lists typical panel items. Some or all of the items may be provided depending on the burner configuration selected.

1. ON-OFF BURNER SWITCH

2. FUEL SELECTOR SWITCH - Gas-Off-Oil

Gas position: Selects gas as the firing fuel

Off position: Burner off

Oil position: Selects oil as the firing fuel

3. CONTROL CIRCUIT BREAKER

Supplementary low overcurrent protection only. No larger than 15 amps.

4. AUTO-MANUAL MODULATION SELECTOR SWITCH

Auto position: Selects boiler modulation control. In this position, the burner will operate automatically in response to load demand.

Manual position: Selects 135 ohm potentiometer for manual modulating control.

5. MANUAL MODULATING CONTROL - 135 ohm (full modulation burners only) increases or decreases the burner firing rate.

6. SIGNAL LAMPS

a) LOAD DEMAND (white): Illuminates when the control circuit is energized (powered).

b) LOW WATER (red): Illuminates when the water level in the boiler gets too low.

c) FUEL VALVE (green): Illuminates when the main fuel valve or valves (gas or oil) are energized (open).

d) FLAME FAILURE (red): Illuminates when the flame safeguard system fails to detect pilot or main flame.

FLAME SAFEGUARD CONTROLS

The flame safeguard controls the burner's operating sequence: pre-purge, trial for ignition, main flame and shutdown. This safety control also includes flame detection system to confirm proper operation or cause a manual reset lockout in the event of a pilot or main flame failure. External controls connected to the flame control's limit circuit, such as the boiler operating control, will trigger normal burner startup, and upon reaching operating set point, normal burner shutdown. Safety devices in the flame control's running interlock circuit, such as the combustion air switch, will cause an immediate safety shut down if conditions are not correct for safe operation.

When a parallel positioning system is furnished, the flame safeguard may be incorporated as an integral component to the parallel positioning control. Consult boiler controls documentation. If using a C-B Hawk control system refer to manual 750-366 (Hawk 1000) or 750-342 (Hawk 4000) and to the flame safeguard manual 750-234 (CB780E) or 750-264 (CB120).

FIRING RATE CONTROLS

LHL burners use a two position actuator and linkage to control the air and gaseous fuels (oil burners control oil flow with electric valves). At startup fire, the air damper and fuel valves are positioned for stable low fire operation. When the actuator is commanded to its second position, the linkage drives the air damper and fuel valves open until high fire is reached. LHL burners typically use a boiler-mounted control that keeps the burner at its low fire rate to prevent thermal shock, until conditions are suitable for high fire.

Full modulation burners are capable of firing at any rate between the burner's low and high fire limits. For "single point" modulating systems, a single rotary actuator controls both air and fuel volume via control arms and linkage attached to its shaft. As the actuator rotates from low to high fire, the linkage opens the air damper

and fuel metering valves increase the firing rate. Optional “CAM” trim provides additional precision to the air/fuel mix with the use of several discrete set point adjustments across the modulation range. Further combustion efficiency may be achieved with the use of parallel positioning controls which use multiple directly-coupled actuators (linkeageless) to position the air damper, fuel metering valves and, if applicable, flue gas recirculation (FGR) across the modulation range.

COMBUSTION AIR HANDLING SYSTEM

1. MOTOR AND BLOWER

The impeller is directly driven by the motor at 3450 rpm.

2. AIR VOLUME REGULATOR

Air dampers are located in the air inlet housing and mechanically linked to the modulating motor.

3. COMBUSTION AIR PROVING SWITCH

A pressure sensitive, differential switch actuated by air pressure created by the blower fan. Contacts close to prove combustion air flow.

4. DIFFUSER

Contained by the burner’s firing head, an air flow diffuser shapes combustion air flow and improves flame stability.

When determining boiler room air requirements, the size of the room, air flow, and velocity of air must be reviewed as follows (fpm = feet per minute; cfm = cubic feet per minute):

Size (area) and location of air supply openings in boiler room:	Two (2) permanent air supply openings in the outer walls of the boiler room are recommended. Locate one (1) at each end of the boiler room, preferably 7 foot or lower. This allows air to sweep the length of the boiler.
	A boiler room vent fan is not recommended. Under certain conditions, these fans can cause a light vacuum and “steal” combustion air from the burner resulting in unsatisfactory combustion performance.
	A vent fan in the boiler room is not recommended, as it could create a light vacuum under certain conditions and cause variations in the volume of combustion air. This can result in unsatisfactory burner performance.
	Under no condition should the total area of the air supply openings be less than (1)square foot.
	Size the openings by using the formula: Area (sq-ft) = cfm/fpm
Amount of air required (cfm):	Combustion Air = Rated bhp x 8 cfm/bhp.
	Ventilation Air = Maximum bhp x 2 cfm/bhp.
	Total recommended air = 10 cfm/bhp – up to 1000 feet elevation. Add 3% more per 1000 feet of added elevation.
Acceptable air velocity in Boiler Room (fpm):	From floor to (7) foot height – 250 fpm
	Above (7) foot height – 500 fpm

Example: Determine the area of the boiler room air supply openings for one (1) 300 hp boiler at 800 feet altitude. The air openings are to be 5 feet above floor level.

- Air required: $300 \times 10 = 3000$ cfm
- Air velocity: Up to 7 feet - 250 fpm
- Area required: $\text{Area} = \text{cfm} = 3000/250 = 12$ sq-ft total
- Area/Opening: $12/2 = 6$ sq-ft/opening (2 required)

B. FIRING HEAD

Two side access covers provide access to the firing head internal components. Figure 2-1 shows a radial spud firing head typically used on watertube applications

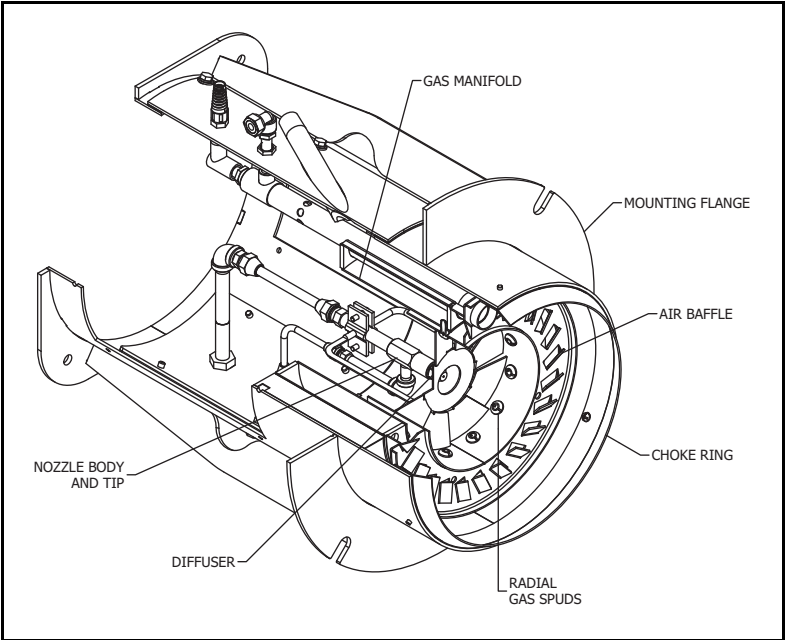


Figure 2-1: Profire V firing head

C. OIL SYSTEM

The V series burners pump high pressure fuel oil to the spray nozzle resulting in combustion-ready finely atomized oil spray.

Oil System Components

Fuel Unit	Standard V13-55 have an oil pump flex-coupled to the blower motor; these units may be optionally equipped with a remote pump. The larger V60-168 use a remote pump with separate motor.
Oil Nozzle	Pump pressurized oil discharges from the nozzle in a fine conical spray pattern. The burner's nozzle is sized to provide the burner's high fire rate, rated gallons per hour (gph). Smaller gph nozzles may be used to match burner output to a heat exchanger's required input. Models V13-34 are supplied with simplex nozzles (return flow nozzles optional on V25-34). Models V35-168 are supplied with return flow nozzles.
Nozzle Adapter	A nozzle adapter provides the means for connecting fuel lines with the nozzle.
Oil Solenoid Valves	Two normally closed (N.C.) and one normally open (N.O.) solenoid valves are part of the oil system on LHO and LHL burners. The two (2) N.C. valves provide positive shutoff of fuel oil while the one N.O. valve cycles the burner to high fire when closed.
Oil Metering Valve	The firing rate is controlled by an adjustable metering valve in the return line. At low fire, the metering valve is open, and is closed at high fire.
Oil Filter	The oil filter prevents foreign matter from entering the burner oil system. This item is provided as an option and shipped loose with the burner.

OPERATION: Fuel oil is delivered to the fuel pump, either by gravity, fuel pump suction, or by a circulating pump, through a fuel oil filter. Pressurized fuel returns to the storage tank until the two solenoid valves open. Straight oil burners (VL13-55) employ direct spark ignition where the oil is ignited when the oil solenoid valves open and the spray contacts the electrical discharge from the direct spark electrodes.

Gas-oil VLG burners use a proven gas pilot where the oil is ignited when the oil solenoid valves open and the oil spray contacts the established gas pilot flame.

On full modulation units, the modulating actuator varies the oil metering valve setting. The metering valve located in the return oil loop reduces the firing rate by opening and allowing more oil to return to the supply tank. Conversely, at high fire, the valve is closed, forcing all oil to exit the spray nozzle.

On LHL units, bypass piping routes most of the oil back to the storage tank while at low fire. At high fire, a valve blocks the return loop and forces all the oil through the nozzle.

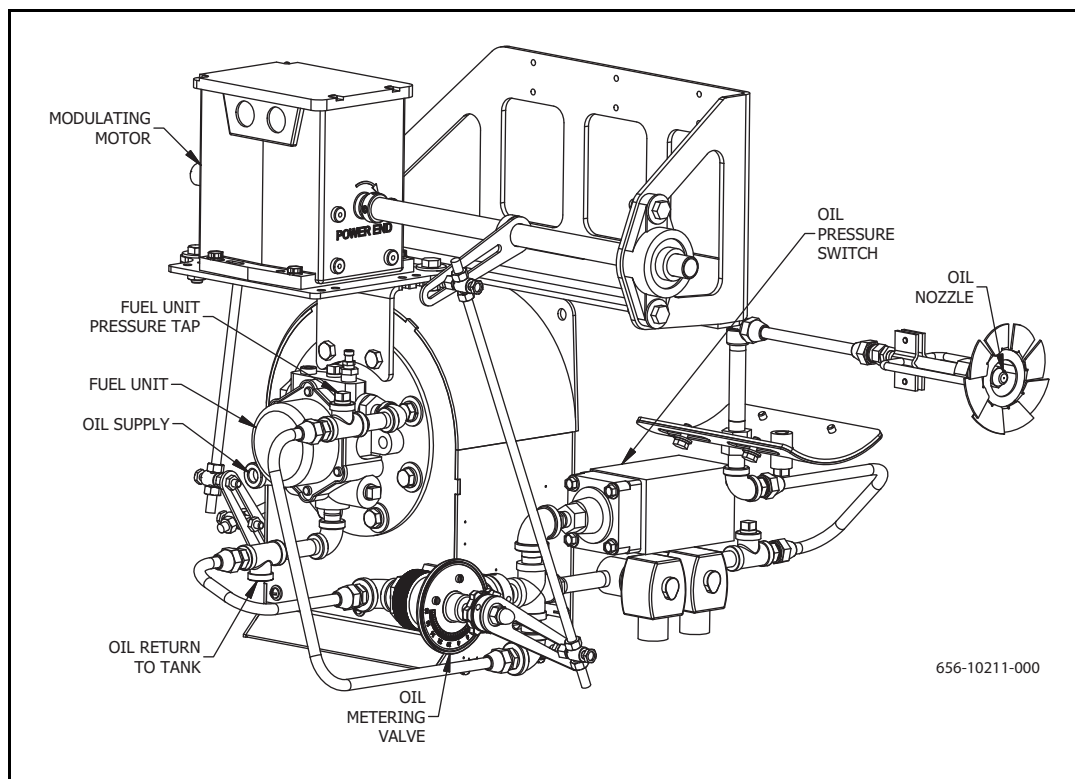


Figure 2-2: Full Modulation Oil System with Integral Pump & Simplex Nozzle (V13-34)

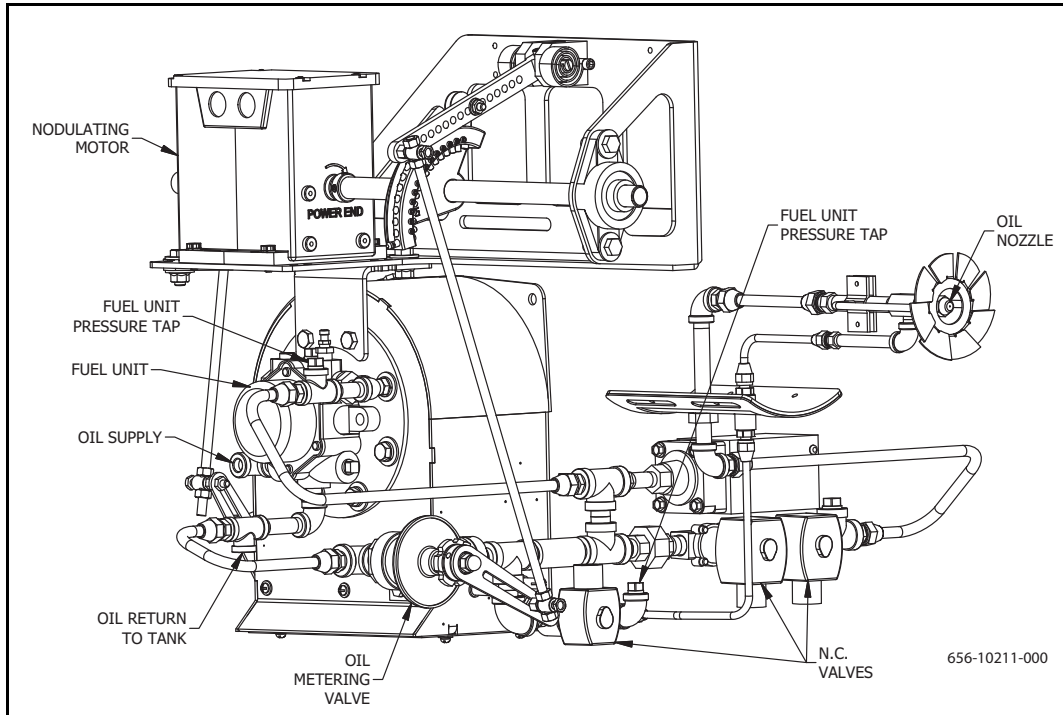


Figure 2-3: Full Modulation Oil System with Integral Pump & Return Flow Nozzle (V13-55)

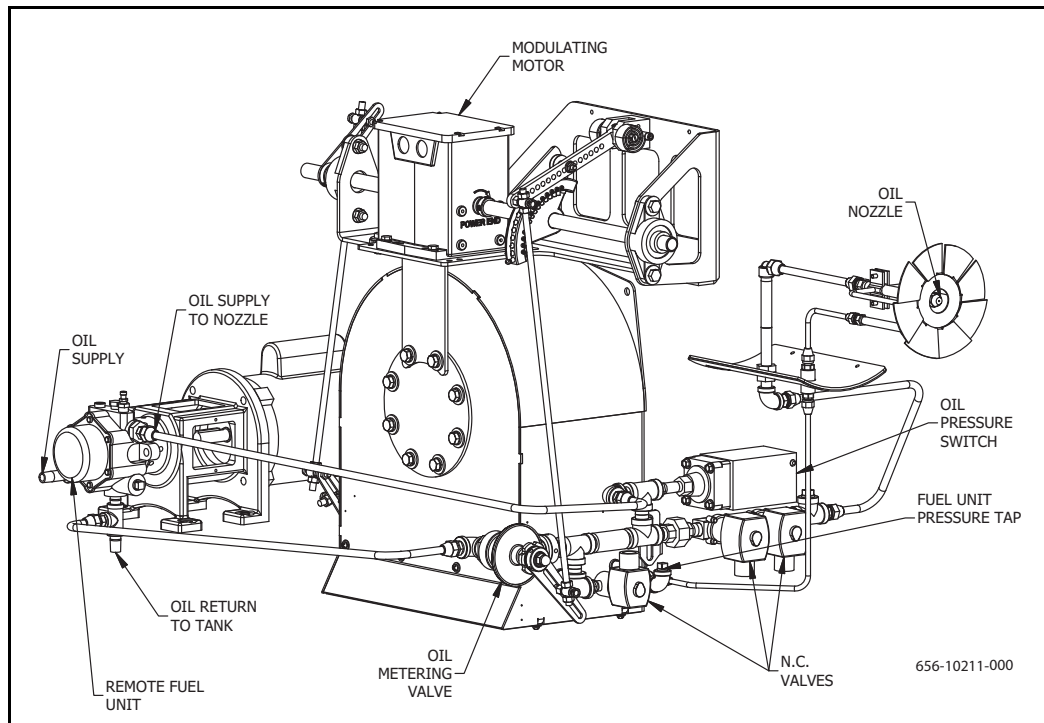


Figure 2-4: Full Modulation Oil System with a Remote Pump (V60-168)

D. GAS SYSTEM

Gas is introduced into the combustion zone from a circular manifold through multiple ports in the manifold. Firing rate is determined by the size and number of ports, by manifold pressure, and by combustion zone pressure. The firing rate is regulated by a rotary, butterfly-type throttling valve at the manifold inlet. The valve is actuated by adjustable linkage from the modulating motor. Depending upon specific requirements, one or two gas safety shutoff valves are provided for installation in the gas train upstream of the butterfly valve. Safety shutoff gas valves are wired into the programming control to automatically open and close at the proper time in the operating sequence.

MAIN GAS TRAIN COMPONENTS

Depending upon the requirements of the regulating authority, the gas control system and gas train may consist of some, or all, of the following items:

Gas Volume Valve	The butterfly type valve is positioned by linkage from the modulating motor and controls the gas flow rate.
Main Gas Valves	Electrically operated safety shutoff valve(s) that open to admit gas to the burner. lowfire Standard UL burners include: • Models V13-25: diaphragm gas valve & solenoid valve • Models V30-50: one (1) motorized gas valve w/proof of closure or two (2) safety shutoff valves • Models V55-120: one (1) motorized gas valve w/proof of closure and one (1) safety shutoff valve • Models V126-168: two (2) motorized gas valves (two motorized gas valves can be optionally provided on all models)
Main Gas Regulator	Regulates gas train pressure to specified pressure required at the burner manifold. Input is set by main gas pressure regulator adjustment.
Main Gas Cocks	Used for manual shutoff of the gas supply upstream of the pressure regulator. A second shutoff cock downstream of the main gas valve(s) provides a means of testing for leakage through the gas valve(s).
High Gas Pressure Switch (Models V30-168)	A pressure actuated switch that remains closed when gas pressure is below a selected setting. Should the pressure rise above the setting, the switch contacts will open causing the main gas valve(s) to close. This switch requires manual reset after being tripped.
Low Gas Pressure Switch (Models V30-168)	A pressure actuated switch that remains closed when gas pressure is above a selected setting. Should the pressure drop below this setting, the switch contacts will open, causing main gas valve(s) to close. This switch requires manual reset after being tripped.

OPERATION: Metered gas flows through the main gas shutoff cock, through the pressure regulator to the automatic gas valves and butterfly valve to the gas manifold.

The butterfly gas valve modulates flow to burner input demand. The butterfly valve is positioned through mechanical linkage by the modulating motor. The air control damper is positioned simultaneously by the modulating motor.

The automatic gas valve(s) cannot be energized unless the combustion air proving switch is closed. The low and high gas pressure switches must be closed to prove proper gas pressure.

A normally open vent valve, if required, is located between the two automatic gas valves. This valve is shut when the automatic gas valves are open. When the automatic valves are closed, the vent valve is open for venting gas to the outside, should any be present.

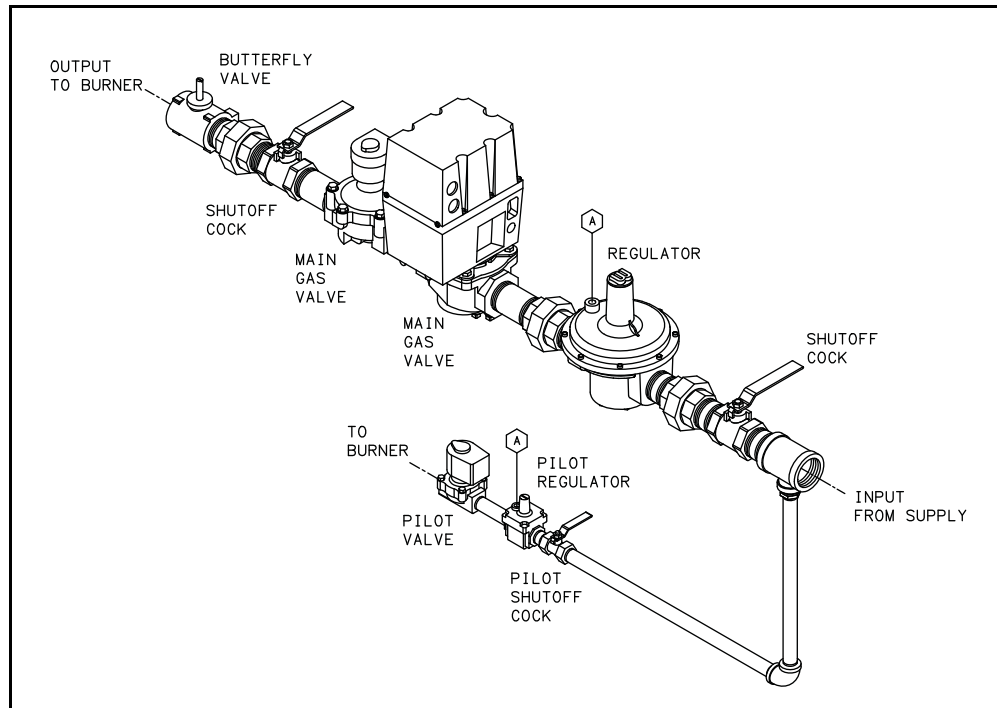


Figure 2-5: Typical Gas Train for Full Modulation System (V13-34)

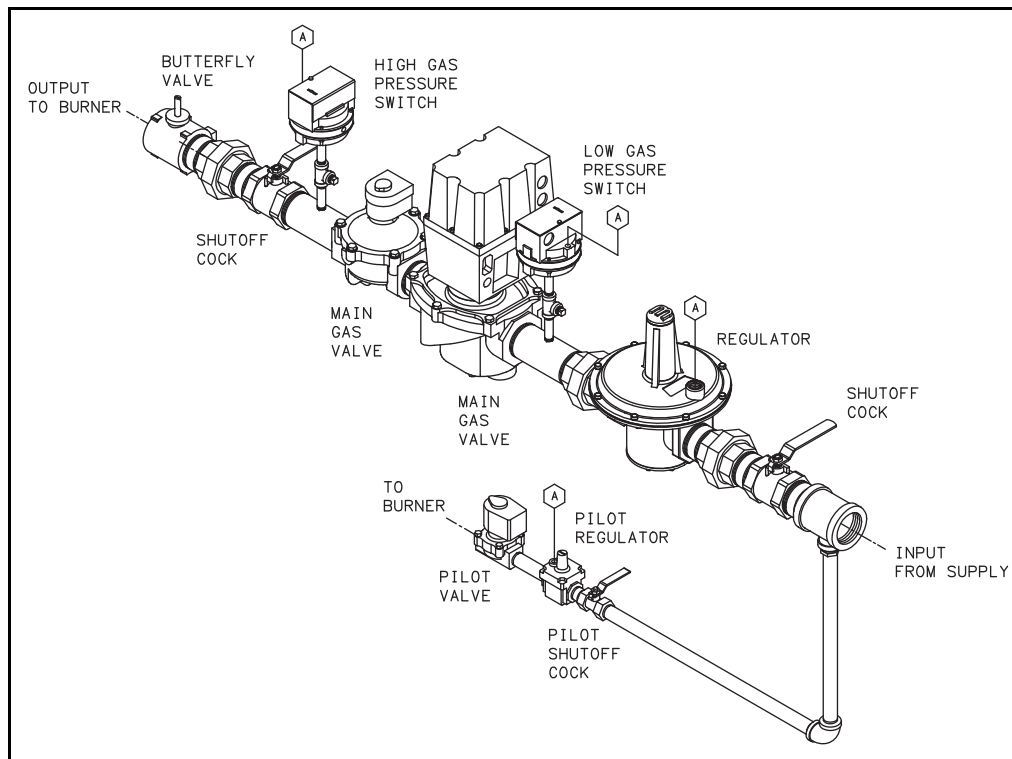


Figure 2-6: Typical Gas Train for LHO/LHL Systems (V35-63) & Full Modulation Systems (V35-168)

PILOT GAS TRAIN COMPONENTS

Models VL 60-168 as well as all VG and VLG models are supplied with a gas pilot system. Oil only models VL 13-55 are supplied with direct spark ignition.

Gas Pilot Valve	A solenoid valve that opens during the ignition period to admit fuel to the pilot. It closes after main flame is established.
Gas Pressure Regulator	Reduces gas pressure to that required by the pilot.
Gas Pilot Shutoff Cock	For manually closing the pilot gas supply.

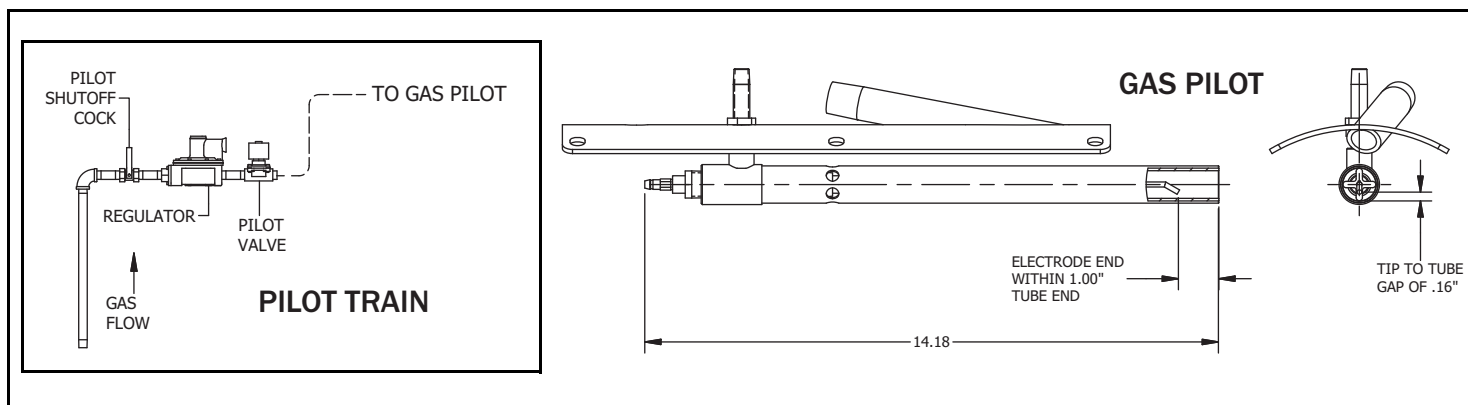


Figure 2-7: Pilot train / Pilot assembly

E. Installation

DRAFT CONDITIONS

A boiler or other heating vessel fired with a V series burner does not depend on chimney draft for proper combustion air. Combustion air is supplied by the burner forced draft blower providing adequate air for any normal combustion condition. Since draft control is essential to maximum efficiency, a draft regulator may be required when the vessel is connected to a tall stack or where wind conditions may cause erratic draft. Excessive furnace draft contributes to inefficient burner operation. Sealed boilers may be operated under positive firebox pressure within the capability of the burner.

COMBUSTION AIR SUPPLY

The space in which the burner operates must be supplied with adequate fresh air for combustion and ventilation purposes. Fresh air supply must meet or exceed all code requirements. Consult with insurance carrier and/or local authorities for specific regulations.

WARNING

THE BOILER ROOM PRESSURE MUST BE AT LEAST EQUAL TO THE OUTDOOR ATMOSPHERIC PRESSURE. WHERE FAN VENTILATION IS USED, AIR MUST BE FORCED INTO THE BOILER ROOM. NEVER EXHAUST AIR FROM THE BOILER ROOM. ADJOINING AREAS HAVING EXHAUST FANS MUST BE POSITIVELY ISOLATED FROM THE BOILER ROOM.

OIL PIPING

The oil only (VL) and gas-oil (VLG) model burners use pressure atomization. Fuel oil is provided by a burner mounted fuel pump directly coupled to the blower motor via a flexible coupling for models V13-55. A remote pump is used for models V60-168. The suction and return line sizes (two-pipe system) are based on the suction rate of the fuel pump and not the burner firing rate. Pipe size must be selected so that suction vacuum is within suitable limits.

A two-pipe system is essential. The suction and return between the storage tank or supply source and the burner must be sized to supply the required quantity of oil circulated, including excess oil returned to the storage tank.

Suction Line Sizing

The suction load is determined by:

- The vertical lift from the oil level in the tank to the pump.
- Pressure drop through valves, fittings, strainers, etc.
- The friction loss due to oil flow. This loss varies with:
 - a. Quantity of oil pumped (gph).
 - b. Length of suction line (feet).
 - c. Diameter of the suction line.
 - d. Number of fittings.

Although the gear type pumps used on the V series burners are capable of developing higher suction, it is not desirable to operate above 15 inches of mercury vacuum. If the vacuum is greater, flow may be erratic.

Refer to the manufacturer's table for line sizing.

1. Check suction capacity.
2. Measure total pipe length (horizontal and vertical).
3. Read up from line "total feet of copper tube" to the intersection line of the specific "suction capacity" in gph.
4. Read left to column "inches of vacuum at fuel unit." This is vacuum required to draw oil through pipe listed at given length.
5. Add 1" of vacuum for every foot of lift.
6. Total inches of vacuum (frictional tube loss plus lift).
7. If total exceeds 15", check next larger pipe size.

Return Line Sizing

Generally, the return line should be sized the same as the suction line.

Two Pipe - Multiple Burner System

Several options exist for a multiple burner installation. Figure 2-8 is a typical installation showing separate suction lines for each burner with a common return line.

Figure 2-9 shows multiple burners with separate suction lines. Figure 2-10 shows multiple burners with oil supplied by a transfer pump. The circulating pump is sized in this case for the total suction capacity of all burners. Note that a special pressure regulating valve is required if the fuel unit inlet pressure is above 3 psi.

Figure 2-11 shows an installation using a day tank. A pump supplies oil to the day tank.

Figure 2-12 shows a flooded loop system. The circulating pump is sized according to the maximum burner firing rate for all burner plus a 30% service factor. The burner return lines feed into the common supply line.

Notice: C-B recommends that all oil firing burners be equipped with an oil strainer (if not included with the burner) to prevent particles from clogging the nozzle. It is essential to follow the strainer manufacturer's maintenance schedule to ensure proper filtration.

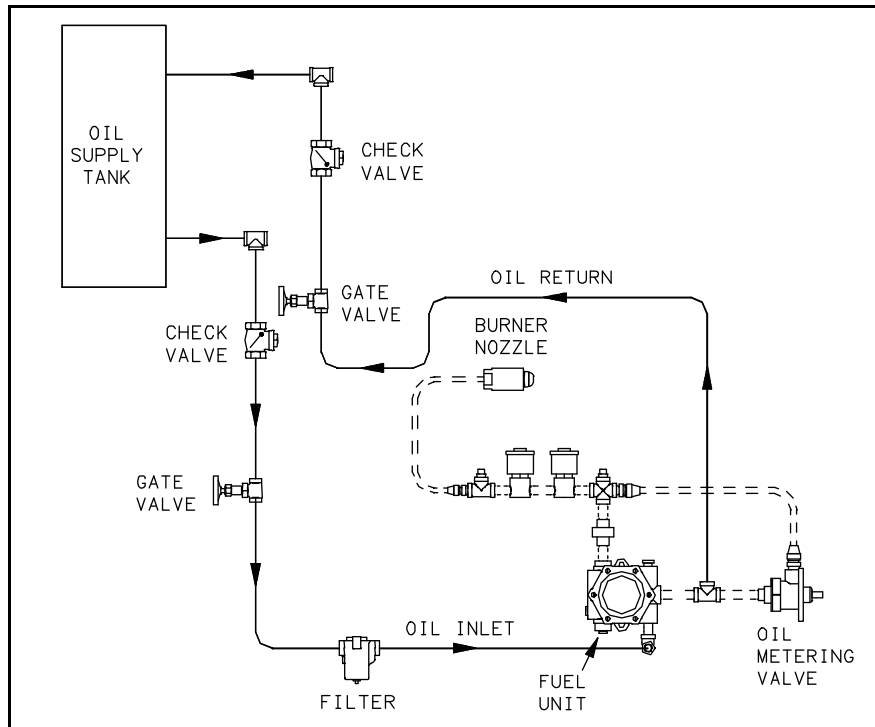


Figure 2-8: Typical No. 2 Oil Loop Single Burner

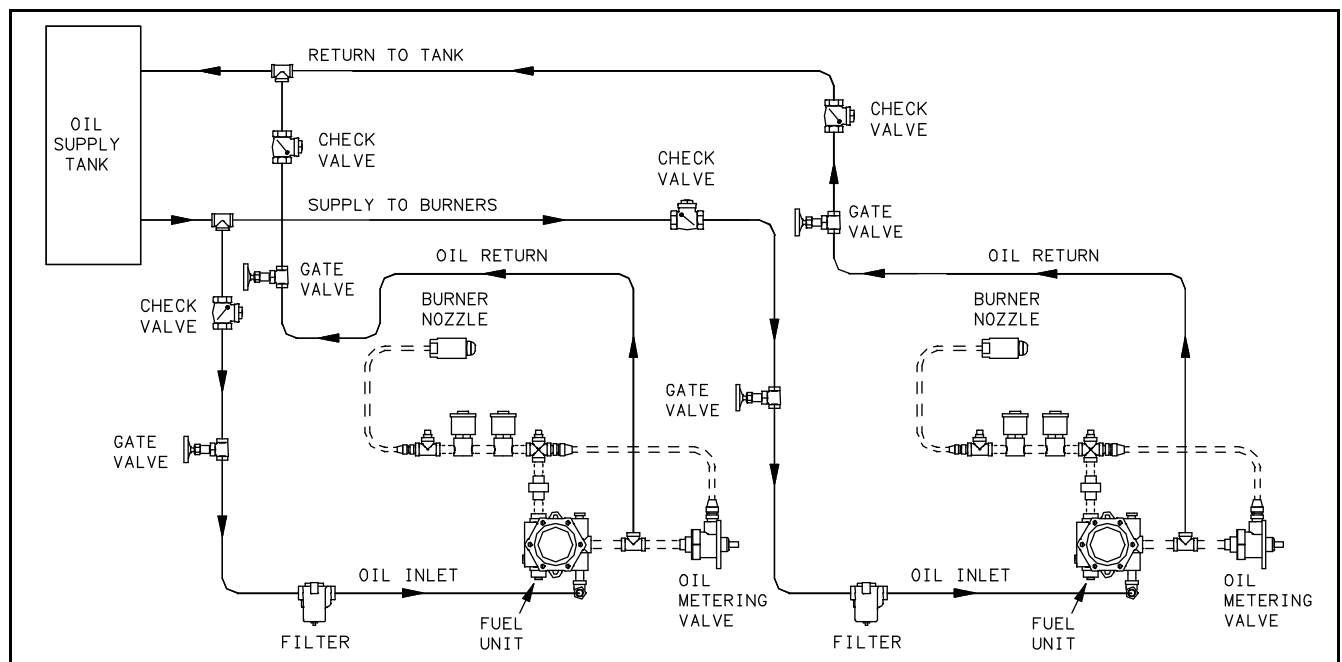


Figure 2-9: Multiple Burners with Separate Suction Lines

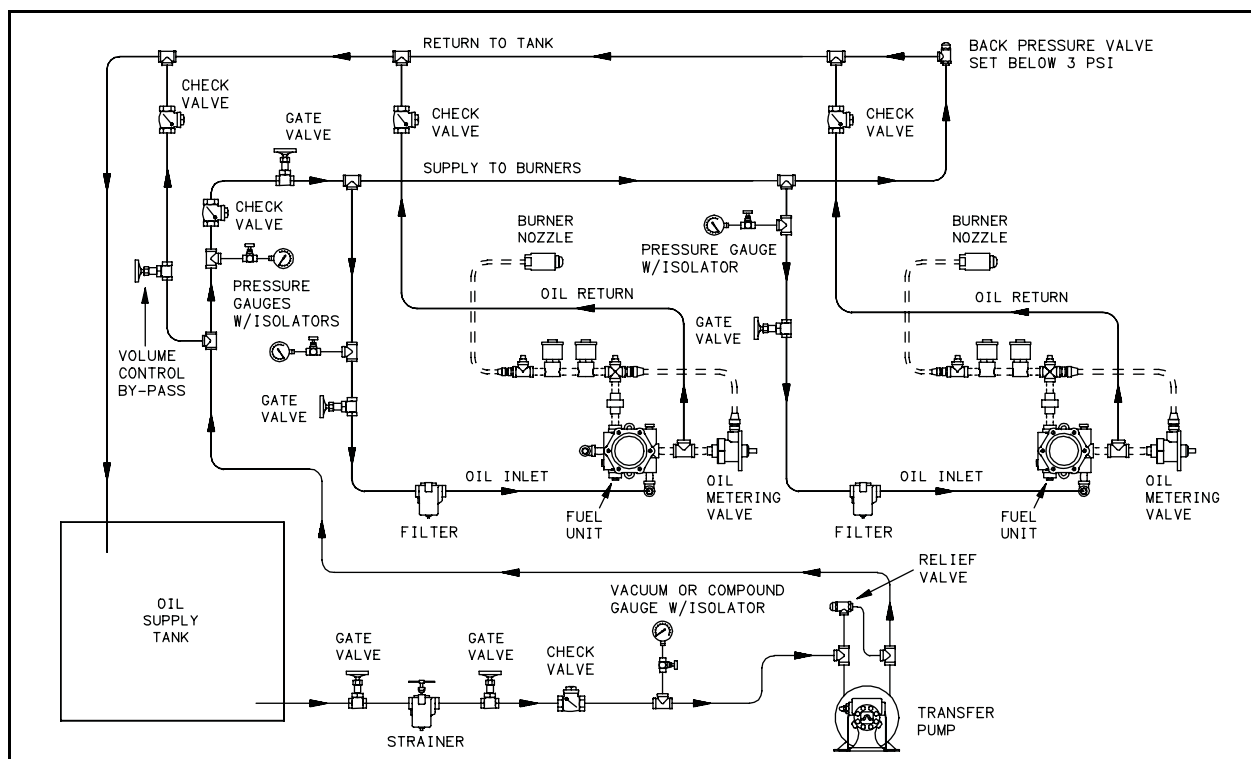


Figure 2-10: Typical Oil Loop for Multiple Burners with Transfer Pump

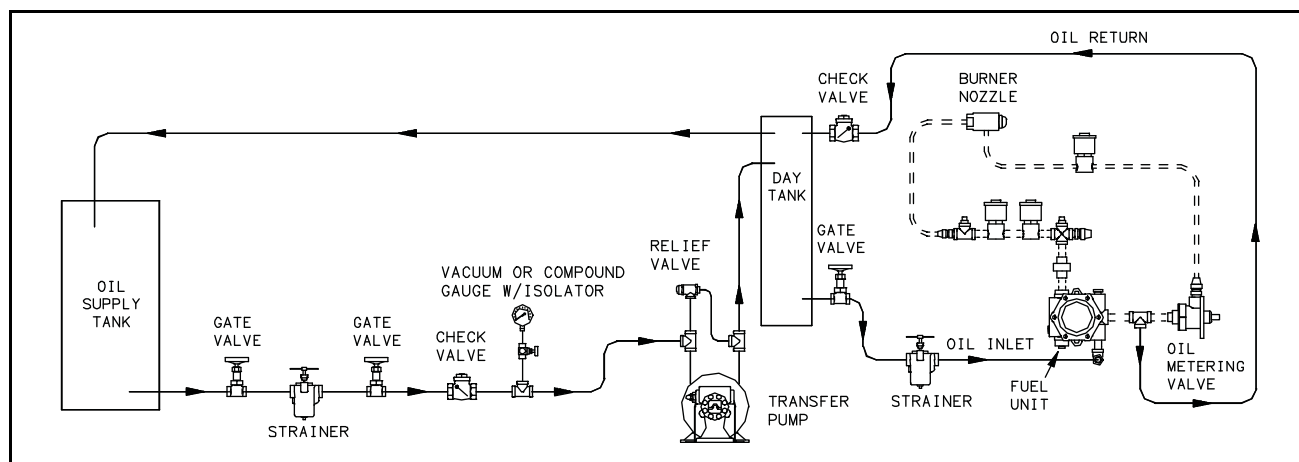


Figure 2-11: Typical Installation Using Day Tank

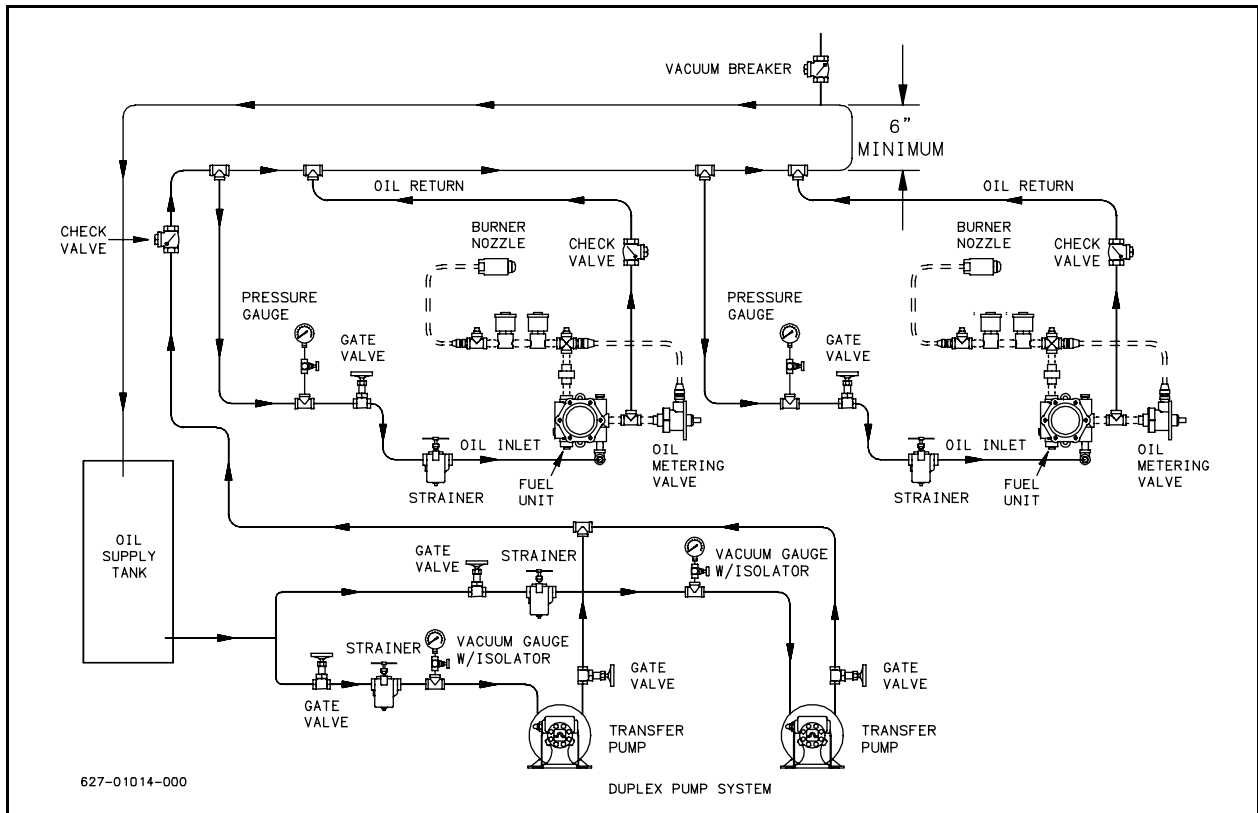


Figure 2-12: Typical Flooded Loop System

GAS PIPING

Refer to Figures 2-5 through 2-6 for typical gas piping arrangements. Normally, the control train is ordered to suit a particular code or insurance regulation, such as UL/cUL, FM, or GAP. Gas service and house piping must supply the quantity of gas demanded by the unit at the pressure required at the burner gas train inlet.

All piping must be in strict accordance with applicable codes, ordinances, and regulations of the supplying utility. In the absence of other codes, piping should be in accordance with National Fuel Gas Code, NFPA No. 54, ANSI No. Z223-1.

Gas train components upstream of the butterfly valve are shipped loose. These components should be mounted by the installer as close to the butterfly valve as practical. If a pre-piped and wired gas train is ordered, the components upstream of the first safety shutoff valve are shipped loose. These components should also be mounted by the installer.

Arrange gas piping at the burner so that the burner is accessible for servicing without disassembly. The pilot gas train is supplied with the burner, and is factory installed. The gas pilot supply line must be connected upstream of the main gas regulator. If a reducing bushing is required between the house piping and the burner piping, it should be close to the burner shutoff valve.

The gas piping must be internally clean and free of foreign material. Before using in service, a leak test must be performed.

INSTALLATION CHECKLIST

1. All burners are carefully assembled and tested at the factory, but before being placed in service all connectors should again be checked for looseness caused during shipment.

Check:

- a. Electrical terminals in the control panel and on all electrical components.
 - b. Pipe fittings and unions.
 - c. Tubing connections.
 - d. Nuts, bolts, screws.
2. Open all necessary oil shutoff valves. Do not run pumps or fuel unit without oil.
 3. Before connecting electrical current to any component, be sure the voltage is the same as that specified on component name-plates.
 4. Before burner operation, be sure all motors are rotating in the proper direction.
 5. Before firing, make sure the burner firing head and dry areas of the boiler are protected with refractory. The burner mounting flange must be properly sealed against the vessel front plate.
 6. Make certain that the operator in charge is properly instructed in operation and maintenance procedures.

CAUTION

BEFORE OPENING THE MANUAL GAS SHUTOFF VALVES, READ THE REGULATOR INSTRUCTIONS CAREFULLY. THE INSTRUCTIONS ARE IN THE REGULATOR BOX. FOLLOW THE MANUFACTURER RECOMMENDATIONS. OPEN SHUTOFF VALVE ON THE INLET SIDE OF THE REGULATOR SLOWLY AND CAREFULLY TO ALLOW INLET PRESSURE TO BUILD UP SLOWLY IN THE REGULATOR UNTIL IT IS FULLY PRESSURIZED. OPEJNING THE SHUTOFF VALVE QUICKLY WILL DAMAGE THE REGULATOR. DO NOT EXCEED THE REGULATOR PRESSURE RATINGS.

V BURNER FIRING MODES

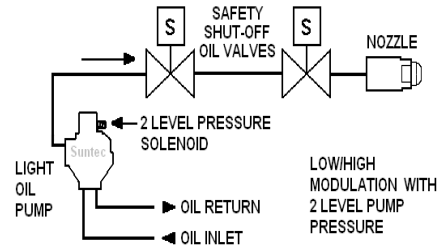
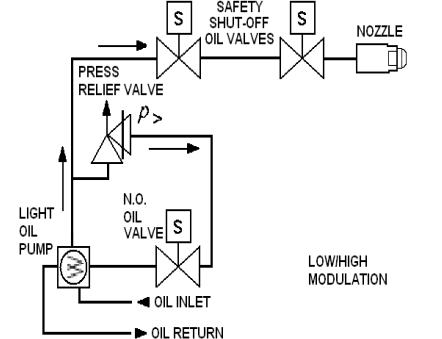
Different modulation modes are available with the Profire V burner. The Model FLX will utilize one of the following:

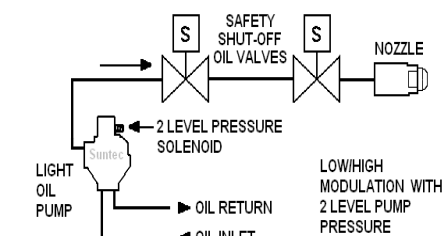
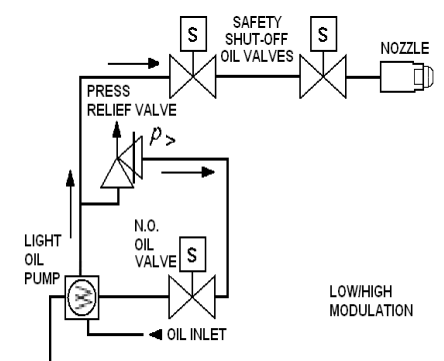
Low - High -Low (60% damper purge).

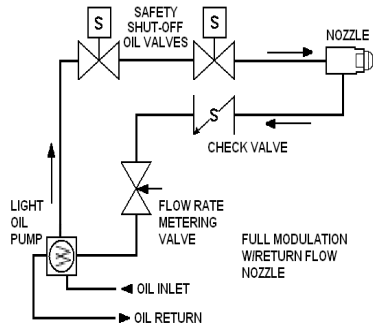
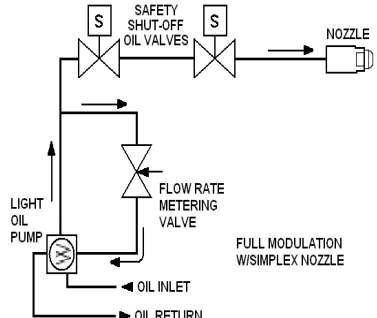
Low - High -Low (open damper purge).

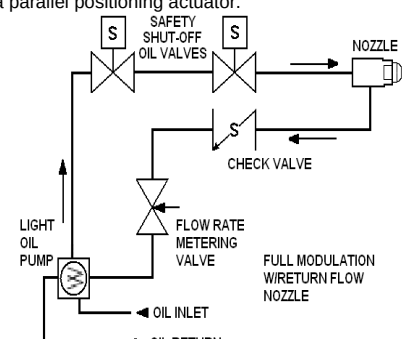
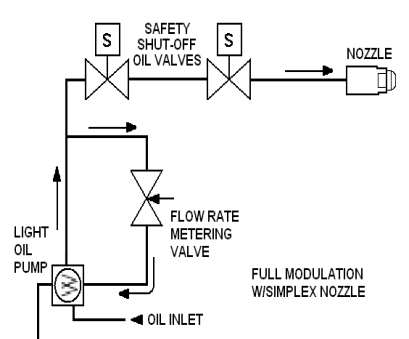
Full Modulation (open damper purge).

See following pages for operating descriptions of each firing mode.

LOW-HIGH-LOW MOD - LOW or 60% DAMPER PURGE				
	Combustion Air	Gas	Oil	
Operating Sequence	COMPONENTS DESCRIPTION:	A two blade damper is controlled by a two position, spring return actuator with mechanical linkage. For 60% damper purge a mechanical stop is provided on the damper to ensure sufficient air flow is provided during prepurge. Power to drive the actuator is routed through a low/auto switch and a remote located modulating control. The actuator also contains a limit switch which is used to actuate the second stage of the oil supply system. (see oil at right).	Safety shut off valve(s) are provided to initiate the flow of gas. The primary is a diaphragm or motorized type valve which have delayed opening rates to prevent an "in rush" of gas. A butterfly type gas metering valve is linked directly to the damper actuator and provides gas flow metering during the drive to the high position. A manually adjusted gas regulator limits maximum firing rate.	Pressure Atomization: Two solenoid type safety shut off oil valves initiate the flow of oil from the high pressure pump to the nozzle. The oil pump has a built in solenoid controlled two level pressure regulating system. Low and high flow rates are set on the pump based on pressure and the nozzle's flow rating. 
	PRE-PURGE:	Damper is in its closed or low fire position. For 60% damper purge this would be against the mechanical stop.	Valves are closed.	The pump is operational but the valves are closed. Oil is flowing through an internal relief valve and returning to the supply system.
	STARTUP, IGNITION:	Damper remains in its low fire starting position.	Valves open. To prevent a surge the primary gas valve opens at a slowed rate. Gas flow to the manifold is metered based on the butterfly valves low fire setting.	Safety shut off valves open allowing oil to flow from pump to nozzle. Oil pressure at the nozzle is based on the pump's low pressure setting. Excess oil is flowing through an internal relief valve and returning to the supply system.
	RUN, MODULATE:	Damper is driven open in 30 seconds by the two position actuator. Low-High-Low burners will modulate from the low to high rate positions based on the signal from the modulating control and the selection of the low/auto switch.	The gas valves remain in their open position. The actuator begins it's travel to the high fire position opening the gas metering valve. The burner will then modulate from low to high as described in the combustion air column.	The safety shut-off oil valves remain open. The pump's solenoid is energized by the auxiliary switch within the damper actuator as it opens the air damper. Oil pressure is then increased based the pumps high pressure setting. The burner will then modulate from low to high as described in the combustion air column.
	SHUT DOWN, POST-PURGE:	Damper returns to its start position based on the 25 second closure speed of the mechanical actuator.	On shut down all gas valves close within 1 second. The butterfly valve closes in 25 seconds with the two position actuator.	All valves immediately return to their startup or de-energized position. The oil pump is operating with post-purge, but oil is flowing through an internal relief valve and returning to the supply system.
VARIATIONS:	None	None	For pumps without the internal dual pressure solenoid an external pressure relief valve and normally open solenoid valve are used. 	

LOW-HIGH-LOW MOD - OPEN DAMPER PURGE				
		Combustion Air	Gas	Oil
COMPONENTS DESCRIPTION		A two blade damper is controlled by a two position, spring return actuator with mechanical linkage. Power to drive the actuator is routed through a low/auto switch and a remote located modulating control. The actuator also contains a limit switch which is used to actuate the second stage of the oil supply system. (see oil at right) A second external switch ensures the damper has returned to the low fire position before ignition is initiated.	Safety shut off valve(s) are provided to initiate the flow of gas. The primary is a diaphragm or motorized type valve which have delayed opening rates to prevent an "in rush" of gas. A butterfly type gas metering valve is linked directly to the damper actuator and provides gas flow metering during the drive to the high position. A manually adjusted gas regulator limits maximum firing rate.	Pressure Atomization: Two solenoid type safety shut off oil valves initiate the flow of oil from the high pressure pump to the nozzle. The oil pump has a built in solenoid controlled two level pressure regulating system. Low and high flow rates are set on the pump based on pressure and the nozzle's flow rating. 
Operating Sequence	PRE-PURGE	From its closed position the damper is driven open by the flame safeguard control where it remains for the duration of the pre-purge cycle.	Valves are closed.	The pump is operational but the valves are closed. Oil is flowing through an internal relief valve and returning to the supply system.
	STARTUP, IGNITION	Damper returns to the low fire position which is proven through the external switch. The burner is now ready for startup.	Valves open. To prevent a surge the primary gas valve opens at a slowed rate. Gas flow to the manifold is metered based on the butterfly valves low fire setting.	Safety shut off valves open allowing oil to flow from pump to nozzle. Oil pressure at the nozzle is based on the pump's low pressure setting. Excess oil is flowing through an internal relief valve and returning to the supply system.
	RUN, MODULATE	Damper is driven open in 30 seconds by the two position actuator. Low-High-Low burners will modulate from low to high rate positions based on the signal from the modulating control and the selection of the low/auto switch.	The gas valves remain in their open position. The actuator begins its travel to the high fire position opening the gas metering valve. The burner will modulate from low to high as described in the combustion air column.	The safety shut-off oil valves remain open. The pump's solenoid is energized by the aux switch within the damper actuator as it opens the air damper. Oil pressure is then increased based the pump's high pressure setting. The actuator begins its travel to the high fire position opening the gas metering valve. The burner will modulate from low to high as described in the combustion air column.
	SHUT DOWN, POST-PURGE	Damper returns to its start position based on the 25 second closure speed of the mechanical actuator.	On shut down all gas valves close within 1 second. The butterfly valve closes in 25 seconds with the two position actuator.	All valves immediately return to their startup or de-energized position. The oil pump is operating with post-purge, but oil is flowing through an internal relief valve and returning to the supply system.
VARIATIONS		None	None	For pumps without the internal dual pressure solenoid an external pressure relief valve and normally open solenoid valve are used. 

FULL MODULATION - OPEN DAMPER PURGE				
		Combustion Air	Gas	Oil
COMPONENTS DESCRIPTION		A two blade damper is controlled by a proportional modulating actuator (or motor) with mechanical linkage. The modulating actuator is capable of stopping at any point along its 90 degree stroke based on a signal from a remotely connected modulating control or from a burner mounted manual potentiometer which is selected through an auto/manual modulation selector switch. The actuator also contains two internal switches that ensure the damper reach the high fire and low fire positions during purge and before ignition is initiated.	Safety shut off valve(s) are provided to initiate the flow of gas. The primary is a diaphragm or motorized type valve which have delayed opening rates to prevent an "in rush" of gas. A butterfly type gas metering valve is linked directly to the damper actuator and provides gas flow metering relative to the actuator position. A manually adjusted gas regulator limits maximum firing rate.	Pressure Atomization: Two solenoid type safety shut off oil valves initiate the flow of oil from the high pressure pump to a return flow nozzle. In the return line from the nozzle an adjustable oil metering valve limits the amount of oil allowed to return to the pump. The metering valve is connected to the damper actuator with mechanical linkage. 
Operating Sequence	PRE-PURGE	From its closed position the damper is driven open by a signal from the flame safeguard control where the high fire air switch is proven. The damper will remain open for the duration of the pre-purge cycle.	Valves are closed.	The pump is operational but the valves are closed. Oil is flowing through an internal relief valve and returning to the supply system.
	STARTUP, IGNITION	Damper returns to the low fire position which is proven through the internal low fire air proving switch. The burner is now ready for startup.	Valves open. To prevent a surge the primary gas valve opens at a slowed rate. Gas flow to the manifold is metered based on the butterfly valve low fire setting.	Safety shut off valves open allowing oil to flow from pump to nozzle. Oil pressure at the nozzle is based on the pump's pressure setting less the volume of oil returning through the metering valve.
	RUN, MODULATE	Damper is driven by the modulating actuator to a firing rate position as determined by the modulating control or manual potentiometer. Actuator can complete full travel to high fire in 30 seconds. Actuator will then continue to adjust firing rate position based on signals from the modulating control until demand is satisfied.	The gas valves remain in their open position. As the actuator begins its travel to the firing rate position it is also adjusting the butterfly gas metering valve increasing the flow of gas to the manifold. The burner will continue to modulate as described under the combustion air heading until demand is satisfied.	The safety shut-off oil valves remain open. As the actuator begins its travel to the firing rate position it is also adjusting the oil metering valve decreasing the amount of oil allowed to return to the pump. This in turn is increasing the pressure and volume of oil at the nozzle. The burner will continue to modulate as described under the combustion air heading until demand is satisfied.
	SHUT DOWN, POST-PURGE	Damper returns to its starting position based on the 30 second closure speed of the mechanical actuator during post purge.	On shut down all gas valves close within 1 second. The butterfly valve closes in 30 seconds with the damper actuator.	All valves immediately close. The metering valve opens to its low fire position in 30 seconds with the damper actuator. The oil pump is operating with post-purge, but oil is flowing through an internal relief valve and returning to the supply system.
VARIATIONS:		Options are available for 4-20amp modulating signal conversion or 4-20 proportional modulating actuators. Also optional is an actuator with dual low fire start switch positions for improved "turn down" in dual fuel situations.	None	On models with a simplex nozzle oil is diverted from the supply line through the meter and back to the pump before the first safety shut-off valve. 

PARALLEL POSITIONING			
	Combustion Air	Gas	Oil
COMPONENTS DESCRIPTION	A two bladed damper is controlled by an independent parallel positioning actuator. The remote mounted modulating control	Safety shut off valve(s) are provided to initiate the flow of gas. The primary is a diaphragm or motorized type valve which have delayed opening rates to prevent an "in rush" of gas. A butterfly type gas metering valve is directly coupled to a parallel positioning actuator. A manually adjusted gas regulator limits maximum firing rate.	Pressure Atomization: Two solenoid type safety shut off oil valves initiate the flow of oil from the high pressure pump to a return flow nozzle. In the return line from the nozzle is an adjustable oil metering valve which limits the amount of oil allowed to return to the pump. The metering valve is direct coupled to a parallel positioning actuator. 
Operating Sequence	PRE-PURGE	From its closed position the damper is driven open by a signal from the parallel positioning control. The damper will remain open for the duration of the pre-purge cycle.	Valves are closed.
	STARTUP, IGNITION	Valves open. To prevent a surge the primary gas valve opens at a slowed rate. Gas flow to the manifold is metered based on the butterfly valves low fire setting.	The pump is operational but the valves are closed. Oil is flowing through an internal relief valve and returning to the supply system.
	RUN, MODULATE	Damper returns to the low fire position in preparation for startup.	Safety shut off valves open allowing oil to flow from pump to nozzle. Oil pressure at the nozzle is based on the pump's pressure setting less the volume of oil returning through the metering valve.
	SHUT DOWN, POST-PURGE	The damper is driven by its parallel positioning actuator to a firing rate position as determined by the parallel positioning control. The actuator and parallel positioning control will then continue to adjust the damper and fuel actuators position based on signals from remote sensors until demand is satisfied.	The safety shut-off oil valves remain open. The metering valve and actuator decreases the flow of oil returning to the pump in conjunction with the opening damper however, position adjustments are made based on the fuel "curve" stored in the parallel positioning control's memory. This in turn is increases the pressure and volume of oil at the nozzle. The burner will continue to modulate as described under the combustion air heading until demand is satisfied.
VARIATIONS	Damper returns to its closed position during or following post purge.	On shut down all gas valves close within 1 second. The butterfly valve returns to it's starting position..	All valves immediately close. The metering valve opens to it's low fire position. The oil pump is operating with post-purge, but oil is flowing through an internal relief valve and returning to the supply system. On models with a simplex nozzle oil is diverted from the supply line through the meter and back to the pump before the first safety shut-off valve. 

F. Startup and Operation

When the installation is complete and all electrical, fuel, water, and vent stack connections are made, make certain the connections are tight. The operator should become familiar with the burner, boiler controls and components. Adjustment procedures should be reviewed prior to firing. The wiring diagram should also be studied along with the operating sequence of the burner programmer. Check the electrical power supply for accordance with the nameplate specifications for all motors and controls.

Read and understand starting instructions before attempting to operate the burner. The following checks must be made:

BOILER

Check boiler water level. Be sure all boiler valves are installed correctly and positioned properly. Set the high limit control slightly above the operating control. Set operating control at the desired temperature or pressure.

BURNER

For protection in shipment, the flame safeguard control chassis is shipped unmounted. Check all screw connections before attaching flame safeguard chassis to base. The screw must be secure to assure low resistance connections. The relay chassis is mounted on the subbase with a screw which, when tightened, completes the connection between the subbase and chassis contacts. Press manual reset button to be sure safety switch contacts are closed.

Check fuses in main panel and in the burner control cabinet. Check wiring to the burner control cabinet for compliance with the wiring diagram and local codes. The control cabinet components are 120 volt. If a control transformer is supplied, ensure that the supply voltage matches its primary voltage.

Check motor rotation by momentarily closing the starter or relay. Blower rotation is clockwise when viewed from the drive end.

Check the pilot electrode setting.

Check control linkage for proper movement of the air volume damper and fuel metering components. This can be done by loosening the linkage at the actuator lever and manipulating by hand.

Check the air shutter and adjust low-fire setting.

FIRING PREPARATIONS

Check to make certain that all plugs, connections, linkages, etc., are tight. Prior to initial firing, oil flow and pressure should be verified.

Gas Burners

A representative of the gas utility should turn on the gas. Determine by a test gauge upstream of the burner regulator that sufficient pressure exists at the entrance to the gas train. The gas pressure regulator must be adjusted to the pressure required and the pressure setting recorded.

On combination fuel models, set the selector switch to gas. On initial startup it is recommended that the main gas shutoff cock remain closed until the programmer has cycled through pre-purge and pilot sequences to determine that the main gas valve opens. Turn the burner switch OFF and let the programmer finish its cycle. Check to see that the gas valve closes tightly.

On burners equipped with high and low gas pressure switches, set switch pressure actuating levels and record settings for future service reference.

See the burner specification nameplate inside the control panel door for minimum and maximum input rate and required manifold pressure.

When the conditions covered above and in Section 2 are assured, the burner is ready for firing. Refer to Section E for starting and operating information.

Oil Burners

Prior to initial firing, oil flow and pressure should be verified. If the burner is a dual fuel model, make certain that the main gas shutoff cock is closed and the fuel selector switch is set to OIL.

If the oil supply tank is below the level of the oil fuel unit, it is recommended that the suction line be primed with oil prior to starting the pump to avoid the possibility of damage to the pump through operation without lubrication.

To check for proper pump rotation, momentarily energize the starter. With rotation verified, operate the pump to determine that oil circulation exists. Observe the oil burner pressure gauge. If not pressure shows after a few moments, stop the oil pump and re-prime. If the supply tank is lower than the pump, it is possible that the initial priming of the suction line, followed by operation of the pump, will not establish oil flow. This might be caused by obstruction in the suction line, excessive lift, inadequate priming, suction line leaks, etc. Until oil flow is established, avoid prolonged operation of the pump. If oil flow is not established after a second priming, investigation is required.

A vacuum (or compound pressure-vacuum) gauge should be installed at the suction port of the pump. It is advisable that the reading be less than 15" Hg vacuum. Vacuum in excess of this may cause unstable firing.

If the vacuum gauge reads higher than calculated, look for restriction in the suction line, a closed valved, kinked copper tubing, plugged filter, sticking check valve, frozen oil line, undersized oil line, or excessive lift.

When there is a positive head of oil at the fuel unit, either from a gravity or by pump circulation, the pressure must not exceed 3 psi at the fuel unit suction inlet. Special pressure regulating valves are available for suction pressure above 3 psi. The fuel unit discharge pressure should be set at 300 psi.

BURNER SETTINGS

To ensure reliable and safe burner performance, the location and gap setting of the electrode for direct spark igniters, and the relative positions of the burner nozzle, diffuser, and air baffle components must be correctly set. The air damper blades must be adjusted, relative to the established flow rates to provide the correct amount of air for complete efficient combustion.

These items are preset at the factory, but must be checked prior to placing the burner into initial service, or after conducting any service work that may have altered their position.

Fuel and air flow rates are individually adjusted at low-fire and at high-fire to achieve rated heat input, firing rate turndown, optimum efficiency, safe operation, and the ability to cope with environmental changes (including air temperature, humidity, barometric pressure), and fuel property changes. Refer to the nameplate inside the control panel for minimum and maximum fuel input ratings.

TEST EQUIPMENT

The following test equipment should be on site:

- Combustion analyzer with O₂ indication.
- U-Tube manometer, or pressure gauge, to measure gas pressures (main and pilot), pressures and vacuum gauge for the oil burners.
- Inclined manometer to measure draft pressures.
- Smoke spot tester for oil burners and CO analyzer for gas fired units.
- Voltmeter/Ammeter.
- Stack Thermometer and Thermocouples



TO PREVENT POSSIBLE SERIOUS INJURY OR DEATH, READ THE FLAME SAFEGUARD MANUAL AND FULLY UNDERSTAND ITS CONTENT BEFORE ATTEMPTING TO OPERATE THIS EQUIPMENT.



SHOULD A STARTING FAILURE OCCUR FOR ANY REASON, COMBUSTIBLE FUMES MAY FILL THE COMBUSTION CHAMBER. NEVER ATTEMPT TO RE-LIGHT THE BURNER UNDER THESE CONDITIONS WITHOUT PURGING THE CHAMBER.

ELECTRICAL INTERFERENCE TEST

Prior to putting the burner into service, conduct the following test to ascertain that ignition spark will not cause the flame relay to pull in.

Gas Fired

Close the pilot and main line manual gas valves. Start the burner and at time of pilot trial with just the electrical ignition system energized. The flame relay should not pull in (should not be energized).

Upon completion of successful test, proceed with startup procedures.

Oil Fired

Disconnect the electrical power to the burner. Disconnect the electric oil safety shutoff valve. Reconnect electric power. Close the pilot line manual gas valve, if used.

Start burner and at the time of pilot trial, with just the electrical ignition system energized. The flame relay should not pull in.

Upon completion of successful test, disconnect power supply. Reconnect oil safety shutoff valve and turn on manual pilot gas valve. Reconnect power supply and proceed with startup procedures.

BURNER IGNITION ADJUSTMENT

Gas Pilot Flame Adjustment

The gas pilot flame is regulated by adjusting the pressure setting of the pilot regulator. Normal setting is 4" to 6" W.C. when the pilot is burning. The flame must be sufficient to be proven by the flame detector and ignite the main flame.

Although it is possible to visibly adjust the size of the pilot flame, obtain a proper DC volt or microamp reading of the flame signal. The flame safeguard amplifier has a meter jack for this purpose. At initial startup and during planned maintenance, test the pilot flame signal, pilot turndown and safety switch lockout.

Gas Pilot Turndown Test

For burners equipped with a gas pilot, conduct the following test:

1. Turn the burner switch "ON". This will start the blower motor and initiate the pre-purge sequence. Make sure a pressure gauge 0" to 10" W.C. or a manometer is installed in the pilot line to monitor the pilot gas pressure.
2. When the pilot comes on, put the programmer timer on pilot hold by placing the "RUN-TEST" switch on the flame safeguard to the "TEST" position.
3. Check the flame signal strength. Adjust the flame signal by increasing or decreasing pilot gas pressure with the reg-

ulator spring. Normal setting is 4" to 6" W.C.

4. Perform a pilot turndown test by reducing the pilot pressure very slowly until the scanner loses sight of the flame and gives a flame lockout, then reset the adjustment to normal level. Note the minimum pressure level.
5. After adjusting the pressure back to normal level, set the programmer to the "RUN" position. Main flame will come on and the burner is in the low-fire position.
6. Start and stop the burner several times to ensure proper pilot setting.

STARTUP SEQUENCE

The programming control sequences the operation of all controls and components through the starting, ignition, firing, and shutdown cycle. The burner and control system are in starting condition when:

- The operating and high limit control (temperature or pressure) are below their cutoff settings
- All power supply switches are closed.
- Power is present at the control panel.

Refer to the controls literature and burner wiring diagrams for detailed information.

1. Begin starting sequence, with burner switch off, and with all manual valves closed. Switch main power on.
2. When firing oil, open the manual oil valves.
3. When firing on gas, open the main manual gas valve.
4. When firing on gas, manually reset the high and low gas pressure switches (if applicable).
5. Place the gas-oil selector switch (if applicable) in position for the desired fuel. With all limit and operating controls calling for heat, the burner will follow the flame safeguard sequence.
6. When the burner motor starts, open the gas cock.
7. If firing on gas, when the main fuel lamp lights indicating pilot flame proven, slowly open the second shutoff cock downstream of the main gas valve(s).

AUTOMATIC SHUTDOWN

Limit or operating controls open:

1. Fuel valves close. Main fuel lamp goes off. Flame safeguard timer starts.
2. Flame safeguard timer and burner motor stop. Burner is ready for startup on the next call for heat.

MANUAL SHUTDOWN

1. Turn selector switch to the off position. The burner shuts down in Automatic Shutdown as above.
2. When the burner motor stops, close all manual valves.

SAFETY SHUTDOWN

If at any time during the operating cycle a flame failure occurs, the burner shuts down as in Automatic Shutdown, with an additional post-purge, and the flame failure lamp is energized. The lockout switch on the flame safeguard control must be manually reset before the burner will fire again.

If a low water condition occurs, the burner shuts down as in Automatic Shutdown.

If a high or low gas pressure condition occurs while firing on gas, the burner shuts down as in Automatic Shutdown. Condition must be corrected and the respective gas pressure switch manually reset before the burner will fire again on gas.

⚠ WARNING

Should a starting failure occur for any reason, combustible fumes may fill the combustion chamber. Never attempt to re-light the burner under these conditions. The combustion chamber must first be purged before re-lighting.

⚠ WARNING

Keep fingers away from the combustion air intake below the damper. The damper is actuated with sufficient force to cause severe injury. Always make high and intermediate rate adjustments when the burner has reached low fire position. Do not disturb the low fire setting.

STARTUP AND OPERATING

Gas Burners

A gas valve leak test must be performed on the automatic safety shutoff valves located in the main gas train prior to any initial commissioning or subsequent maintenance of the burner and gas train systems, where automatic valve proving systems interlocked with the main burner safety control are not provided. This test should be performed periodically to ensure no leakage of valves in their closed or de-energized position.

The unit should be taken out of service if the unit fails any of the following tests. Any defective part must be replaced prior to putting the equipment back into service.

⚠ WARNING

FAILURE TO FOLLOW THIS PROCEDURE MAY RESULT IN EXPLOSION, FIRE, PROPERTY DAMAGE, AND PERSONAL INJURY. THIS PROCEDURE MUST BE PERFORMED ONLY BY AUTHORIZED AND QUALIFIED PERSONNEL.

1. Close the main and pilot gas cocks.
2. Make sure the ON-OFF switch is in the "OFF" position and the fuel selector switch is turned to "GAS."
3. Actuate the manual reset button of the flame safeguard control to close the safety switch contacts.
4. Set the MANUAL-AUTO switch in the "MANUAL" position.
5. Set the manual potentiometer in the low fire position.
6. Open the gas pilot cock.
7. Set the ON-OFF switch to "ON." The burner will start and pre-purge. After pre-purge, the ignition transformer and the gas pilot solenoid are energized. Before proceeding, conduct electrical interference and pilot turndown tests if not previously done (see Section 3.2).
8. On initial startup it is recommended that the main gas shutoff cock remains closed until the programmer has cycled through pre-purge and pilot sequence. Then determine that the main gas valve opens. When this is confirmed, turn the burner switch "OFF" and let the programmer finish its cycle.
9. Check to see that the gas valve has closed tightly. If ignition does not occur, turn the burner switch "OFF" and allow the programmer to recycle for a new ignition trial.
10. Turn the burner "ON" and after pilot ignition when the flame relay pulls in, the slow opening, motorized, main gas valve is energized. The main flame should ignite at this time. The gas valve and air damper continue advancing until high fire is reached.

11. Do not repeat unsuccessful light off attempts without rechecking burner and pilot adjustment. Vent fuel vapors from the combustion chamber after each unsuccessful light off attempt.
12. Set the gas low fire rate by adjusting the butterfly valve and air linkage.
13. When low fire is adjusted, shut down the burner.
14. Restart several times to be sure the low fire setting is suitable. Readjust if necessary. Never start the burner with fuel vapor in the furnace. In case of an emergency, open the main power switches and close all fuel valves.
15. After combustion adjustments are satisfactorily set, allow the heating vessel to slowly reach normal operating pressure or temperature.
16. Turn the potentiometer switch to the high fire position. Check high fire at this point using combustion instruments.
17. Do not disturb established low fire adjustment. Allow the burner to return to low fire position before adjusting high or intermediate settings.

Do not repeat unsuccessful light off attempts without rechecking burner and pilot adjustment. Vent fuel vapors from the combustion chamber after each unsuccessful light off attempt. Set the gas low fire rate by adjusting the butterfly valve and air linkage. Refer to the adjustment section of this manual. Using the combustion analysis instrument, adjust the low fire. Typical combustion analysis for low fire is 5% to 6% O₂ on standard turndown systems, and between 6.5% and 9% for higher turndown systems. Verify the minimum input rate by measuring the gas meter.

When low fire is adjusted, shut down the burner. Restart several times to be sure the low fire setting is suitable. Readjust if necessary. Never start the burner with fuel vapor in the furnace. In case of emergency, open the main power switches and close all fuel valves. After combustion adjustments are satisfactorily set, allow the heating vessel to slowly reach normal operating pressure or temperature.

After the boiler has reached operating temperature or pressure, turn the potentiometer switch in small increments to the high fire position. Check high fire at this point using combustion instruments. High fire combustion analysis typically is 3% to 4% O₂. Verify maximum input rate by measuring the gas meter.

Do not disturb established low fire adjustment. Allow the burner to return to low fire position before adjusting high or intermediate setting. CO levels should be less than 400 ppm on an air-free basis at all firing rates, with <50 ppm as the target value.

When conditions covered above are assured, refer to NORMAL OPERATION below.

Oil Burners

1. The fuel selector switch should be set to "OIL" and the "ON-OFF" switch is in the "OFF" position. Actuate the manual reset button of the flame safeguard control to close the safety switch contacts. Set the ON-OFF switch to ON. The burner will start and pre-purge. After pre-purge, the ignition transformer will direct spark. If the flame detector proves the presence of a satisfactory pilot, the programmer will proceed to main flame ignition.
2. Set the "ON-OFF" switch to "ON." The burner will start and pre-purge. After pre-purge, the ignition transformer will direct spark. If the flame detector proves the presence of a satisfactory pilot, the programmer will proceed to main flame ignition.
3. Make initial air shutter settings for smooth ignition. Do not repeat unsuccessful light off attempts without rechecking burner and pilot adjustment. Vent fuel vapors from the combustion chamber after each unsuccessful light off attempt. Set the oil low fire rate by adjusting the oil return pressure and air linkage. Using the combustion analysis instrument, adjust the low fire. Typical combustion analysis for low fire is 5% to 6% O₂.
4. When low fire is adjusted, shut down the burner. Restart several times to be sure the low fire setting is suitable. Readjust if necessary. Never start the burner with fuel vapor in the furnace. In case of emergency, open the main power switches and close all fuel valves. After combustion adjustments are satisfactorily set, allow the heating vessel to slowly reach normal operating pressure or temperature.
5. After the boiler has reached operating temperature or pressure, turn the potentiometer switch in small increments to the high fire position. This will cause the metering valve to close, resulting in an increase in the oil pressure feeding the burner nozzle. In high fire the oil metering valve should be in the fully closed position and the fuel oil pressure should be about 300 psi. Check high fire at this point using combustion instruments. High fire combustion analysis typically is 3.5% to 4% O₂. Verify maximum input rate by measuring the oil meter if available or by weighing the oil.

The burner should be set up and maintained to yield smoke spot levels less than a #1 spot (ASTM D2156 Shell-Bacharach Scale) to minimize soot buildup in the boiler.

Do not disturb established low fire adjustment. Allow the burner to return to low fire position before adjusting high or intermediate settings.

When conditions covered above are assured, refer to NORMAL OPERATION below.

Combination Gas-Oil Burners

In general, the combination fueled system is to be started first using oil, because, as a fuel, oil has a greater combustion air requirement than natural gas.

Refer to the Gas Burner or Oil Burner adjustment procedures.

Once the adjustments are set for oil, shut down the burner and restart the adjust the natural gas fuel. DO NOT READJUST THE AIR DAMPERS. The adjustment is made by balancing the fuel input rate against the existing flow of combustion air.

When conditions covered above are assured, refer to NORMAL OPERATION below.

Note: SIZE 1 & 2 COMBINATION GAS/OIL UNITS USE A DIRECT COUPLING FROM THE BLOWER MOTOR TO THE OIL PUMP. WHEN FIRING GAS FOR AN EXTENDED PERIOD OF TIME, THE COUPLING SHOULD BE MANUALLY REMOVED AND REPLACED ONLY WHEN FIRING OIL. IF THE COUPLING IS LEFT CONNECTED TO THE BLOWER MOTOR, ENSURE THAT THERE IS PROPER OIL CIRCULATION AT ALL TIMES TO AVOID DAMAGE AND SEIZURE OF THE PUMP.

NORMAL OPERATION

Normal operation must be with the MANUAL-AUTO switch selector on AUTO.

In automatic operation, the operating cycle always proceeds sequentially through pre-purge, pilot ignition, main flame ignition, run and post-purge. The length of purge and ignition trial vary according to the type of programmer used.

During the run cycle, burner input is regulated to the load demand by the modulating pressure or temperature control on the boiler. The burner will continue to modulate until the operating pressure or temperature is reached.

Programmer control operation should be tested when the burner is initially placed into service, when a control is replaced, and at scheduled intervals in the maintenance program.

SHUTDOWN

When the operating limit control setting is reached or the burner switch is turned OFF, the following sequence occurs:

1. The fuel valve(s) de-energize and flame extinguishes. The blower motor continues running during post-purge (if so equipped with post-purge feature).
2. At the end of the post-purge the blower motor is de-energized. The programmer returns to its starting position and stops. Unit is ready to restart.

Abnormal shutdown might result from motor overload flame outage, low water, current or fuel supply interruption, combustion or atomizing air pressure below minimum level, tripped circuit breakers, blown fuses, or other interlock devices. Check for cause and correct before restarting burner.

Safety shutdown caused by ignition or flame failure will actuate a red indicator light and energize an audible alarm (if so equipped). If the programmer has a non-recycling interlock circuit, any interruption in this circuit during the pre-purge or firing cycle will cause a safety shutdown. This type of shutdown requires manual reset of the programming control and must be corrected before operation can be resumed.

G. Adjustments

While each burner is tested at the factory for correct operation before shipment, variable conditions such as burning characteristics of the fuel used and operating load conditions may require further adjustment after installation to assure maximum operating efficiency.

Prior to placing the boiler into initial service, a complete inspection should be made of all controls, connecting piping, wiring, and all fastenings such as nuts, bolts, and setscrews to be sure that no damage or misadjustments occurred during shipment and installation.

A combustion efficiency analysis made during the initial startup will help to determine what additional adjustments are required in a particular installation.

COMBUSTION ADJUSTMENT ON OIL AND GAS

Flame appearance alone is not sufficient to judge combustion efficiency, although it may help in making preliminary settings.

The proper settings of air-fuel ratios must be determined by flue gas analysis. Combustion gas analysis indicates the air to fuel ratio and the degree of complete combustion. Instruments are available to measure carbon dioxide (CO₂), oxygen (O₂), and carbon monoxide (CO). At no time should CO₂ measurements alone be used to indicate proper excess air levels. Only O₂ measurement can definitively show whether sufficient air has been provided for combustion.

STACK TEMPERATURE

Net stack temperature is obtained by subtracting the ambient temperature from the flue gas temperature. A high net stack temperature indicates wasted heat. Stack temperature should be as low as possible without causing flue gas condensation.

Stack heat loss can be reduced by decreasing either the temperature or the volume of the flue gas, or both. Flue gas temperature is reduced by improving heat transfer or by reducing excess combustion air. A certain amount of excess air is necessary to complete combustion. More efficient burners require minimum excess air.

SMOKE MEASUREMENT

Smoke measurements can be made using a variety of different methods. The standards will vary somewhat according to the equipment used, and instructions accompanying the instrument should be followed.

Smoky combustion can result from:

- improper air delivery
- insufficient draft
- improper fuel viscosity
- improper fuel-air ratio
- excessive air leaks in the combustion chamber
- improper fuel oil temperature

TEST EQUIPMENT

The following test equipment should be used to set up and adjust the burner correctly:

- Combustion analyzer with O₂ indication.
- U-Tube manometer, or pressure gauge, to measure gas pressures (Main and Pilot), vacuum and pressure gauges for oil.
- Inclined manometer to measure draft pressures.
- Smoke spot tester for oil burners and CO analyzer for gas fired units.
- Voltmeter/Ammeter.
- Stack Thermometer and Thermocouples.

GAS ADJUSTMENTS

Low-fire combustion analysis typically is 6% to 9% O₂ and less than .04% CO (400 ppm). High-fire reading typically is 3% to 5% O₂ and less than .04% CO. The V/Series burners are capable of operating at low excess air and less than 50 ppm CO levels at all firing rates.

FUEL OIL ADJUSTMENTS

Adjust for a “clean fire.” Typically for No. 2 oil, O₂ is 5% to 6% at low-fire and 3.5% to 4.5% at high-fire.

GAS PILOT FLAME ADJUSTMENT

The gas pilot flame is regulated by adjusting the pressure setting of the pilot regulator. Normal setting is 4” to 6” W.C. when the pilot is burning. The flame must be sufficient to be proven by the flame detector and ignite the main flame.

To adjust pilot gas pressure, unscrew regulator cap and turn the adjusting screw in or out.

Although it is possible to visibly adjust the size of the pilot flame, obtain a proper DC volt or microamp reading of the flame signal.

The flame safeguard amplifier has a meter jack for this purpose. At initial startup and during planned maintenance, test the pilot flame signal, pilot turndown, and safety switch lockout. Refer to the flame safeguard instruction manual.

Check the pilot electrode setting. The pilot is accessible by loosening the four screws on the side of the firing head and disconnecting the gas line.



AN ULTRA-VIOLET FLAME SENSOR ELECTRICAL SPARK INTERFERENCE TEST MUST BE PERFORMED AFTER FINAL ADJUSTMENT.

DIRECT SPARK (OIL ONLY) ADJUSTMENT

Oil only burner models VL13 to 55 are equipped with a direct spark ignition. Remove the oil drawer assembly and check electrode settings and nozzle size.

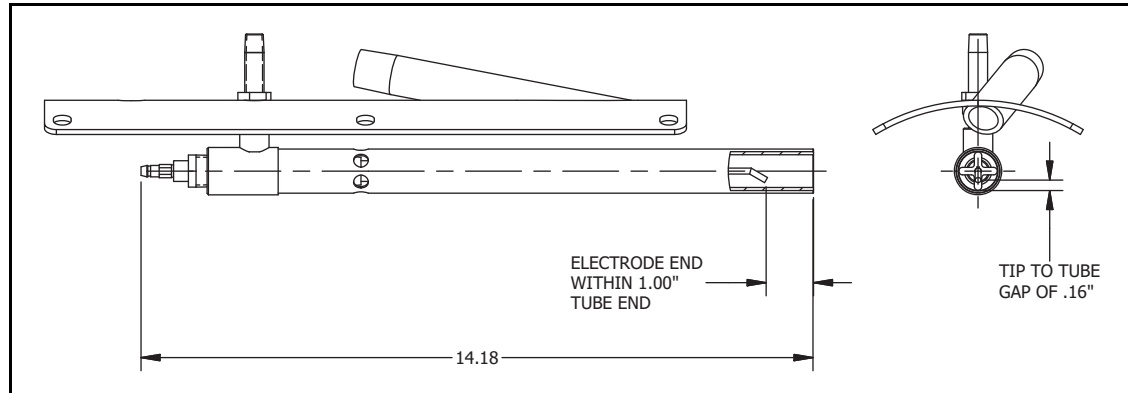


Figure 2-13: Direct Spark Ignition- Oil Only

BURNER PILOT SETTINGS

To ensure reliable and safe burner performance, the location and gap setting of the electrodes, and the relative positions of the burner nozzle, diffuser, and air baffle components must be set correctly. These items are preset at the factory, but must be checked prior to placing the burner into initial service, or after conducting any service work that may have altered their position.

The nozzle/diffuser assembly must be removed from inside the burner to enable measurement and readjustment:

1. Lock out and tag the electrical power supply to the burner to prevent inadvertent operation during checkout or maintenance activities.
2. Disconnect the high voltage power supply from the oil-spark-ignition electrodes (if installed).
3. Disconnect the oil piping from the side of the blast tube.
4. Remove the fasteners that secure the drawer to the side of the burner housing, and remove the complete assembly.

For burners with a gas pilot:

1. Disconnect the pilot line and loosen the locking screws on the pilot access cover located on the side of the blast tube.
2. Disconnect the high voltage ignition cable by pulling it straight back, away from the pilot assembly. The pilot assembly will slide back away from the diffuser.
3. Turn the assembly and retract it through the access hole.
4. Check the electrode position.
5. Re-assemble in reverse order.

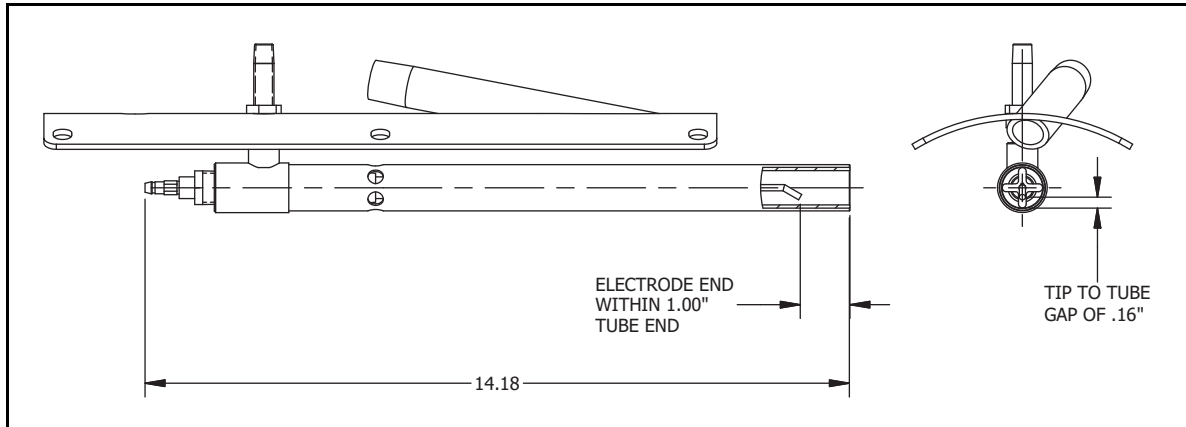


Figure 2-14: Gas Pilot

Measure the position of the tip of the nozzle to the diffuser and compare to the following drawer assembly drawings. To adjust:

1. Loosen the locking screws on the diffuser clamp.
2. Slide the diffuser clamp along the length of the burner pipe until the correct dimension is achieved.
3. Tighten the diffuser clamp securely to the burner pipe. Apply a lock-tight type compound to the screws before tightening.
4. Carefully install the drawer assembly into the burner.
5. Re-connect the oil line and high voltage power cable to the assembly.

Measure the position of the diffuser to the air baffle and compare to the following drawer assembly drawings. To adjust:

1. Measure the distance between the leading edge of the diffuser and the front face of the inner ring on the air baffle assembly.
2. If adjustment is required, loosen the burner pipe locking setscrew located on the rear cap at the top of the fan housing, and slide the burner pipe until the correct dimension is achieved.
3. Tighten the burner pipe locking setscrew securely.

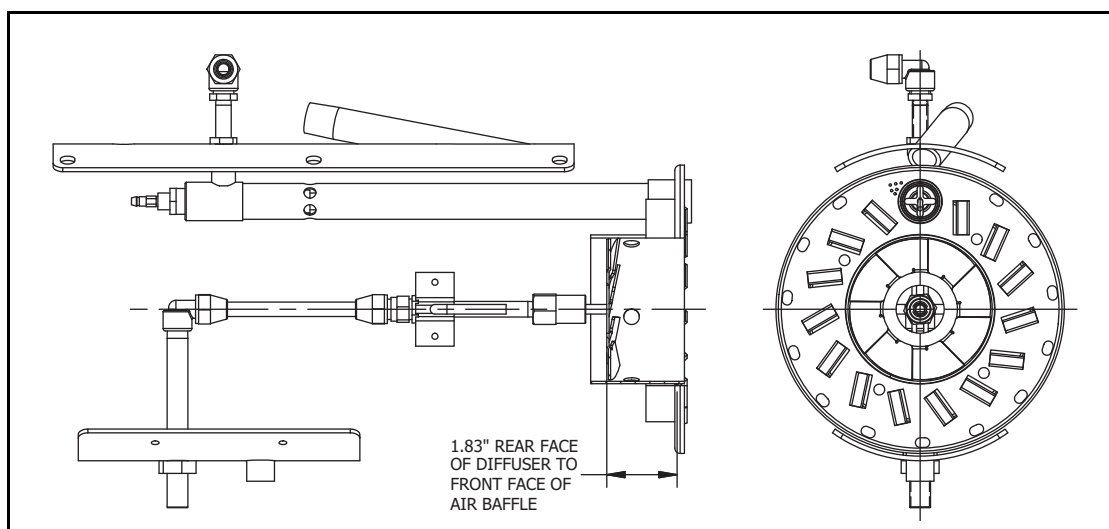


Figure 2-15: Drawer Assembly for (VG) Gas Only (V13-34) - Watertube/

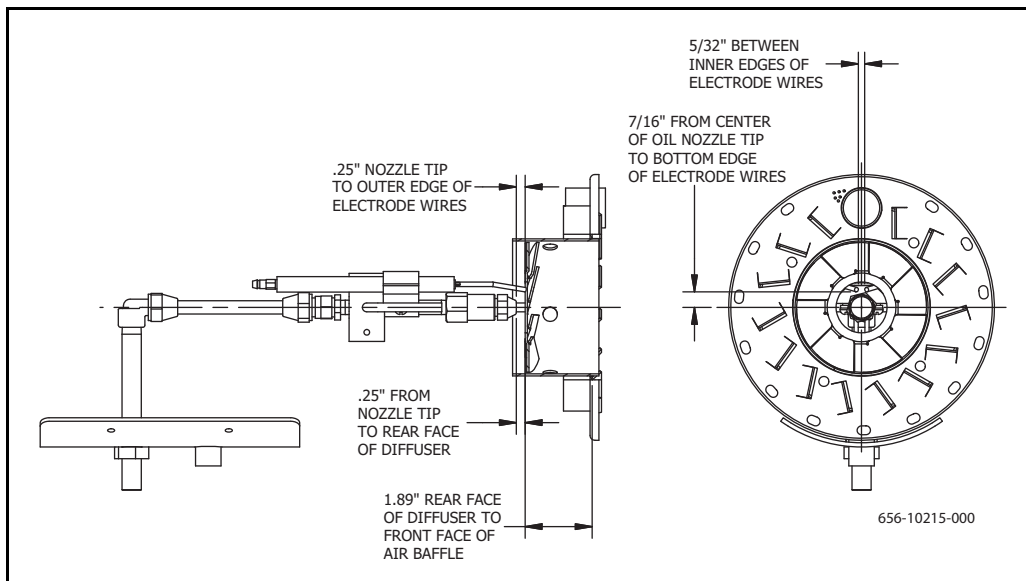


Figure 2-16: Drawer Assembly for (VL) Oil Only (V13-34) - Watertube

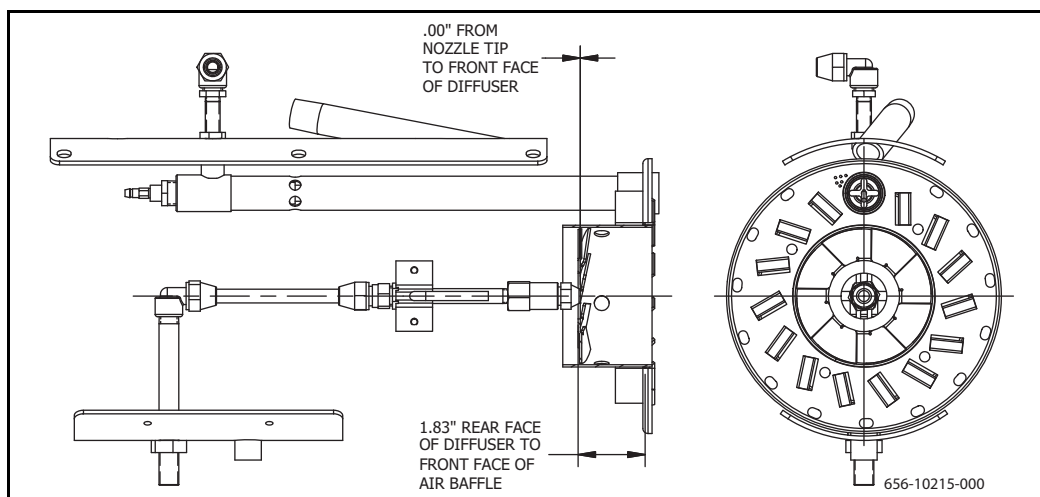


Figure 2-17: Drawer Assembly for (VLG) Gas/Oil (V13-34) - Watertube

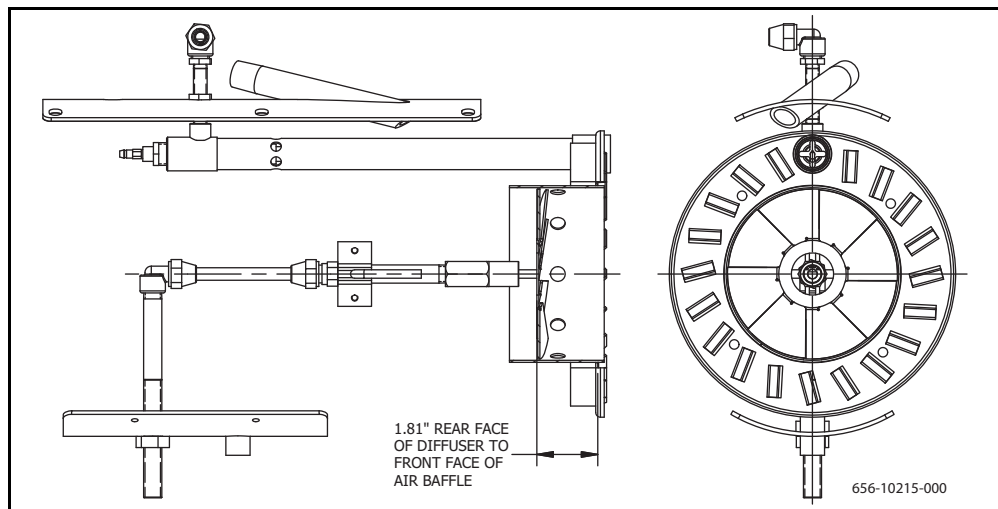


Figure 2-18: Drawer Assembly for (VG) Gas Only (V35-55) - Watertube

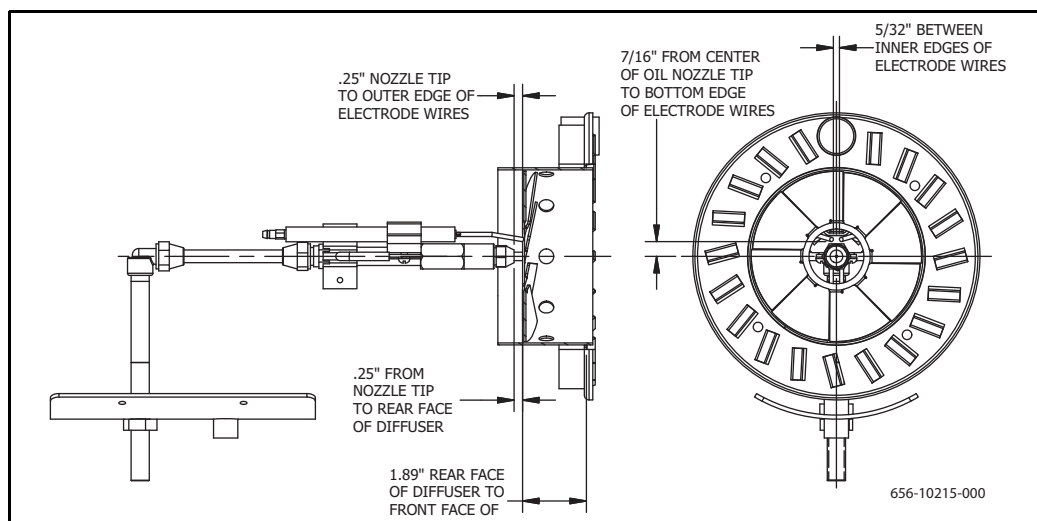


Figure 2-19: Drawer Assembly for (VL) Oil Only (V35-55) - Watertube

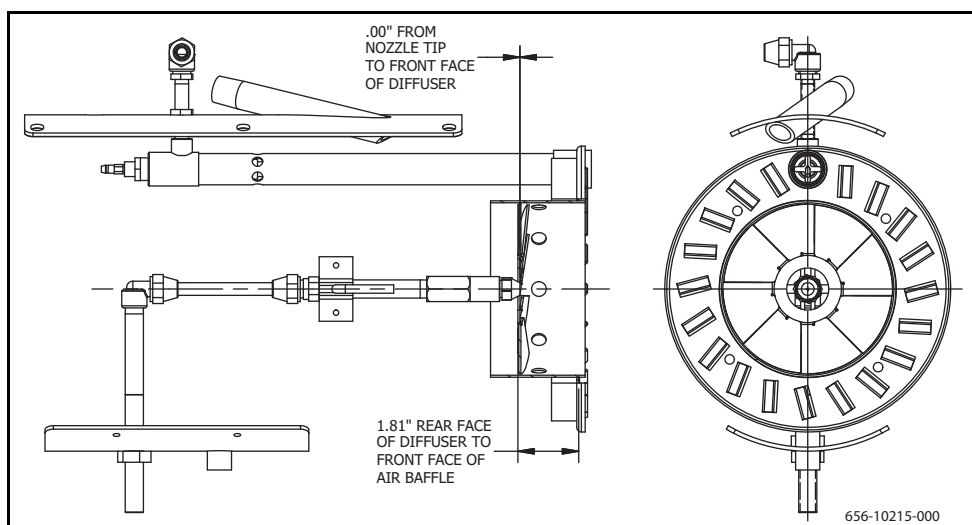
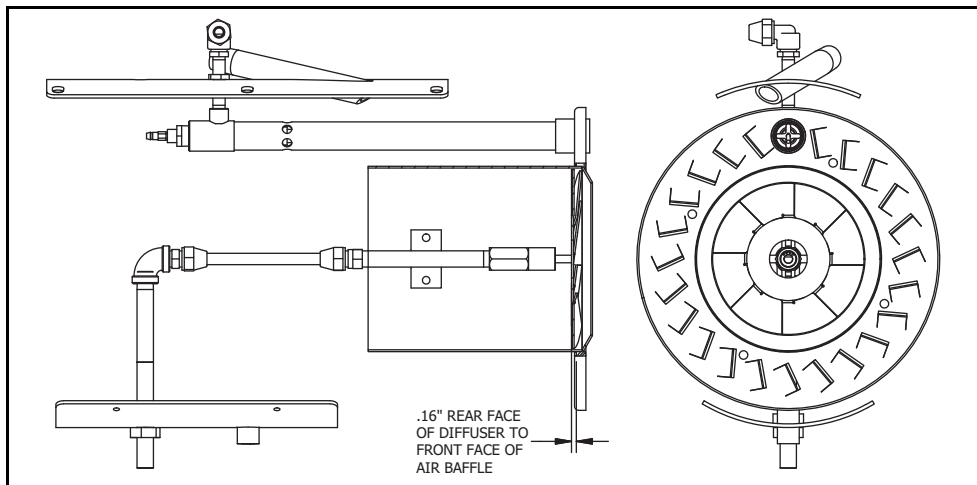
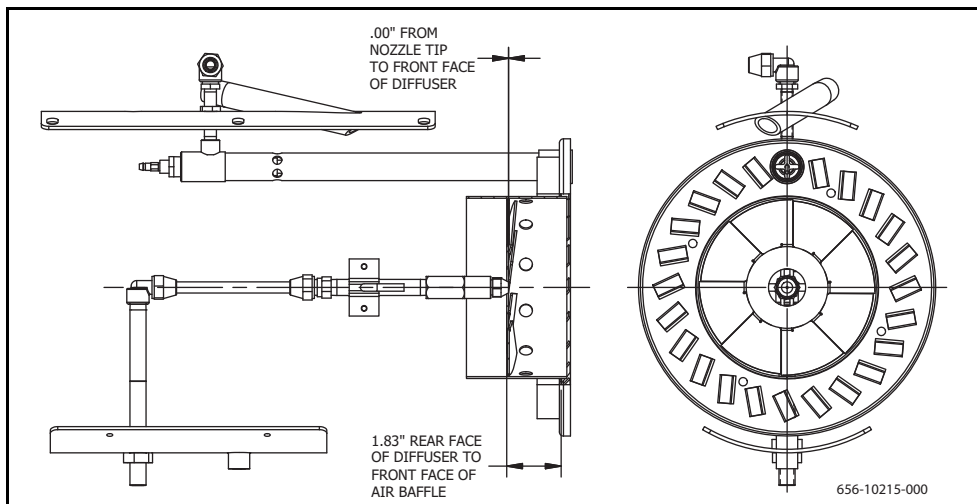


Figure 2-20: Drawer Assembly for (VLG) Gas/Oil (V35-55) - Watertube**Figure 2-21: Drawer Assembly for (VG) Gas Only (V60-110) - Watertube****Figure 2-22: Drawer Assembly for (VLG) Gas/Oil (V60-110) - Watertube**

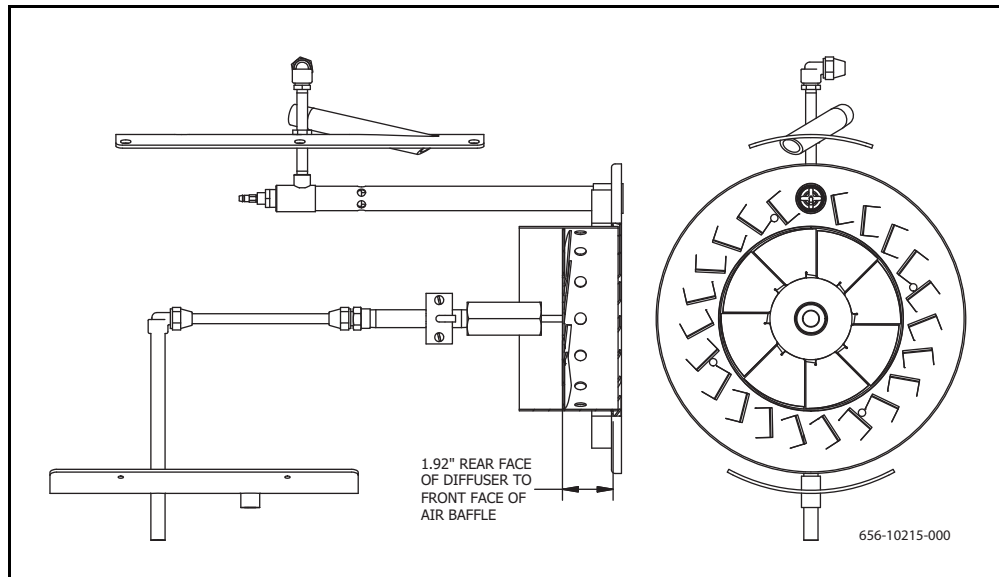


Figure 2-23: Drawer Assembly for (VG) Gas Only (V120-168) - Watertube

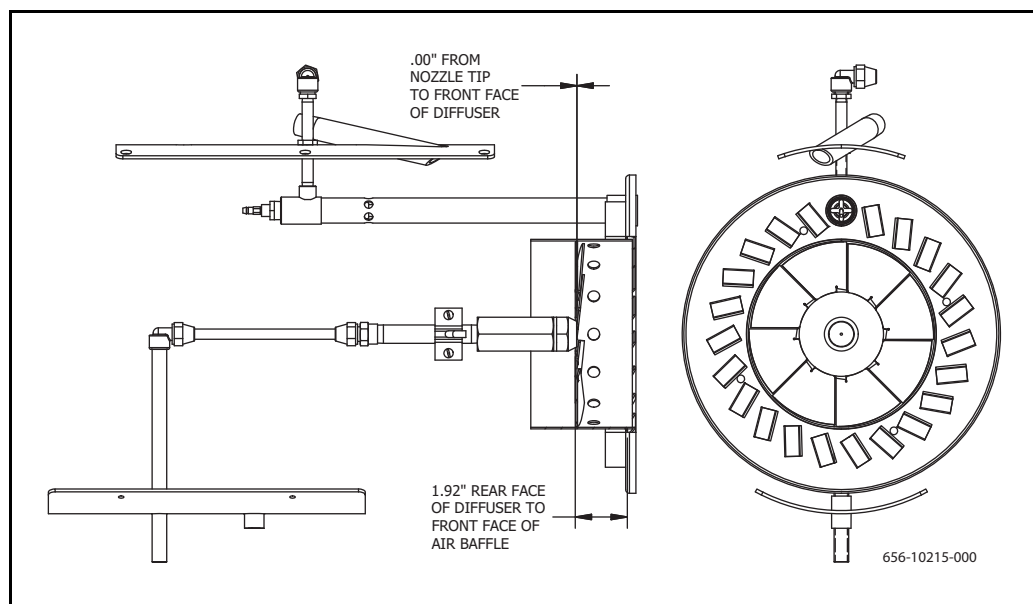


Figure 2-24: Drawer Assembly for (VLG) Gas/Oil (V120-168) - Watertube

H. Gas System Adjustments

Refer to the burner data plate located inside the control panel door. The nameplate will list the following burner information:

- burner and control voltage
- phase
- cycle
- motor amperage
- maximum and minimum fuel input settings
- manifold pressure (at zero furnace pressure - add the furnace pressure to get the correct manifold pressure at maximum firing rate)

These procedures assume that the pre-startup tasks, check list, electrical interference test, and pilot turndown tests have been performed in accordance with the instructions in this manual.

For most efficient combustion, allow the boiler to fully warm up before making adjustments. Refer to the boiler instruction manual for the boiler control settings.

GAS PRESSURE

Gas must be supplied at a pressure high enough to overcome the pressure loss in the burner gas train and furnace pressure while running at full input. Refer to nameplate inside control panel for gas pressure requirements at train inlet and manifold. The pressures listed are based on nominal 1000 Btu/cu ft. natural gas at elevations up to 2000 feet above sea level.

The gas pressure required at the burner manifold is the pressure that is required to fire the burner at its rated capacity. The gas pressure regulator must be adjusted to achieve this pressure to assure full input.

LOW GAS PRESSURE SWITCH

Turn adjusting screw until indicator moves to a pressure setting slightly below the operating gas pressure. The control will break a circuit if pressure is below this set point. The control should be finally adjusted to prevent operation with low gas pressure, but not at a pressure so close to normal operating pressure that unnecessary shutdowns occur. The switch must be manually reset after tripping. To reset, allow gas pressure to rise and press the manual reset button.

HIGH GAS PRESSURE SWITCH

Turn the adjusting screw until the indicator moves to a pressure setting slightly above the maximum operating gas pressure. The control will break a circuit if pressure exceeds this value. The control should be adjusted to prevent operation with excessive gas pressure, but not at a pressure so close to normal operating pressure that unnecessary shutdowns occur. This switch must be manually reset after tripping. To reset, allow gas pressure to drop and press the manual reset button.

GAS FLOW

The volume of gas is measured in cubic feet as determined by a meter reading. The gas flow rate required depends on the heating value (Btu/cu ft). The supplying utility can provide this information as well as pressure

correction factors. To determine the required number of cubic feet per hour of gas, divide burner input (Btu/hr) by the heating value (Btu/cu ft).

NOTE: When checking the input rate, Make sure no other equipment is operating on the same meter.

GAS COMBUSTION ADJUSTMENT

After operating for a sufficient period of time to assure a warm boiler, make adjustments for most efficient combustion. The butterfly gas valve directly controls the rate of flow. The low-fire light-off setting should be regarded as preliminary until proper gas pressure for high-fire operation is established.

Determine the actual gas flow from a meter reading at high-fire. With the butterfly valve open and with regulated gas pressure set, the actual flow rate should be quite close to the required input. If corrections are necessary, increase or decrease the gas pressure by adjusting the gas pressure regulator, following manufacturer's directions for regulator adjustment.

When proper gas flow is obtained, take a flue gas analysis reading.

With the high-fire air-fuel ratio established, the gas pressure regulator needs no further adjusting.

Recheck low-fire and adjust if necessary.

Proper setting of the air-fuel ratios at all rates must be determined by combustion analysis.

NOTE: Check for CO through the entire firing range.

LOW-HIGH-LOW GAS BURNER ADJUSTMENT

The gas burner adjustments on a Low-High-Off system consist of the gas pressure regulator, gas butterfly valve, low and high gas pressure switches and an air damper assembly.

The auxiliary switch inside the M436 Mod motor makes or breaks the high-fire gas. The Low-High-Low boiler control energizes the M436 motor, driving it to high-fire. When the boiler control de-energizes the M436, a built-in return spring drives it to the low-fire position.

All gas only (VG) V13-55 models use a butterfly gas valve to control the gas flow to the burner. The M436 Mod motor controls the position of the valve.

1. Open the manual gas shutoff cocks.
2. Check the gas pressure at the inlet of the regulator and the pressure downstream of the regulator. Make sure they are in accordance with the regulator specifications. The gas pressure required at the manifold is the pressure that is required to fire the burner at its rated capacity. To adjust the regulator, unscrew the cap located on the top and turn the adjustment screw clockwise to increase pressure, or clockwise to decrease pressure.
3. Turn the burner switch to the "ON" position. The burner will start in the low-fire position.
4. After a few seconds, the O₂ analyzer should have an accurate reading of the O₂ present in the flue gas. Normally, O₂ levels are set between 4% to 6% at low-fire for standard turndown systems on gas and 6% to 9% O₂ for high turndown systems, with the target value of less than 50 ppm CO. To obtain the proper readings, adjust the air shutter and low-fire regulator pressure.
5. Operate the boiler at low-fire until it is up to operating pressure (steam) or temperature (hot water).
6. Bring the burner to the high-fire position. Adjust the high-fire gas input to match maximum rating. At high-fire, the

butterfly valve should be near the full open position. Adjust the gas regulator so the manifold pressure matches the rating on the burner data plate. Verify and record the readings and pressures. high-fire is typically 3% to 4% O₂ with less than 50 ppm CO.

7. Adjust the low and high gas pressure switches by turning the adjusting screw until the indicator moves to a pressure slightly lower than normal operating pressure for the low gas pressure switch, and slightly higher for the high gas pressure switch (usually 20% below and 20% higher than normal pressure).
8. Verify low-fire and high-fire rate by clicking the meter as previously explained.
9. After completing all adjustments, replace the regulators, gaskets, and slotted aluminum screw caps. Tighten all linkages and marked settings. The burner should be adjusted to provide correct fuel flow at a constant rate, as indicated on the burner data plate. Complete the Startup Report.

FULL MODULATION GAS BURNER ADJUSTMENTS

The burner adjustments on a full modulation gas burner consist of the gas pressure regulator, butterfly gas valve, low and high gas pressure switches (model V30-168), and air dampers.

1. Open the manual gas shutoff cocks.
2. Check the gas pressure at the inlet of the regulator and the pressure downstream of the regulator. Make sure they are in accordance with the regulator specifications. The gas pressure required at the manifold is the pressure that is required to fire the burner at its rated capacity. To adjust the regulator, unscrew the cap located on the top and turn the adjustment screw clockwise to increase pressure, or counterclockwise to decrease pressure.
3. Set the "MANUAL-AUTO" switch to the "MANUAL" position.
4. Position the manual flame control potentiometer in the "CLOSED" (low-fire) position.
5. Turn the burner switch to the "ON" position. The burner will start and be in the low-fire position.
6. After a few seconds, the O₂ analyzer should have an accurate reading of the O₂ present in the flue gas. Normally, O₂ levels are set between 4% to 6% at low-fire for standard turndown systems on gas and 6% to 9% O₂ for high turndown systems, with the target value of less than 50 ppm CO. To obtain the proper readings, adjust the air shutter and low-fire regulator pressure.
7. Operate the boiler at low-fire until it is up to operating pressure (steam) or temperature (hot water). Then increase the fuel input to the boiler by turning the manual flame control potentiometer towards "OPEN" in small increments. This will cause the butterfly valve to open, allowing more gas into the burner.
8. At each point allow the burner to operate for a few minutes before recording the O₂, CO, and pressure readings. Observe that the O₂ and CO levels remain within an acceptable limit. Adjust the pressure regulator as necessary to correct this situation. Continue to do this until the burner reaches high-fire (the potentiometer is at the "OPEN" position).
9. Adjust the high-fire gas input to match maximum rating. At high-fire, the butterfly valve should be near the full open position. Adjust the gas regulator so the manifold pressure matches the rating on the burner data plate. Verify and record the readings and pressures. high-fire is typically 3% to 4% O₂ with less than 50 ppm CO as a target value.
10. Modulate the burner to low-fire. Verify the readings. The burner should be adjusted to provide correct fuel flow at a constant rate, as indicated on the burner data plate.
11. Adjust the low and high gas pressure switches by turning the adjusting screw until the indicator moves to a pressure slightly lower than normal operating pressure for the low gas pressure switch, and slightly higher for the high gas pressure switch (usually 50% below and 50% higher than normal pressure, respectively).
12. Tighten all linkages and marked settings. Complete the Startup Report.
13. Turn the "MANUAL-AUTO" switch to "AUTO". The burner will now modulate according to the load demand to the boiler.

LOW NOX FULL MODULATION COMBINATION GAS BURNER ADJUSTMENT

LNV burners are equipped with an FGR (flu gas recirculation) valve to lower the NO_x emissions. An adjustable cam is provided to adjust the FGR valve position throughout the firing range on gas. Follow the steps for gas from Section 4.4.12 with the following additions:

1. Make sure the FGR valve is in the nearly closed position.
2. Start the burner and hold at low-fire until the boiler is at the proper operating pressure or temperature.
3. With an analyzer in the stack, adjust the FGR valve cam screw to obtain <30 ppm NO_x levels.

NOTE: Do not adjust the burner below <20 ppm. Unstable combustion and high CO emissions will result.

4. Monitor O₂ and CO levels during this process. The introduction of FGR into the combustion chamber will lower the flue O₂ levels. Too much FGR may induce high levels of CO in the flue gas. It may be necessary to adjust the air damper blades to raise the O₂ to proper low-fire values. If the proper NO_x values can not be reached by adjusting the cam screw, the FGR linkage will have to be adjusted as well.
5. Once the low-fire setting is complete, continue with the instructions above, adjusting the cam at each screw to obtain the proper NO_x values. Verify the values modulating back to low-fire and adjust accordingly.

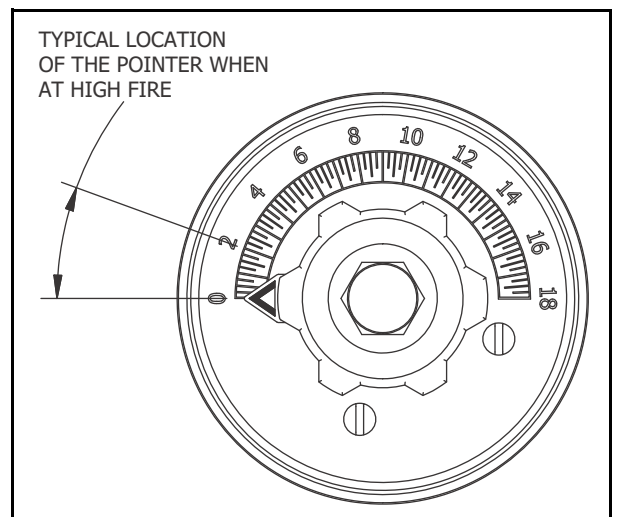
I. Oil System Adjustments

Refer to the burner data plate located inside the control panel door. The nameplate will list the following burner information:

- burner and control voltage
- phase
- cycle
- motor amperage
- maximum and minimum fuel input settings
- manifold pressure (at zero furnace pressure - add the furnace pressure to get the correct manifold pressure at maximum firing rate)

These procedures assume that the pre-startup tasks and check list have been performed in accordance with the instructions in this manual.

For most efficient combustion, allow the boiler to fully warm up before making adjustments.



ON-OFF OIL BURNER ADJUSTMENT

On-Off burners use the Suntec B2TC-8931 oil pump model. High-fire pressure adjustment is 200 - 300 psi (solenoid energized), and low-fire pressure adjustment is 100 - 200 psi (solenoid de-energized).

1. Briefly push in the starter contact and release to ensure that the blower motor and oil pump are rotating in the correct direction.
2. Turn the burner switch to the "ON" position.
3. Make sure a pressure gauge, 0 - 600 psi range, is installed downstream of the solenoid valves. Adjust the burner

for a smooth ignition of the main flame. Disconnect the wiring to the solenoid on the Suntec B2TC-8931 oil pump. Loosen and remove the knurled nut on the solenoid. Adjust the screw, clockwise to increase the low-fire oil pressure, and counterclockwise to decrease the low-fire oil pressure, until a smooth ignition of the oil flame is obtained and a satisfactory low-fire oil flame is established. Turn the burner off and restart to ensure smooth ignition is obtained at the set low-fire pressure. Replace knurled nut and tighten finger tight.

4. Adjust the high-fire oil input to match the maximum rating. Turn the burner off and reconnect the wiring to the solenoid valve. Restart the burner and allow the burner to go through ignition and low-fire. When the solenoid energizes, the oil pump discharge pressure is at high-fire pressure. The high-fire pressure adjustment screw is located on the oil pump body. Adjust the screw, clockwise to increase the pressure and counterclockwise to decrease the pressure, until the correct amount of oil pressure is obtained. The high-fire oil pressure should be 300 psi. High-fire is typically 3.5% to 4.5% O₂, with less than No.1 smoke (Bacharach). The burner should be adjusted to provide the correct amount of fuel flow at a constant rate at high-fire position as indicated on the burner data plate located inside the control panel.
5. Tighten all linkages and marked settings. Complete the Startup Report.

LOW-HIGH-OFF/LOW OIL BURNER ADJUSTMENT

The Suntec B2TD-8842 oil pump is typically incorporated and is a two-stage, two-step oil pump. The lowfire pressure adjustment is 100 - 200 psi (solenoid de-energized). High-fire pressure adjustment is 200 - 300 psi (solenoid energized).

1. Turn the burner switch to the "ON" position.
2. Adjust low-fire with the oil pressure regulating valve to have approximately 100 to 200 psi, and adjust the air shutter for a clean fire. Record the combustion reading from the flue gas analyzer, normally 3.5% to 4.5% O₂ and less than No. 1 smoke (Bacharach). To adjust the oil pressure regulating valve, remove the lockscrew and adjust the pressure by turning the allen screw clockwise to increase pressure, and counterclockwise to decrease pressure.
3. Operate the boiler at low-fire until it is up to operating pressure (steam) or temperature (hot water).
4. Adjust high-fire fuel input to match maximum oil pressure. At high-fire, the pressure should be 300 psi. Verify and record the readings and pressures. High-fire is typically 3.5% to 4.5% O₂ with less than No. 1 smoke (Bacharach). The burner should be adjusted to provide correct fuel flow at a constant rate, at the low-fire and high-fire position as indicated on the burner data plate.
5. Tighten all linkages and marked settings. Complete the Startup Report.

FULL MODULATION OIL BURNER ADJUSTMENT

The oil burner adjustments consist of the oil metering valve and air damper shutters. The oil metering valve position (indicated by a scale on the valve) will vary the oil pressure to the nozzle. Models V13 to V34 use a simplex oil nozzle, while models V35 to V168 use a return flow oil nozzle. An oil pressure gauge should be installed in the return line to monitor the oil pressure. At low-fire, the pressure range in the return line should be between 40 and 80 PSI with the oil metering valve position set between 6 and 8 on the scale. At highfire, the return line pressure will vary from 135 to 200 PSI dependent upon the brand of the oil nozzle. At high-fire, the oil metering valve position will be approximately 2 on the scale.

1. Set the "MANUAL-AUTO" switch on the "MANUAL" position.
2. Position the manual flame control potentiometer in the "CLOSED" (low-fire) position.
3. Turn the burner switch to the "ON" position. The burner will start and be in the low-fire position.
4. Adjust low-fire with the metering valve position to have approximately 80 to 90 psi, and adjust the lowfire air shutter for a clean fire. Record the combustion reading from the flue gas analyzer, normally 4.5% to 6.5% O₂ and less

than No. 1 smoke (Bacharach).

5. Operate the boiler at low-fire until it is up to operating pressure (steam) or temperature (hot water). Then increase the fuel input to the boiler by turning the manual flame control potentiometer towards "OPEN" in small increments. This will cause the metering valve to close, resulting in an increase in the oil pressure feeding the burner nozzle.
6. At each point, allow the burner to operate for a few minutes before recording the O₂, CO, smoke, and pressure readings. Observe that your O₂ and CO levels remain within an acceptable limit. Adjust the oil pressure as necessary to correct this situation. For burners with the cam trim option, adjust the cam screws throughout the range to obtain correct O₂ and CO levels. Continue to do this until the burner reaches high-fire (the potentiometer is at the "OPEN" position).
7. Adjust the high-fire fuel input to match maximum oil pressure. At high-fire, the metering valve should be pressures. high-fire is typically 3.5% to 4.5% O₂ with less than No. 1 smoke (Bacharach). Adjust the high-fire excess air rate using the high-fire shutter adjustment.
8. Modulate the burner to low-fire. Verify the readings once again. The burner should be adjusted to provide correct fuel flow at a constant rate, at the low-fire and high-fire position as indicated on the burner data plate.
9. Tighten all linkages and marked settings. Complete the Startup Report.
10. Turn the "MANUAL-AUTO" switch to "AUTO". The burner will now modulate according to the load demand to the boiler.

J. Combination Gas-Oil System

In general, the combination fueled system is to be started first using oil, because as a fuel, oil has a greater combustion air requirement than natural gas. After being completely adjusted for oil combustion, the burner is restarted and adjusted using natural gas as fuel. Combustion adjustment of the combination burner for natural gas involves balancing the input rate only against the existing flow of combustion air, as established initially for oil.

NOTE: Do not readjust the air shutter when tuning the combination burner for combustion of natural gas.

NOTE: For burners equipped with a Siemens modulation motor, fuel-air adjustments for each fuel are independent of each other. Refer to the Siemens modulating motor product literature for proper adjustment.

LOW-HIGH-OFF/LOW COMBINATION GAS-OIL BURNER ADJUSTMENT

1. Turn the fuel selector switch to the "OIL" position.
2. Turn the burner switch to the "ON" position.
3. Proceed with startup and adjustments using the same procedures as explained above for oil burners.
4. After the system has been completely adjusted for oil firing, place the burner switch to "OFF" and position the fuel selector switch to "GAS".
5. Proceed with startup and adjustments using the same procedures as explained above for gas burners. Do not alter the air settings set for oil. Correct the O₂ levels by adjusting the butterfly valve for models V35-55, and the regulators low and high pressures for models V13-34.

FULL MODULATION COMBINATION GAS-OIL BURNER ADJUSTMENT

1. Set the "MANUAL-AUTO" switch to the "MANUAL" position.
2. Position the manual flame control potentiometer in the "CLOSED" (low-fire) position.
3. Turn the fuel selector switch to the "OIL" position.
4. Turn the burner switch to the "ON" position.
5. Proceed with startup and adjustments using the same procedures as explained above for oil burners.
6. After the system has been completely adjusted for oil firing, place the burner switch to "OFF" and position the fuel selector switch to "GAS".
7. Proceed with startup and adjustments using the same procedures as explained above for gas burners. Do not alter the air settings set for oil. Correct the O₂ levels by adjusting the butterfly valve.

K. Modulation Control

LINKAGE CONTROL ADJUSTMENT

The linkage consists of adjustable cams, levers, rods and ball joints that transmit motion from the modulating motor to the air damper, gas butterfly valve and oil metering unit. When properly adjusted, coordinated movement of the air and fuel control devices provide proper fuel-air ratios through the firing range. In linkage adjustments, several important factors serve as guides:

- The modulating motor must be able to complete its full travel range. Restrictions will damage the motor and/or linkage.
- Lever and rod adjustments should be made with the motor in low-fire position.

The modulating motor will be stopped at the end of its stroke by an internal limit switch. Combustion gas analysis indicates the air to fuel ratio and the degree of complete combustion. The closer the rod comes to parallel with the lever, the slower the rod moves. The angles of the driven levers on the jackshaft can be adjusted to vary the rate of change. The closer the rod to the hub of the lever, the less distance it will travel. Increasing the lever length on the damper, metering unit and valve(s) decreases flow rate.

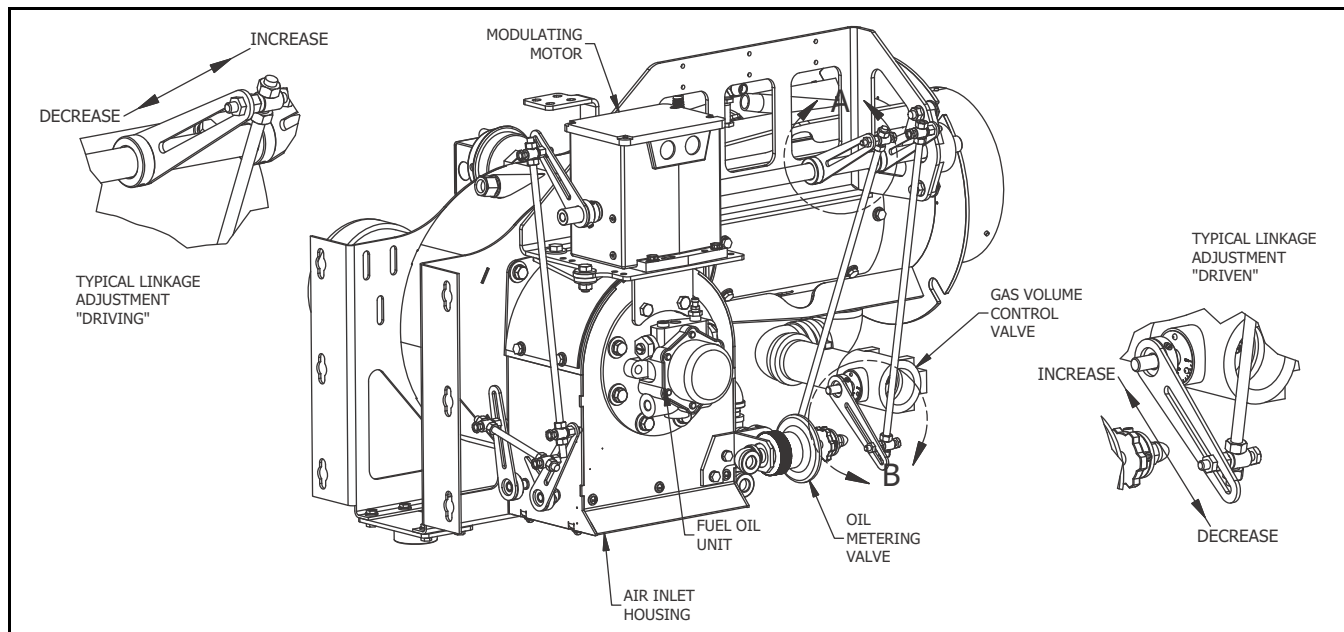


Figure 2-25: Linkage Adjustment

CAM TRIM ADJUSTMENT

After low and high-fire adjustments are complete, final adjustment is made with the cam assembly to obtain a good air-fuel ratio throughout the entire firing range. The input of combustion air is fixed at any given point in the modulating cycle. The fuel input may be varied to obtain correct flue gas readings. The adjustment is made to the metering cam by means of the 14 adjusting screws which are turned in (clockwise from the hex-socket end) to increase the flow of fuel, and out (counterclockwise from the hex-socket end) to decrease it. A 3/32" hex key is required. It will be necessary to cut off the short end of a hex key to approximately 3/8" to adjust the first two socket head setscrews at the low-fire position. Take a combustion analysis at various points of the cam profile. Adjustment can be made without cycling the burner, then operate the automatic modulating cycle to assure satisfactory results. Tighten the locking setscrews.

NOTE: It is essential that the cam spring, cam follower bearing wheel, and cam follower arm at the pivot point be greased sparingly every month to ensure smooth operation of the cam assembly. Regular automotive bearing grease should be used.

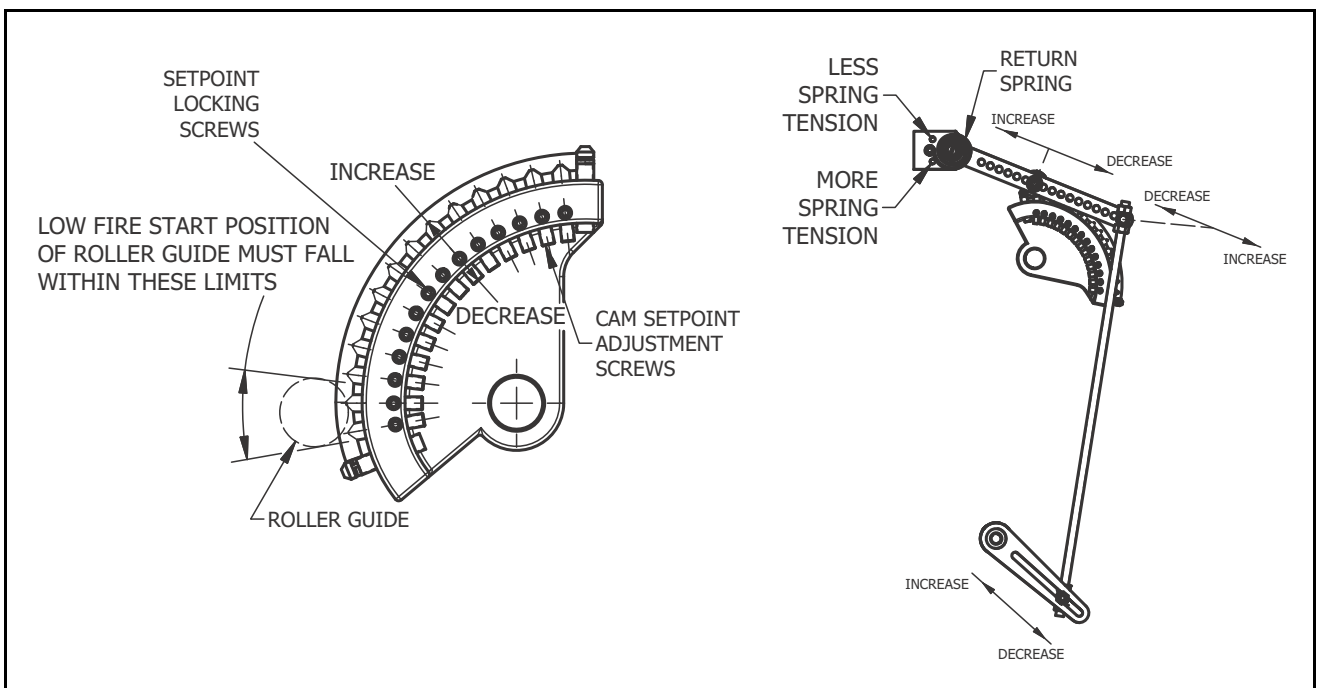


Figure 2-26: Cam Trim Adjustment

PARALLEL POSITIONING ADJUSTMENT

For parallel positioning systems refer to the controls documentation and to the accompanying wiring diagram for information on adjusting the system. For C-B Hawk systems, see the following manuals:

Hawk 1000 — 750-366

Hawk 4000 — 750-342

In a properly tuned parallel positioning system the independent actuators for fuel, air, and FGR (if so equipped) will be coordinated to provide optimum combustion throughout the firing range.

L. Air and Fuel Controls

The V series burners have a two-blade air shutter design. Both blades are coupled together and are attached to the modulation motor. Changing the positions of the linkage rods on the linkage control arms will change the way the damper blades open and close.

Fuel and air flow rates can be individually adjusted at low-fire and high-fire to achieve rated heat input, firing rate turndown, optimum efficiency, safe operation, and the ability to cope with environmental changes (air temperature, humidity, barometric pressure), and fuel property changes. Adjustments may be required to meet certain environmental emissions criteria, such as NO_x or CO. Combustion adjustments also vary with specific system applications.

Turndown capability for oil is less than that of natural gas. On combination fueled burners, gas turndown performance may be restricted by the excess air and fuel turndown levels set for oil combustion.

Excess air (O₂) and unburned fuel (CO) levels in boiler flue gases are used to determine combustion efficiency and fuel and air input adjustments. The system should be adjusted to a minimum excess air quantity that provides low levels of unburned fuel with sufficient remaining O₂ to cope with normal atmospheric and fuel related changes. Unburned fuel is measured as CO when burning natural gas, and smoke spots when burning oil.

The burner should be set up and maintained to yield smoke spot levels less than No. 1 spot (ASTM D2156 Shell Bacharach Scale) to minimize soot and buildup in the boiler.

WARNING

Keep fingers away from the air inlet area of the damper. The damper is actuated with sufficient force to cause severe injury.

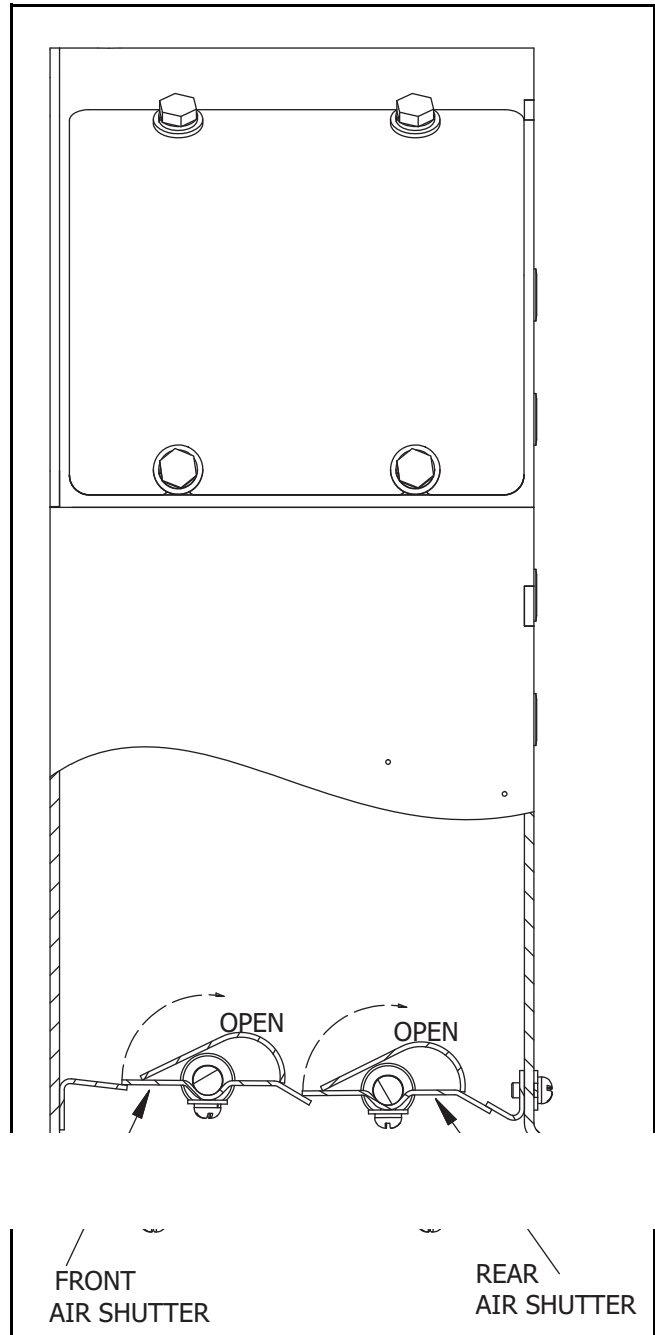


Figure 2-27: Air Shutters

M. Maintenance

A maintenance program avoids unnecessary downtime, costly repairs, and promotes safety. It is recommended that a record be maintained of daily, weekly, monthly, and yearly maintenance activities.

Electrical and mechanical devices require systematic and periodic inspection and maintenance. Any “automatic” features do not relieve the operator from responsibility, but rather frees him from certain repetitive chores, providing time for upkeep and maintenance.

Unusual noise, improper gauge reading, leak, sign of overheating, etc. can indicate a developing malfunction requiring corrective action.



ONLY FACTORY AUTHORIZED BURNER SERVICE PERSONNEL SHOULD START UP, ADJUST, OR SERVICE THE EQUIPMENT.



ANY COVER PLATES, ENCLOSURES, OR GUARDS ANCHORED TO THE BURNER, OR ANY BURNER RELATED EQUIPMENT, MUST REMAIN IN POSITION AT ALL TIMES. ONLY DURING MAINTENANCE AND SERVICE SHUTDOWN CAN THESE COVER PLATES, ENCLOSURES, OR GUARDS BE ALLOWED TO BE REMOVED. THEY MUST BE REPLACED, AND SECURELY ANCHORED BEFORE TESTING, ADJUSTING, OR RUNNING THE BURNER OR BURNER RELATED EQUIPMENT.

CONTROL SYSTEM

Most operating controls require very little maintenance beyond regular inspection. Examine electrical connections. Keep the controls clean. Remove any dust from the interior of the control. Covers should be left on controls at all times. Keep the control cabinet doors closed. Dust and dirt can damage motor starters and relay contacts. Starter contacts are plated with silver and are not harmed by discoloration. Never use files or abrasive materials such as sandpaper on contact points.

PROGRAMMING CONTROL

This control requires no adjustment, nor should any attempt be made to alter contact settings or timing logic. Those programmers with contacts may require occasional cleaning. If so, follow instructions given in the manufacturer's bulletin. Never use abrasive materials. The manufacturer's bulletin also contains troubleshooting information. The flame detector lens should be cleaned as often as conditions demand.

A periodic safety check procedure should be established to test the complete safeguard system. Tests should verify safety shutdown with a safety lockout upon failure to ignite the pilot or the main flame, and upon loss of flame. Each of these conditions should be checked on a scheduled basis. The safety check procedures are contained in the manufacturer's bulletin.

AIR HANDLING SYSTEM

A balanced blower wheel requires minimal maintenance. Check for dirt buildup and clean the blades as required. Inspect the impeller hub and blades for cracks. Replace if any are noticed. Make sure the air inlet cone fits inside the impeller.

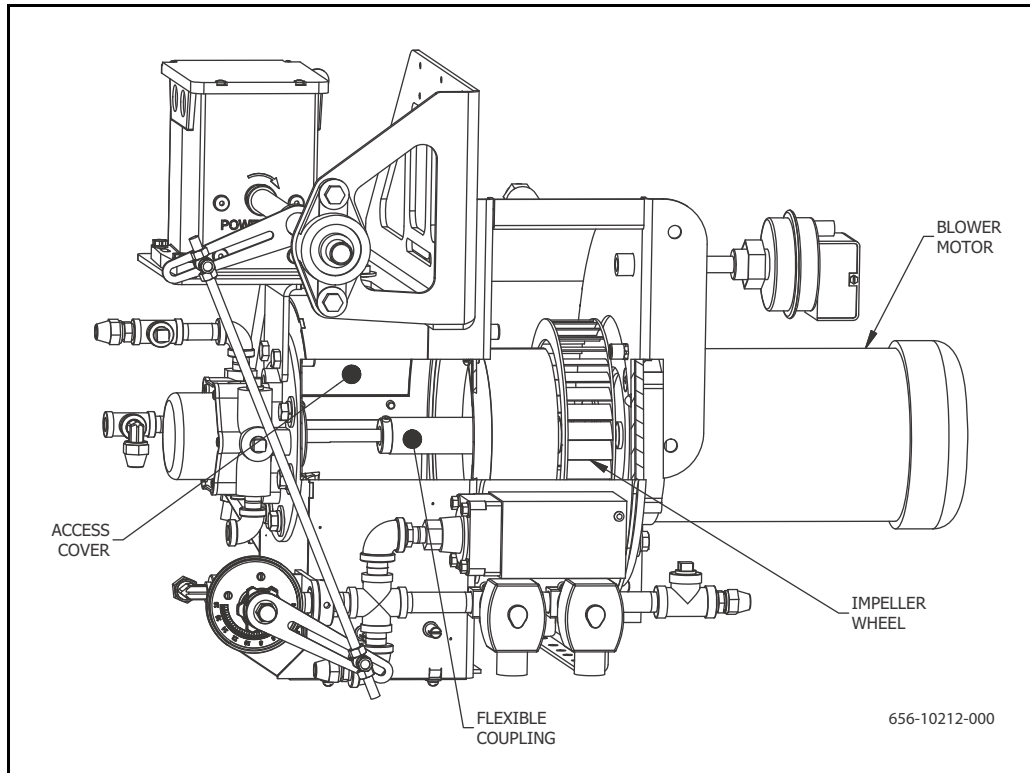


Figure 2-28: Air Handling System

IMPELLER AND INLET CONE

Proper clearance between the impeller and the inlet housing set at 3/8" nominal. Adjust the inlet cone so it is centered in the inlet of the impeller and tighten the bolts. There should be no contact between the inlet cone and the impeller. Inserting a bar through the impeller blade and using it as a lever will only damage the blade.

FIRING HEAD INSPECTION

Open side access panels to view the drawer assembly. Inspect the lead wire to the ignition electrode. It must be firmly attached and the insulation should be clean and free of cracks. The oil nozzle should be inspected periodically.

If fibrous material is discovered in the gas spud ports, remove the gas spud and back flush with shop air. Further inspection of gas piping and gasket connections must be made to isolate the contaminate source. Be sure to orientate the gas spuds in the correct position when reassembling the gas spuds.

The drawer assembly may be removed for inspection and/or service. For drawer assembly drawings, refer to Figures 2-15 to 2-24.

1. Shut off the burner; position the switch to "Off".
2. Shut off all electric power to the burner.
3. Disconnect the fuel lines from the drawer assembly access cover.

4. After making note of where the bolts are located in relationship to the access cover slots, remove the drawer assembly access cover bolts. Pull the drawer partially out of the housing. Reach inside to disconnect the ignition cables from the electrodes for direct spark applications. Pull the drawer assembly completely out of the housing.
5. To reinstall the drawer assembly, insert it part way into the housing, connect the ignition cables, if applicable, and seat the assembly fully. Install the access cover bolts loosely. Slide the cover into the original location and tighten the bolts. Reconnect the fuel lines.

PILOT AND IGNITION ELECTRODE

Failure to keep the ignition electrode clean and properly set can cause faulty operation. Not only must the gap be correct, but the electrode points must be carefully located with respect to the nozzle. Sometimes difficulty in securing the electrodes in their clamps can be corrected by using light metal shims around the porcelain. Defective or cracked porcelains require replacement to prevent short circuiting of the spark. A gradual wearing away of the electrode tips may require re-spacing of the points or replacement of the electrode.

The pilot should be checked monthly for loosening of components and carbon buildup. Before removing the pilot, ensure that the fuel supply is shut off.

On direct spark oil units, once the drawer assembly has been removed, check the electrode to nozzle gap and adjust if necessary.

For burners equipped with a gas pilot, the pilot is located on the side opposite to the main gas entrance.

1. Close the gas pilot cock.
2. Disconnect the pilot gas supply line.
3. Remove the screws on the pilot access plate.
4. Disconnect the pilot gas supply line.
5. Remove the screws on the pilot access plate.
6. Disconnect the high voltage ignition cable by pulling it straight back, away from the pilot assembly.
7. The pilot gun assembly will slide back away from the flame side of the burner.
8. Once the pilot assembly is clear of the burner head bracket, turn the pilot assembly and retract it through the access hole.
9. Inspect the electrode and adjust the gap if necessary.
10. Thoroughly clean and adjust the porcelain insulated electrodes.
11. Correct all variations from the clearance dimensions.
12. If the insulation on the high voltage cables becomes cracked or charred, install new cables. Ignition cable should not be exposed to moisture, abrasion, or rough handling.
13. See that the connectors are in perfect contact with the cable end. Unscrewing the snap portion of the connector will show whether this is true.

FLAME SCANNER

The scanner must be clean. Even a small amount of contamination will reduce the flame signal. Wipe the scanner lens with a clean soft cloth. Check pilot and flame signal strength.

To insure proper atomizing, the tip must be screwed in tightly with the swirler seating spring pressing the swirler tight against the nozzle tip. Turn the swirler a few times to be sure it fits snugly in the nozzle and the spring is pressing the two parts firmly together. When reinstalling, be sure the nozzle is centered with the proper distance from the diffuser.

OIL NOZZLE

The nozzle should be checked. Inside the nozzle lies a small screen that keeps out any particle not caught by the strainer. These particles will interfere with the normal oil flow pattern exiting the nozzle. A distorted flame can indicate a clogged nozzle. Inspect and clean the nozzle and screen. To clean the screen, swirler, and tip, unscrew the tip from the nozzle body. Clean the nozzle parts in solvent. Never use wire or sharp metal tools to clean the nozzle orifice. A metal tool will distort the orifice and ruin the nozzle. Reassemble the nozzle. The tailpiece must be screwed in with the swirler seating tight against the tip to ensure proper atomization. Reassemble the nozzle into the nozzle body. If a nozzle is replaced, it must be an identical nozzle (make, size, and spray angle).

DIFFUSER

The diffuser is factory set and does not require attention under normal operating conditions. If fouled with carbon, the diffuser should be removed for cleaning:

1. First remove the electrode leads, the gas pilot assembly, air and oil tubes before you attempt to remove the diffuser.
2. Mark the diffuser relative position to the blast tube, with a scribed or pencil line where the three mounting screws are located, to insure that the diffuser is placed back in the same position.
3. Remove the screws holding the diffuser to the blast tube and slowly pull the diffuser along the blast tube towards the firing head.
4. Clean all carbon from the diffuser vanes and reinstall in reverse order of disassembly aligning the diffuser with the scribed marks.
5. When reinstalling, be sure the diffuser is centered with the proper distance.

FIRING RATE CONTROLS

Check all rods and linkages. Make sure all connections are tight. Adjust if necessary. Perform a combustion test and readjust the burner if necessary.

BURNER MOUNTING INSPECTION

The seal between the burner flange and furnace front plate must not permit combustion gases to escape. Periodic inspection is important.

OIL SYSTEM

Little maintenance is required on the oil systems other than cleaning the oil filter. This procedure should be done at regular intervals. Increased inlet vacuum reading may indicate a clogged filter. Follow the strainer manufacturer's maintenance schedule.

Maintenance checks on the flexible coupling between the fuel unit and motor for alignment, tightness and wear and oil piping connection tightness should also be made at regular intervals. You access the coupling by removing the airbox cover and loosening the two setscrews on the flex coupling.

GAS SYSTEM

Check the gas train for leaks. Check the gas valves and verify the low and high gas pressure settings.

CAUTION

All power must be disconnected before servicing the valves.

SOLENOID VALVES

A faint hum from the solenoid is normal when the coil is energized. Should the valve fail to operate, check that there is voltage at the valve coil. If there is no voltage at the coil, check for loose wiring connections. If there is proper voltage at the valve coil and the valve still fails to open, replace the coil. Refer to manufacturer's bulletin for correct procedure in coil replacement.

Should it become necessary to replace the complete valve, be sure that the flow is in the direction of the arrow on the valve body.

Test for gas leaks and check valve action several times to ensure proper operation before attempting to relight burner.

MOTORIZED MAIN GAS VALVES

Should the valve fail to operate, check for voltage at the valve. Make certain that the main shutoff cock is closed prior to testing. The actuator is not field repairable nor should it be disassembled. Replace the actuator if valve fails to operate.

After replacement, cycle the valve with the fuel shut off to determine that it opens and closes. If the valve has a visual indicator, observe its position for correct operation.

ELECTRIC MOTORS

Motor supply voltage must not vary more than 10 percent from nameplate ratings. At initial startup and at least once a year thereafter, check the motor current with a meter while the burner is in high-fire position. If the reading exceeds the nameplate rating plus service factor, determine the cause and correct it immediately. In dusty locations, clean the motor regularly to assure adequate cooling. Lubricate in accordance with the manufacturer's instructions.

CHECKING FLAME FAILURE

Pilot Flame Failure

1. Shut off the main fuel supply and close the gas pilot shutoff cock.
2. The pilot ignition circuit will be energized at the end of the pre-purge period. There should be an ignition spark, but no flame. Since there is no flame to be detected, the program relay will signal the condition.
3. The ignition circuit will de-energize and the control will lock out on a safety shutdown and the flame failure light will be activated.
4. The blower will run through post-purge and stop. Turn the burner switch off and reset the safety switch. Re-open the gas pilot shutoff cock and re-establish main fuel supply.

Main Flame Failure

1. Shut off the main fuel supply and leave the gas pilot shutoff cock open.
2. Turn the switch on. The pilot will light upon completion of the pre-purge period. The main fuel valves will be energized, but there should be no main flame.
3. The fuel valves de-energize within four seconds after the main burner ignition trial ends. The control will lock out on a safety shutdown.
4. The flame failure light (and optional alarm) will be activated. The blower motor will run through the post-purge and stop. Turn the burner switch off and reset the safety switch. Re-establish main fuel supply.

Loss of Flame

1. With the burner in normal operation, shut off the main burner fuel supply to extinguish main flame.
2. The fuel valves will be de-energized and the relay will signal the condition within four seconds. The control will then lock out on a safety shutdown.
3. The flame failure light (and optional alarm) will be activated. The blower motor will run through the post-purge period and stop.

Turn the burner switch off and reset the safety switch. Re-establish the main fuel supply.

EXTENDED SHUTDOWN

When shutting down the burner for an extended period of time, the operator should use the following general guidelines to protect the burner from its surrounding elements. This will add to the operating life of the burner:

1. Turn the main electrical disconnect switch to the burner to "Off."
2. Close all main fuel valves.
3. If the burner operates in a damp environment, cover it with plastic to protect all electrical components from moisture. Remove burner control and store in a dry area.

RECOMMENDED MAINTENANCE SCHEDULE

ITEM	SERVICE BY	REMARKS
DAILY		
Gauges, Monitors, and Indicators	Operator	Make visual inspection and record readings in log.
Instrument and Equipment Settings	Operator	Make visual check against recommended specifications.
Low Water, Fuel Cutoff, and Alarms	Operator	Refer to instructions.
WEEKLY		
Firing Rate Control	Operator	Verify factory settings.
Igniter	Operator	Make visual inspection. Check flame signal strength.
Pilot and Main Fuel Valves	Operator	Open limit switch. Make audible and visual check. Check valve position indicators, and check fuel meters.
Flame Failure Controls	Operator	Close manual fuel supply for (1) pilot and (2) main fuel cock and/or valve(s). Check safety shutdown timing. Record in log.
Flame Signal Strength Controls	Operator	Read and log the flame signal for both pilot and main flame. Notify service if readings are very high, very low, or fluctuating.
Linkages	Operator	Check all burner linkages for tightness. Tighten if required.
MONTHLY		
Low Fan Pressure Interlock	Operator	Manually adjust until switch opens.
High and Low Gas Pressure Interlocks	Operator	Refer to instructions. Manually adjust until switch opens.
Scanner and Diffuser	Operator	Check, inspect, and clean for soot buildup.
Pilot Assembly	Operator	Check for loosening of components, erosion, or carbon buildup.
QUARTERLY		
Burner Mounting Flange	Operator	Check tightness of burner mounting flange and burner drawer.
Handhole Covers	Operator	Check tightness of handhole plates on upper and lower drum.
Sight Glass (steam only)	Operator	Check for leaks around sight glass packing nuts.
ANNUALLY		
Strainer (Oil Units)	Operator	Replace or clean the oil strainer element.
Impeller	Operator	Inspect and clean the combustion impeller.
Combustion Test	Service Technician	Perform complete combustion test. Adjust burner if necessary. Read and log data.
Pilot Turndown Test	Service Technician	Required after any adjustment to flame, scanner, or pilot adjustment.
Operating Controls	Service Technician	Refer to instructions.

N. Troubleshooting

PROBLEM	SOLUTION
Burner Does Not Start	1. No voltage at program relay power input terminals. a. Main disconnect switch open. b. Blown control circuit fuse. c. Loose or broken electrical connection.
	2. Program relay safety switch requires resetting.
	3. Limit circuit not completed - no voltage at end of limit circuit program relay terminal. a. Pressure or temperature is above setting of operation control. b. Water below required level. •Low-water light (and alarm horn) should indicate this condition. •Check manual reset button, if provided, on low-water control. c. Fuel pressure must be within settings of low pressure and high pressure switches. d. Check burner air proving switch and high-fire limit switch.
	4. High or low gas pressure - investigate and repair.

PROBLEM	SOLUTION
No Ignition	- Lack of spark. - Electrode grounded or porcelain cracked. - Improper electrode setting. - Loose terminal on ignition cable, cable shorted. - Inoperative ignition transformer. - Insufficient or no voltage at pilot ignition circuit terminal.
	- Spark but no flame. - Lack of fuel - no gas pressure, closed fuel valve, empty tank, broken line. - Too much air flow. - No voltage to pilot solenoid. - Defective pilot solenoid. - Improperly positioned electrode (direct spark models).
	- Low -fire switch open in low-fire proving circuit. - Damper motor not closed, slipped cam, defective switch. - Damper jammed or linkage binding.
	- Running interlock circuit not completed. - Combustion proving switches defective or not properly set. - Motor starter interlock contact not closed.
	Flame detector defective, sight tube obstructed, or lens dirty.

PROBLEM	SOLUTION
Pilot Flame, But No Main Flame	Insufficient pilot flame.
	- Gas fired unit. - Manual gas cock closed. - Main gas valve inoperative. - Gas pressure regulator inoperative.
	- Oil fired unit. - Oil supply cut off by obstruction, closed valve, or loss of suction. - Supply pump inoperative - No fuel. Broken, loose or missing oil pump coupling. - Main oil valve inoperative. - Check oil nozzle, gun and lines.
	flame detector defective, sight tube obstructed or lens dirty.
	Insufficient or no voltage at main fuel valve circuit terminal.

PROBLEM	SOLUTION
Burner Stays in Low-Fire	1. Pressure or temperature above modulating control setting.
	2. Manual-automatic switch in wrong position.
	3. Inoperative modulating motor.
	4. Defective modulating control.
	5. Binding or loose linkages, cams, setscrews, etc.

PROBLEM	SOLUTION
Shutdown Occurs During Firing	1. Loss or stoppage of fuel supply.
	2. Defective fuel valve, loose electrical connection.
	3. Flame detector weak or defective.
	4. Scanner lens dirty or sight tube obstructed.
	5. If the programmer lockout switch has not tripped, check the limit circuit for an opened safety control.
	6. If the programmer lockout switch has tripped: a. Check fuel lines and valves. b. Check flame detector. c. Check for open circuit in running interlock circuit. d. The flame failure light is energized by ignition failure, main flame failure, inadequate flame signal, or open control in the running interlock circuit.
	7. Improper air/fuel ratio. a. Slipping linkage. b. Damper stuck open. c. Fluctuating fuel supply. •Temporary obstruction in the fuel line. •Temporary drop in gas pressure.
	8. Interlock device inoperative or defective.
	9. air in the oil lines. Bleed lines.

PROBLEM	SOLUTION
Modulating Motor Does Not Operate	1. Manual-automatic switch in wrong position.
	2. Linkage loose or jammed.
	3. Motor does not drive to open or close during pre-purge or close on burner shut-down. a. Motor defective. b. Loose electrical connection. c. Damper motor transformer defective.
	4. Motor does not operate on demand. a. Manual-automatic switch in wrong position. b. Modulating control improperly set or inoperative. c. Motor defective. d. Loose electrical connection. e. Damper motor transformer defective.

O. Burner Specs

Model FLX Burner Characteristics

Model No.	Burner Maximum Input MBH	Burner Model	Fan Motor (3450 RPM) Voltage
FLX-150	1500	PFVLG-15	115/230/1/60
FLX-200	2000	PFVLG-20	115/230/1/60
FLX-250	2500	PFVLG-25	115/230/1/60
FLX-300	3000	PFVLG-30	115/230/1/60
FLX-350	3500	PFVLG-35	208/230/1/60
FLX-400	4000	PFVLG-40	208/230/1/60
FLX-450	4500	PFVLG-45	208-230/460/3/60
FLX-500	5000	PFVLG-50	230/460/3/60
FLX-550	5500	PFVLG-55	230/460/3/60
FLX-600	6000	PFVLG-60	460/3/60
FLX-700	7000	PFVLG-70	460/3/60
FLX-800	8000	PFVLG-80	460/3/60
FLX-900	9000	PFVLG-90	460/3/60
FLX-1000	10000	PFVLG-100	460/3/60
FLX-1100	11000	PFVLG-110	460/3/60
FLX-1200	12000	PFVLG-120	460/3/60

Notes:

1. Burner model selection shown is subject to changed and is based on actual application (altitude, gas pressure, reduced

NOx, etc.)

2. Standard voltage for Canadian application is 575/3/60.
3. Burner operation is Full Modulation on Elite Series and for the Econo series Low-High-Low for units 150 - 600 and modulated firing on 700 and greater.
4. Burner models shown are for combination gas/oil firing. For straight gas, delete the letter L, and for straight oil, delete the letter G.

Model FLX Minimum Required Gas Pressure

Model No.	Std. Gas Train Size (In.) Note 3	Min. Gas Pressure (in WC) Note 4	Min. Gas Pressure (in WC) Note 5	Burner Model
FLX-150	1	11.2	12.5	PFVG-15
FLX-200	1	19.4	21.7	PFVG-20
FLX-250	1.5	12.4	15.7	PFVG-25
FLX-300	1.5	15.9	20.7	PFVG-30
FLX-350	1.5	15.5	22.0	PFVG-35
FLX-400	1.5	18.7	27.2	PFVG-40
FLX-450	2	16.0	26.7	PFVG-45
FLX-500	2	17.6	21.0	PFVG-50
FLX-550	2	22.9	27.1	PFVG-55
FLX-600	2	20.0	24.9	PFVG-60
FLX-700	2	25.2	31.9	PFVG-70
FLX-800	2.5	19.9	22.2	PFVG-80
FLX-900	2.5	24.7	27.7	PFVG-90
FLX-1000	2.5	31.6	31.6	PFVG-100
FLX-1100	2.5	37.3	37.3	PFVG-110
FLX-1200	2.5	38.2	38.2	PFVG-120

Notes:

1. Table is based on 1,000 Btu/cu. ft. natural gas and elevation of 1,000 feet.
2. Minimum gas pressure also applies to 200 fuel series.
3. As an option, the standard gas train can be replaced with an oversized design to reduce inlet gas pressure requirements.
4. Use this column for all U.S. installations.
5. Use this column for all Canadian installations.

START-UP / SERVICE REPORT

The following information should be filled in by the service technician at start-up or after any adjustment to the burner.

A copy of the start-up report MUST be returned to CB in order to validate the warranty of the burner.

Burner Model _____ Serial Number _____ Start-up Date _____

Test Conducted	GAS			OIL			Control Checks	Test	Set Point
	Low	50%	High	Low	50%	High			
Firing Rate MMBtu / gph							Low Water Cut Off		
Stack Temp (Gross) °F							Aux. LWCO		
Room Temp °F							High Water Cut Off		
O2%							Operating Limit		
CO2%							High Limit		
CO (PPM)							Operating Control		
NOx (PPM)							Stack Temp Interlock		
Smoke (Bacharach)							Flame Failure		
Combustion Eff. %							Combustion Air Switch		
Stack Draft "W.C.							High Purge Switch		
Furnace Pressure "W.C.							Low Fire Interlock		
Blast tube Pressure "W.C.							Oil Pressure Switch		
Steam Pressure PSIG							Oil Valve with P.O.C. Interlock		
Water Temperature °F							High Gas Pressure Switch		
Supply oil pressure PSIG							Low Gas Pressure Switch		
Return oil pressure PSIG							Gas Valve P.O.C. Interlock		
Vacuum oil pump "HG							Pilot Turndown Test		
Oil Temperature							Flame Signal Pilot		
Atom. air pressure									
Gas Pressure @ Burner	Inner Manifold								
Manifold "W.C.	Outer Manifold								
Center Gas pressure "W.C.									
Gas Pressure @ Regulator Inlet PSIG									
Gas Pressure @ Regulator Outlet PSIG									
Pilot Gas Pressure @ Regulator Outlet "W.C.									
Flame Signal Main	Low	50%	High						

Electric Motors	Voltage			Amperage		
	L1	L2	L3	L1	L2	L3
Control Voltage						
Blower Motor						
Air Compressor						
Air-Oil or Metering						

(For Low NOx Burners)

Blast Tube Temp. Interlock		
FGR Line Purge Switch		
FGR Valve P.O.C. Switch		

Adjusted by:

Date:

Accepted by:

(Signature Required)

CB-8209

CHAPTER 3

Pressure Vessel Care

- A. General 3-1
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- F. Cleaning 3-6
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- J. Preparation For Extended Layup 3-11

A. GENERAL

This chapter is devoted primarily to the waterside care of the pressure vessel.

Proper water supply and treatment are essential to boiler life and length of service. Proper water treatment will pay dividends in the form of longer life, less downtime, and prevention of costly repairs.

Hot water boilers require proper circulation. The system must be operated as intended by its designer in order to avoid the possibility of thermal shock with severe stress to the pressure vessel.

Although it is of prime importance, the subject of water supply and treatment cannot adequately be covered in this manual. For specific information or assistance with your water treatment requirements, contact your local Cleaver- Brooks authorized representative.

B. WATER REQUIREMENTS (HOT WATER BOILERS)

Air Removal

The hot water outlet (Figure 3-1) is located in the top drum of the boiler. This location reduces the possibility of released air (which is trapped at the top of the drum) from entering the system. Any air (or oxygen) that may be released in the boiler will collect at the top of the upper drum, where it will escape through the air vent tapping. The tapping must be properly piped to the expansion tank or a stand pipe and air bleeder to remove gases that collect at the top of the drum.

- A. HOT WATER OUTLET
- B. AIR VENT TAPPING
- C. PRESSURE/TEMPERATURE GAUGES

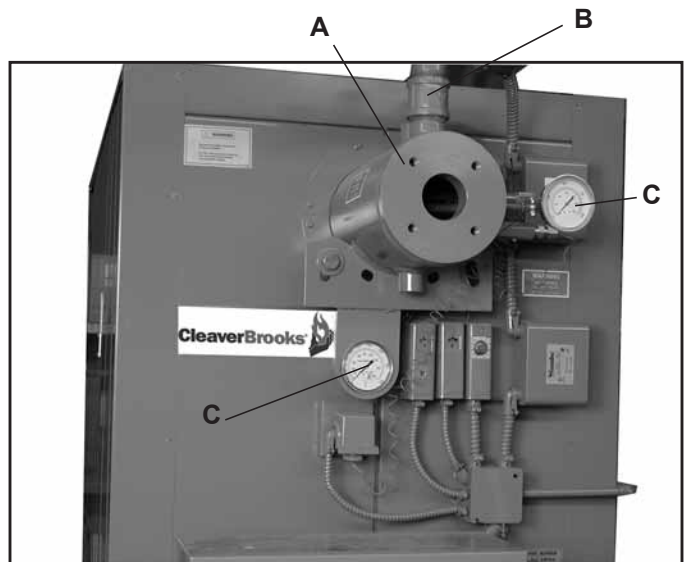


Figure 3-1: Upper Drum (Hot Water)

Continuous Flow

The system must be piped and the controls arranged so that there will be water circulation through the boiler under all operating conditions. Constant circulation through the boiler eliminates the possibility of stratification within the unit.

Refer to Table 3-1 to determine the minimum continuous flow rate through the boiler.

Table: 3-1 Minimum Flow Rates for Hot Water Boilers

MODEL NO.	DT = 20°F		DT = 40°F		DT = 60°F		DT = 80°F		DT = 100°F	
	DP (PSIG)	GPM	DP (PSIG)	GPM	DP (PSIG)	GPM	DP (PSIG)	GPM	DP (PSIG)	GPM
FLX-150	1.14	122.0	0.30	61.1	0.13	41.1	0.08	30.8	0.05	24.4
FLX-200	1.14	162.3	0.30	81.1	0.13	54.1	0.08	40.6	0.05	32.5
FLX-250	1.77	202.8	0.46	101.4	0.21	67.6	0.12	50.7	0.08	40.6
FLX-300	1.85	243.4	0.48	121.7	0.22	81.1	0.12	60.9	0.08	48.7
FLX-350	2.49	284.0	0.65	142.0	0.29	94.7	0.17	71.0	0.11	56.8
FLX-400	1.35	324.5	0.35	162.3	0.16	108.2	0.09	81.1	0.06	64.9
FLX-450	1.71	365.1	0.44	182.6	0.20	121.7	0.11	91.2	0.08	73.0
FLX-500	2.03	405.7	0.54	202.8	0.25	135.2	0.14	101.4	0.09	81.1
FLX-550	2.50	446.3	0.67	223.1	0.31	148.7	0.17	111.5	0.11	89.2
FLX-600	2.99	486.8	0.77	243.4	0.35	162.3	0.20	121.7	0.13	97.4
FLX-700	1.75	567.9	0.45	284.0	0.21	189.3	0.12	142.0	0.08	113.6
FLX-800	2.27	649.1	0.59	324.5	0.27	216.4	0.15	162.3	0.10	129.8
FLX-900	2.85	730.2	0.74	365.1	0.33	243.4	0.19	182.6	0.12	146.0
FLX-1000	4.08	811.4	1.02	405.6	0.42	270.4	0.25	202.8	0.15	163.6
FLX-1100	4.42	892.6	1.15	446.2	0.48	297.4	0.28	223.0	0.18	178.4
FLX-1200	6.20	973.6	1.60	486.8	0.59	324.6	0.31	243.4	0.22	194.8

CAUTION

In order to avoid damage to the equipment, a circulating pump should be interlocked with the burner so that the burner cannot operate unless the circulating pump is running.

It is recommended that the system circulating pumps be kept running, even though the heat users do not require hot water. The relief device or bypass valve will allow continuous circulation through the boiler and will help prevent rapid replacement of boiler water with “cold” zone water.

CAUTION

The operator should determine that a circulation of water exists through the boiler before initial firing or when firing after the unit has been drained and refilled. A reduced circulation of water or no water circulation through the boiler when the burner is operating may result in damage to the equipment.

System Pressure

The design of the system and the usage requirements often will dictate the pressure exerted upon the boiler. Some systems are pressurized with nitrogen. Caution must be exercised to make sure that the proper relationship of pressure to temperature exists within the boiler so that all of its internal surfaces are fully wetted at all times. It is for this reason that the internal boiler pressure, as indicated on the water pressure gauge, must be held to the level shown in Figure 3-2.

It is advisable to install a thermometer in the return line to indicate return water temperature. With the return water temperature and the supply water temperature to the system known, the temperature differential will be established. Knowing the flow rate, the operator easily can detect any excessive load condition and take appropriate corrective action.

Pressure Drop

There will be a pressure drop of less than 4 psi through all standardly equipped Cleaver-Brooks boilers operating in any system that has more than the 20°F temperature drop. This drop will vary with boiler size and circulation rate. For specific information, refer to table 3-1, Minimum Flow Rates for Hot Water Boilers.

Minimum Boiler Water Temperature

The recommended **minimum boiler water temperature** (outlet or supply) should be no less than 160°F (71°C) when the boiler is operating. This is specifically relevant during times when there is little load or during intermittent firing. The recommended **minimum system return water temperature** shall be 140°F (60°C) when firing natural gas or 150°F (66°C) when firing oil. And for special burner applications firing digester gas, minimum return water should always be above 160°F (71°C) and supply outlet temperature greater than 170°F (77°C).

These recommendations are provided to reduce or minimize the formation of condensation on the fireside of the boiler. Failure to do so will lead to corrosion of the boiler tubes and will not be covered by warranty. When supply temperature is lower than 160°F (71°C), the combustion gases are cooled to the point where the water vapor in the gases condenses. When this occurs, fireside corrosion may result if the condensed moisture stays on the steel fireside surfaces. This may occur more frequently during seasonal or light load conditions and specifically if the boiler is oversized for the system load.

If the system water temperature requirement is to be less than 160°F (71°C), mixing valves or blend pump should be employed to mix the supply water with return water. **NOTE:** When system 3-way valves are used, they should be set so that the boiler is not by-passed, thus impairing circulation within the boiler when the burner is firing. This could lead to over-temperature and nuisance shutdowns, as the high limit control will trip, requiring a manual reset of the control. Repeated overheating could lead to other damage.

Multiple Boiler Installations

When multiple boilers of equal or unequal size are installed, care must be taken to ensure proportional flow through the boilers. Proportional flow can best be accomplished by use of balancing cocks and gauges in the supply line from each boiler. If balancing cocks or orifice plates are used, a significant pressure drop (for example, 3-5 psi) must be taken across the balancing device to accomplish proportional flow.

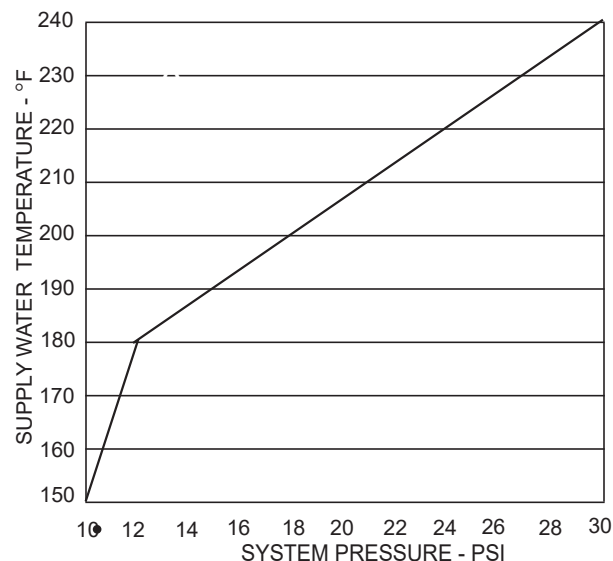


Figure 3-2: Minimum System Operating Pressure

Variations in water temperature and firing rates will result if care is not taken to ensure proportional flow through the boilers. In extreme cases, differences in firing rates could result in a net header water temperature below the desired temperature.

C. WATER REQUIREMENTS (STEAM BOILERS)

Deaeration

The most important factor in the life of a steam pressure vessel is the proper conditioning of the boiler feed water. Corrosive gasses, such as oxygen and carbon dioxide, must be removed from the feed water in order to prevent degradation of the pressure vessel. For this reason Cleaver- Brooks recommends the use of a deaeration system as an integral part of a complete boiler installation. If circumstances do not allow the implementation of a deaeration system, then serious consideration should be given to effective alternatives such as a feed water preheater combined with a chemical oxygen scavenger. Complete boiler water chemistry parameters are given in Table 3-3.

Feed Water Supply

The internal dynamics of the Model FLX steam boilers require the capability to deliver large quantities of feed water to the boiler on demand. (Feed water inlet Figure 3-3.) Sudden changes in firing rate or operating pressure of the boiler will initiate a “call for water” from the make-up controller, which will require that the feed water be delivered to the boiler in sufficient quantities to prevent a low water cutoff trip. Table 3-2 lists the minimum feed water flow requirements for the various boiler models. In addition, feed water must be warmed to a minimum of 60°F. in order to ensure reliable operation of the boiler. The feed water supply should be adjusted to deliver water to the boiler at or above these minimum rates.



Figure 3-3: Feed Water Inlet Steam Boiler

Table: 3-2 Minimum Boiler Feed Water Flow Rates (Steam Boiler)

BOILER MODEL	150	200	250	300	350	400	450	500	550	600	700	800	900	1000	1100	1200
Minimum Feed Rate (gpm)	4.9	6.6	8.2	9.9	11.6	13.2	14.9	16.5	18.2	19.8	23.1	26.4	29.7	33.0	36.3	39.6

Note: Feedwater to the boiler must be at least 60 °F for minimum performance; 212 °F is preferred.

D. Water Treatment

Properly treated boiler water will result in maximum effectiveness and long trouble-free life of the pressure vessel. Contact your local Cleaver-Brooks Representative or water management consultant for complete information on how to prevent damage resulting from inadequate water treatment.

The objectives of water treatment in general are to:

- Prevent hard scale and soft sludge deposits that inhibit heat transfer and that could lead to overheated metal and costly downtime and repairs.
- Eliminate corrosive gases in the supply or boiler water.

To accomplish these objectives, the boiler requires proper water treatment before and after introduction of water into the unit. The selection of pretreatment processes depends upon the water source, its chemical characteristics, the amount of makeup water needed, system operation practices, etc.

Because of the variables involved, no one boiler compound can be considered a cure-all; nor is it advisable to experiment with homemade treating methods. A sound treatment program should include a periodic analysis of the water in the system.

The internal or waterside surfaces of the pressure vessel should be inspected at sufficient intervals to detect the presence of any corrosion, pitting, contamination, or accumulations of foreign matter. If any of these conditions are detected, contact your local Cleaver-Brooks authorized representative for advice on corrective action. It is recommended that a properly sized water meter be installed in the raw water makeup line to accurately determine the amount of raw water admitted to the boiler. It is a false assumption that a hot water boiler does not require water treatment. Even though a hot water unit generally operates on a closed system and blowdown seldom is practiced, the need remains to be alert to system water losses. Knowing the amount of makeup water admitted to the system will aid in maintaining proper waterside conditions.

E. Blowdown

A steam boiler requires periodic blowdown of the boiler and water column (Figure 3-4). Blowdown is the removal of some of the concentrated water from the boiler and the water level control system, in order to lower the concentration of solids in the water.

Solids are introduced to the boiler with the feedwater, even though this water may be treated prior to use. These solids become less soluble when the water is heated and evaporated, and tend to accumulate on heating surfaces.

Periodic blowdown and chemical treatment are necessary to prevent concentration of solids in the boiler water, and attachment of these solids to waterside heating surfaces (scaling).

Scale has a low heat transfer value and acts as an insulating barrier on heating surfaces. A buildup of scale will result in lower operating efficiency and, consequently, higher fuel consumption. More importantly, scale buildup can result in overheating of boiler metal. This can result in tube failures or other pressure vessel damage.



Figure 3-4: Low Water Cutoff and Gauge Glass with Blowdown Valve

CAUTION

Boiler and water level control blowdown must be performed on a regular basis to ensure that concentrated solids are removed from the boiler and in order to avoid damage to the equipment.

Water column and gauge glass blowdown valves are located on the water column assembly. The boiler blowdown tapping(s) can be found at the bottom of the lower drum.

Most blowdown lines are provided with two valves. These are generally a quick-opening valve nearest the boiler and a slow-opening globe-type valve downstream. Valves will vary depending upon pressure involved and the make or manufacturer.

Blowdown Procedure

Blowdown is most effective when the boiler water is hot and the burner is being fired at the lowest rate. This ensures that the water in the boiler is being circulated, and that the solids in the water are in suspension.

 CAUTION

Be sure that the blowdown piping is in good condition, the discharge vents are clear of obstruction, and that the waste is piped to a safe point of discharge, in order to avoid serious personal injury or death.

If a quick-opening valve and globe-type or slow-opening valve are installed, the quick-opening valve is normally opened first and closed last. Control of the water released from the boiler is accomplished with the slow-opening valve.

 CAUTION

When initially opening the blowdown valve, open the valve slowly to heat the discharge piping. Failure to follow this procedure could result in rapid expansion and damage to the piping.

The drop of the water level in the gauge glass can be used in determining the length of time that the blowdown valve is left open. This is to be used as a reference only, as proper water analysis on a regular basis will serve as an indicator of the effectiveness of the blowdown procedures used.

 CAUTION

Do not pump the lever action valve open and closed when draining water during blowdown. The hydraulic forces resulting from this pumping action could break the valve bodies or pipe fittings in the blowdown lines.

Blowdown valves should be closed in a specific order after draining water for blowdown. Close the downstream (slow opening) valve first, followed by the quick-opening valve next to the boiler. Open the downstream valve slightly to release the water trapped between the valves, then close the valve again.

The water column and gauge glass should be blown down by draining until the water in the gauge glass is clear. Open and close the water column and gauge glass blowdown valves slowly, allowing the water in the gauge glass to rise to a normal level before repeating the process.

Under no circumstances should a blowdown valve be left open and unattended during the blowdown operation.

Frequency of Blowdown

In practice, the boiler blowdown valve(s) should be opened periodically in accordance with a set operating schedule. Frequency and duration of the blowdown are to be determined by chemical analysis of boiler water and waterside boiler condition, as observed during regular inspections.

From an economy standpoint, frequent short blowdown is preferred to irregularly scheduled, lengthy blowdown. This is particularly true when the suspended solids content of the water is high.

F. Cleaning

Although it may be necessary to clean the system, information in this chapter deals primarily with cleaning the boiler under isolated conditions.

System piping connected to the boiler may contain oil, grease, or other foreign matter. These impurities must be removed to prevent damage to the heating surfaces of the pressure vessel. Chemical cleaning generally is necessary in this case and the entire system should be drained after cleaning. Consult your local Cleaver-Brooks authorized representative for recommended cleaning compounds and application procedures. For information on Boilout, see Section G, in this chapter.

Pressure Vessel

Cleaning of the waterside of the pressure vessel should be done during the course of initial installation. The waterside of the pressure vessel must be cleansed of grease, sludge, and foreign material. Such deposits will shorten the life of the pressure vessel and interfere with the efficient operation and function of control or safety devices. In addition, deposits might cause unnecessary and expensive rework, repairs, and downtime.

The pressure vessel and the hot water system represent in effect, a closed system. Although individual components of the system may already have been cleaned, it is possible that:

- The cleaning was not adequate.
- An old system was partially or totally involved.
- Conditions may have prevented an adequate cleaning of the piping.

Therefore, it is recommended that the entire system be cleaned after installation of all components is completed. The pressure vessel waterside should be inspected on a periodic basis. An inspection will reveal the true internal conditions and will serve as a check against conditions indicated by chemical analysis of the boiler water. An inspection should be performed 3 months after the initial start up, then at regular 6, 9, or 12 month intervals thereafter. The frequency of periodic inspections will depend upon the internal conditions found, the particular installation, and the operating conditions that the boiler is subjected to.

If any deterioration or unusual conditions are observed, contact your local Cleaver-Brooks authorized Representative for recommendations.

Table: 3-3 **Water Capacity**

Boiler Size	150-250	300-350	400-600	700-900	1000-1200
Water Capacity (US gal.) Hot Water	91	106	174	228	269
Water Capacity (US gal.) Steam - Flooded	194	215	293	464	562

G. Boilout

Any oil, grease, or other contamination found to be present on waterside heating surfaces should be removed promptly by boiling out the unit with an alkaline detergent solution.

Note: Before boiling out, the burner must be ready for firing. Refer to CHAPTER 2 - Profire V Burner.

There are several chemicals suitable for boilout. One combination often used is soda ash (sodium carbonate) and caustic soda (sodium hydroxide) at the rate of 3 to 5 pounds each per 1,000 pounds of water, along with a small amount of laundry detergent added as a wetting agent.

If the system is to be cleaned with the boiler, consider the additional water content of the system in determining the amount of chemical required. The water capacity of Cleaver- Brooks FLX Boilers is listed in Table 3-3.

Boilout Procedure

1. Prepare the boiler for firing by taking the standard precautions. Check for any situations that might present a hazard.
2. Remove upper and lower drum handhole covers and inspect all internal waterside surfaces. Remove debris and wash all internal surfaces, including tubes. It may be necessary to use a high pressure hose or a wash out lance to flush out inaccessible areas. Reinstall the lower drum handhole cover. (Use standard service gaskets during the boilout procedure.)
3. The relief valve(s) must be removed before adding the boilout solution so that neither the solution nor the contaminants that it may carry can come in contact with the valve(s). Use care in removing, handling, and reinstalling these valves.

Note: For relief valve installation information, refer to Chapter 8, Section E. "Controls."

4. Replace the regular gauge glass with a temporary gauge glass that can be discarded after the cleaning (steam boilers).
5. An overflow pipe should be connected to one of the top boiler openings and routed to a safe point of discharge. A relief valve tapping is usually used for this purpose. The overflow connection to the boiler should incorporate a tee fitting for adding cleaning solution to the boiler.
6. Fill the unit with clean water to a point just below the access port in the upper drum. It is important that the water used for the filling process is at a temperature of 70°F or above.
7. Add the boilout solution using a chemical pump.



The chemicals used in this procedure are corrosive to eyes and skin. Always refer to the Material Safety Data Sheet to ensure that the proper safety equipment and precautions are present. Failure to heed this warning could result in serious personal injury or death.

8. Reinstall the upper handhole cover.
9. Continue to fill the boiler until it is full (indicated by flow from the overflow connection).
10. Recheck the burner, gauge glass, pressure gauge, feedwater supply and the position of all valves. Make sure that all water feeding and level indicating apparatus are in proper working condition.
11. Fire the boiler intermittently at the burners lowest fire rate until the water reaches the boiling point. The water should be held at this temperature for at least five hours.

Note: Do not produce pressure in the boiler.

12. Throughout the entire process, each blow-down point or valve should be blown at least once every two hours. The total amount of water blown from all points each time should be approximately one-half gauge glass, this amount being equally divided among the various manual blowdown points and continuous blowdown system. Blow the surface and/or continuous blow-down points first, followed by the other blowdown points lower on the boiler. After each blowdown cycle, the water level should be brought back to full. If the total alkalinity in the cleaning solution falls to a level below 3000 ppm, it may be necessary to add additional solution, using a chemical pump.

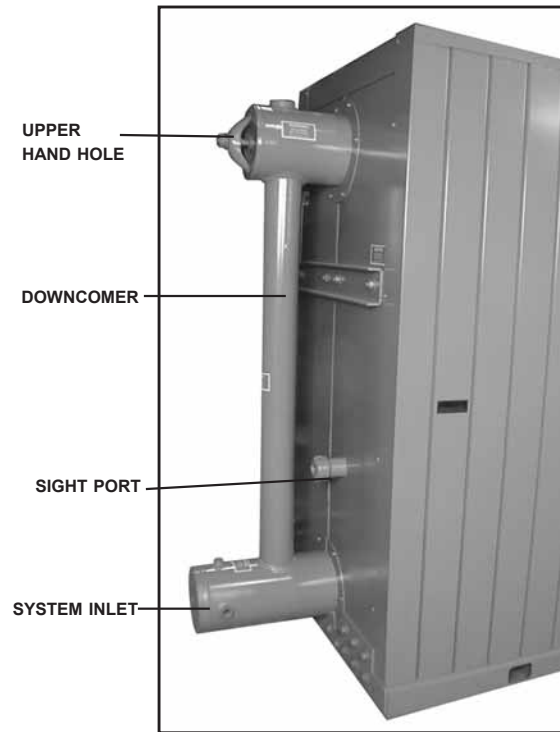


Figure 3-5: Rear Panel (Hot Water Boiler)

13. Allow a small amount of fresh water to enter the boiler in order to create a slight overflow that will carry off surface impurities. Continue to boil and overflow until the water clears.
14. It is difficult to provide specific recommendations regarding the duration of the cleaning process. In general, a period of 18 to 36 hours will prove sufficient to internally clean the water-side of the boiler. The condition of the water blown from the boiler is the best indicator as to whether the cleaning process is complete.
15. Discontinue firing, and allow the water to cool. After letting the water cool to 120°F or less, drain the boiler.



Be sure to drain the hot water to a safe point of discharge to avoid the possibility of scalding, serious personal injury or death.

16. Remove the drum handhole cover, and wash the waterside surfaces thoroughly, using a high pressure water stream. Direct the water stream into each individual tube. If possible, this washing should be done from the bottom up. A wash out lance is available from your local Cleaver-Brooks authorized representative.
17. Inspect the waterside surfaces. If they are not clean, repeat the boilout procedures.
18. Replace the handhole covers (using new gaskets) and reinstall the relief valve(s).
19. If the boiler is to be put into service immediately, fill the boiler with clean, treated water and fire the burner until the water has been heated to at least 180°F to drive off any dissolved gases that might otherwise corrode the metal.
20. If the boiler is not to be put into immediate service, refer to the section on boiler layup procedures in this chapter.

H. Washing Out

Depending on system integrity, feedwater quality, or operating conditions, the water side of the boiler may need to be washed out on occasion.

In theory, a hot water system and boiler that have been initially cleaned, filled with clean, treated water, and with no makeup water added, will require no further cleaning or treatment. However, minor system leaks may allow the admission of additional water or air into the boiler.

Introduction of raw (untreated) makeup water or air to a hot water boiler may lead to pitting, corrosion, or formation of sludge, sediment, or scale on the pressure vessel waterside.

The waterside condition of steam boilers can be likewise affected by feedwater quality, load demands, operating conditions, or blowdown practices.

The waterside of a hot water or steam boiler should be cleaned and inspected no later than three months after the boiler is put into service. Subsequent cleaning of waterside surfaces should be performed as indicated through periodic inspection.

In order to thoroughly wash out the waterside of the pressure vessel, the handhole covers at the ends of the upper and lower drums must be removed. The interior surfaces of the drums should be washed with a high pressure hose. Tubes should be cleaned by directing a high pressure stream of water into the end of each tube, first from the bottom, and then from the top drum.

Note: A washout lance for this purpose is available from your local Cleaver- Brooks authorized representative.

Control and water column connections on steam boilers should be checked for accumulated deposits, and cleaned as required.

After waterside cleaning has been completed, replace the handhole covers, using new gaskets.

Note: Handhole cover gaskets are installed dry; that is, without application of a sealing compound.

I. Periodic Inspection

Insurance regulations or local codes and good maintenance will require that the pressure vessel be inspected periodically by an authorized inspector. Sufficient notice is generally required to allow removal of the boiler from service and preparation for inspection. An internal inspection may be required before cleaning or flushing.

Have the following information available for the inspector: boiler design, dimensions, generating capacity, operating pressure and temperature, time in service, defects found previously, and any repairs or modifications made to the unit. Reference records of previous inspections also should be available. Be prepared to perform any testing required by the inspector, including a hydrostatic test.

When shutting down a boiler, the load should be reduced gradually and the pressure vessel should be cooled at a rate that avoids a temperature differential that can cause harmful stresses. Normally, all pressure should be relieved before a vessel is drained in order to prevent uneven contraction and temperature differential that can cause tubes to leak. Draining the unit too quickly may cause the baking of deposits that may be present on the heating surfaces.

Note: Check to see that system valves, feedwater valves, all fuel valves, expansion tank, and electrical switches are shut off prior to opening the handholes or the burner access door. After proper cooling and draining of the vessel, flush out the waterside with a high pressure water stream. Remove any scale or deposits from the waterside surfaces and check for internal or external corrosion or leakage.

Fireside surfaces also should be cleaned so that metal surfaces, welds, joints, tube fittings, and any previous repairs can be readily checked.



To avoid the hazard of electrical shock, which could cause serious personal injury or death, the use of a low voltage flashlight is recommended during an internal inspection.

Fireside Inspection

Access for inspection of the firing chamber, or furnace, is gained through the hinged burner door. Inspection of the upper pass requires removal of the side casing panels and second and fourth pass cover plates. Refer to Chapter 8, Section C, "Fireside Cleaning," for information regarding outer and inner casing removal.

Fireside tube surfaces should be checked for corrosion or accumulation of soot. Use a vacuum cleaner and wire brush to remove light corrosion or soot.

Localized, heavy corrosion on fireside tube surfaces may indicate a leaking tube or ferrule connection. If a tube or tube ferrule leak is indicated, the source of the leakage must be found and repaired before putting the boiler back in service. A leak from a tube-to-drum connection may require removal and reseating of the tube. A heavily corroded or leaking tube must be replaced in order to assure continued reliable operation of the boiler. Information regarding tube replacement can be obtained from your local Cleaver-Brooks authorized representative.

Waterside Inspection

Check all water piping and valves for leaks, wear, corrosion, and other damage. Replace or repair the piping and valves as necessary. Inspection covers at one end of the upper and lower drums provide access to the interior of the drums for visual inspection or washout. The interior surfaces of the drums should be examined for any sign of corrosion or accumulation of deposits.

J. Preparation for Extended Layup

Many boilers used for heating or seasonal loads or for standby service may have extended periods of non-use. The procedures outlined in this section are designed to allow a boiler to be kept off line for any period of time without damage to the unit. Special care must be taken so that neither waterside nor fireside surfaces are allowed to deteriorate from corrosion. Operating boilers can be protected from corrosion and scale by applying various chemical treatments and monitoring the system on a regular basis. However, boilers that are taken off line, even for short intervals, are susceptible to oxygen attack. Boiler drums and/or tubes may sustain pitting type damage during either wet or dry layup if proper precautions are not taken.

Oxygen solubility at ambient (off-line) temperatures can be many times that of normal boiler operating temperatures. The higher the oxygen concentration, the greater the oxygen corrosion potential. Problems also can occur as a result of improper shutdown procedures, where settled solids can dry in a hard, adherent deposit.

Care must be taken to prevent fireside corrosion, especially when firing oil that contains sulfur. Dormant periods, and even frequent shutdowns, expose the fireside surfaces to condensation during cooling. Moisture and any sulfur residue can form an acid solution. Under certain conditions, and especially in areas with high humidity, the corrosive effect of the acid can be serious. An acid solution could eat through or severely damage boiler tubes or other metal heating surfaces during the time that a boiler is out of service.

Too many conditions exist to lay down definite rules for individual installations. In general, there are two methods of storage: wet or dry. Your local Cleaver-Brooks authorized representative can recommend the better method based on the circumstances of your particular installation. Regardless of the method employed, the boiler should be thoroughly cleaned and inspected prior to storage. With either method, common sense dictates a periodic recheck of fireside and waterside conditions during layup to meet the requirements of special or job site conditions.

Preparing The Boiler For Layup

To prepare a boiler for layup, thoroughly clean the fireside by removing any soot or other products of combustion from the tubes, exposed drum surfaces, and refractory.

CAUTION

The insulating refractory covering the top of the bottom drum must be protected from damage when work is being done in the boiler furnace area. Damage to the insulation may eventually cause damage to the boiler itself.

Generally, a good brushing will clean fireside surfaces. Use a wire brush for metal surfaces and a soft bristle brush for the refractory. Sweep away or vacuum any accumulation.

To prevent condensation from forming in the control cabinet, keep the control circuit energized. For extended layup periods, especially where high humidity or large swings in ambient temperature occur, the flame safeguard control should be removed and stored in a dry atmosphere.

It is recommended that the burner air inlet be blocked to prevent the flow of warm, moist air through the boiler.

CAUTION

A label should be affixed to the burner advising that the air inlet has been blocked. Failure to remove the air inlet block when attempting to operate the burner may result in damage to the equipment.

Dry Storage

Dry storage generally is used for boilers that are to be out of service for some time or for boilers that might be subjected to freezing conditions. With the dry storage method, the boiler must be thoroughly dried because any moisture would cause corrosion. Drying can be accomplished by the use of a small stove or heater.

Both fireside and waterside surfaces must be cleaned of all scale, deposits, soot, and other combustion products as soon as possible after shutdown.

All openings to the pressure vessel, such as handholes or inspection ports, should be closed tightly. Feedwater and system valves should be closed. Dampers should be closed to prevent air from reaching the fireside surfaces.

Steps must be taken to eliminate moisture by placing moisture-absorbing materials on trays inside the boiler. Two moisture-absorbing materials are: quick-lime (at 2 pounds for 3 cubic feet of volume) or silica gel (at 5 pounds for 30 cubic feet of volume). As soon as the material is in place, close all boiler openings and blank all connections.



Materials described in this section may be considered hazardous under the U.S. Occupational Safety and Health Act of 1970. Material Safety Data Sheets should be obtained and understood prior to the use of these products to avoid the possibility of serious personal injury or death.

Wet Storage

Note: It is always best to consult with a water treatment consultant before proceeding with extended layup.

Wet storage is used when the boiler will be out of service for shorter periods of time, when a boiler is held in standby conditions, or in cases where dry storage is not practical. The boiler held in wet storage can be brought back into service more quickly than one held in dry storage. However, the possibility of freezing temperatures must be considered. Again, take care to protect metal surfaces. Because of the number of variables, it is difficult to offer definite recommendations. However, it is suggested that the pressure vessel be drained, thoroughly cleaned internally, and refilled to overflowing with treated water.

If deaerated water is not available, the unit should be fired to boil the water for a short period of time in order to drive off oxygen in the water.

Tightly close all connections and apply a small positive pressure to compensate for the vacuum that will develop as the unit cools to room temperature. Internal water pressure should be maintained at greater than atmospheric pressure. Nitrogen often is used to pressurize the vessel.

The boiler water should be tested weekly as long as the unit is in storage. Additional chemicals may be required to prevent internal corrosion. If more chemicals are added, it is desirable to circulate the boiler water for a short time by means of an external pump.

Contact your local Cleaver-Brooks authorized representative for water treatment chemicals or for assistance as needed.

CHAPTER 4

Sequence of Operation

General 4-1
Circuit And Interlock Controls 4-1
Sequence Of Operation - Oil Or Gas 4-3
Flame Loss Sequence 4-4

A. GENERAL

Chapter 4 outlines the electrical sequencing of various controls through the pre-purge, ignition, run, and shutdown cycles of the burner.

The program relay establishes the sequence of operation and directs the operation of all other controls and components to provide an overall operating sequence.

Note: The make or model of the program relay provided will vary depending upon job specifications. The following sequence applies regardless of the make or model. Please refer to the Wiring Diagram prepared by Cleaver-Brooks for your specific installation.

Abbreviations for the various electrical components are listed in Table 4-1. The sequences outlined in Chapter 4 employ specific nomenclature to aid in applying the text to the wiring diagram.

The burner and control system are in starting condition when the following conditions exist:

- Boiler water is up to the correct level, closing the low-water cutoff switch.
- The low-water light (panel) is off.
- The operating limit pressure control (steam boiler) or the operating limit temperature control (hot water boiler) and high limit pressure or temperature control are below their cutoff setting.
- All applicable limits are correct for burner operation.
- The load demand light glows.

All entrance switches are closed and power is present at the line terminals of:

- Blower motor starter
- Oil pump motor starter (if provided).

B. CIRCUIT AND INTERLOCK CONTROLS

The burner control circuit is a two-wire system designed for 115 Vac, 60 Hz, single-phase power.

The electrical portion of the boiler is made up of individual circuits with controls that are wired in a manner designed to provide a safe workable system. The program relay provides connection points for the interconnection of the various circuits.

The controls used vary depending upon the fuel oil or gas and the specific requirement of applicable regulatory bodies. Refer to the boiler wiring diagram to determine the actual controls provided. The circuits and controls normally used in the circuits follow and are referred to in the following sequence of operation.

Limit Circuit:

- Burner switch (BS)
- Operating limit control (OLC) - pressure or temperature
- High limit control (HLC) - pressure or temperature
- Low-water cutoff (LWCO)
- Gas-oil selector switch (GOS) - (Combination burner only)
- Low gas pressures switch (LGPS)
- High gas pressure switch (HGPS)

Fuel valve interlock circuit

- Main gas valve auxiliary switch (MGVAS)
- Oil valve auxiliary switch (OVAS)

Blower Motor Starter Circuit

- Blower motor starter (BMS)

Running Interlock Circuit

- Blower motor starter interlock (BMSI)
- Combustion air proving switch (CAPS)

Low Fire Proving Circuit

- Low fire switch (LFS)

Pilot Ignition Circuit

- Gas pilot valve (GPV)
- Ignition transformer (IT)
- Gas pilot vent valve (GPVV) (if provided)

Flame Detector Circuit

- Flame detector (FD)
- Main fuel valve circuit
- Main gas valve (MGV)
- Main gas vent valve (MGVV) (if provided)
- Oil valve (OV)
- Main fuel valve light (FVL)

Firing Rate Circuit

- Damper motor transformer (DMT)
- Modulating damper motor (MDM)
- Manual-automatic switch (MAS)
- Manual flame control (MFC)
- Modulating control (MC)

To comply with requirements of insurance underwriters such as Factory Mutual (FM), Industrial Risk Insurers (IRI) or others, additional interlock devices may be used in addition to the circuits mentioned in Section B.

High Fire Proving Circuit

- High fire switch (HFS)

Running Interlock and Limit Circuit

- Low oil pressure switch (LOPS)
- High oil pressure switch (HOPS)
- Auxiliary low-water cutoff (ALWCO)

C. SEQUENCE OF OPERATION - OIL OR GAS

On a combination fuel unit, the gas/oil switch must be set for the proper fuel.

The following sequence occurs with power present at the program relay (PR) input terminals and with all other operating conditions satisfied.

Pre-Purge Cycle - When the burner switch (BS) is turned “on,” and controls wired in the “limit” and “fuel valve interlock” circuits are closed and no flame signal is present, the “blower motor start circuit” is powered energizing the blower motor starter (BMS). The load demand light (LDL) turns on.

At the same time, the program relay signals the modulating damper motor (MDM) to open the air damper. The damper begins to open and drives to its full open or high fire position. Opening the damper motor allows a flow of purging air through the boiler prior to the ignition cycle.

On certain boilers the circuitry will include a high fire switch (HFS). The purpose of the switch is to prove that the modulating damper motor (MDM) has driven the damper to the open position during the pre-purge cycle. In this instance, the “high fire proving circuit” is utilized.

The controls wired into the “running interlock circuit” must be closed within 10 seconds after the start sequence. In the event any of the controls are not closed at this time, or if they subsequently open, the program relay will go into a safety shutdown.

At the completion of the high fire purge period, the program relay signals the modulating damper motor (MDM) to drive the air damper to its low fire position.

To assure that the system is in low fire position prior to ignition, the low fire switch (LFS) must be closed to complete the “low fire proving circuit.” The sequence will stop and hold until the modulating damper motor (MDM) has returned to the low fire position and the contacts of the low fire switch (LFS) are closed. Once the low fire switch is closed, the sequence is allowed to continue.

Note: The ignition trial cannot be started if flame or a flame simulating condition is sensed during the pre-purge period. A safety shutdown will occur if flame is sensed at this time.

Ignition Cycle - The ignition transformer (IT) and gas pilot valve (GPV) are energized from the appropriate pilot ignition terminal.

Note: An oil-fired burner may be equipped with a direct spark rather than a gas pilot. The ignition sequence of both is identical.

The pilot flame must be established and proven by the flame detector (FD) within a 10 second period in order for the ignition cycle to continue. If for any reason this does not happen, the system will shut down and safety lockout will occur.

Note: Depending upon the requirements of the regulatory body, insurer or fuel being burned, either the 10 or 15 second pilot ignition terminal may be used. Both provide the same function but differ in time interval allowed for proving main flame ignition. Refer to the boiler wiring diagram.

With a proven pilot, the main fuel valve(s) (OV or MGCV) is energized and the main fuel valve light (FVL) in the panel is lighted. The main flame is ignited and the trial period for proving the main flame begins. It lasts 10 seconds for light oil and natural gas. At the end of the proving period, if the flame detector still detects main flame, the ignition transformer and pilot valve are deenergized and pilot flame is extinguished.

Note: If the main flame does not light, or stay lit, the fuel valve will close. The safety switch will trip to lock out the control. Refer to flame loss sequence (section D) for description of action.



The cause for loss of flame or any other unusual condition should be investigated and corrected before attempting to restart. Failure to follow these instructions could result in serious personal injury or death

Run Cycle - With main flame established, the program relay releases the modulating damper motor (MDM) from its low fire position to control by either the manual flame control (MFC) or the modulating control (MC), depending upon the position of the manual-automatic switch (MAS). This allows operation in ranges above low fire.

With the manual-automatic switch (MAS) set at automatic, subsequent modulated firing will be at the command of the modulating control (MC), which governs the position of the modulating damper motor (MDM). The air damper and fuel valves are actuated by the motor through a linkage and cam assembly to provide modulated firing rates.

Note: Normal operation of the burner should be with the manual-automatic switch in the automatic position and under the direction of the modulating control. The manual position is provided for initial adjustment of the burner over the entire firing range. When a shutdown occurs while operating in the manual position at other than low fire, the damper will not be in a closed position, thus allowing more air than desired to flow through the boiler. Excess air flow subjects the pressure vessel metal and refractory to undesirable conditions.

The burner starting cycle is now complete. The (LDL) and (FVL) lights on the panel remain lit. Demand firing continues as required by load conditions.

Burner Shutdown-Post Purge - The burner will fire until steam pressure or water temperature in excess of demand is generated. With modulated firing, the modulating damper motor (MDM) should return to the low fire position before the operating limit control (OLC) opens. When the limit control circuit is opened, the following sequence occurs:

The main fuel valve circuit is deenergized, causing the main fuel valve (MGV) or (OV) to close. The flame is extinguished. The control panel lights (LDL) and (FVL) are turned off. The blower motor continues to run to force air through the boiler for the post purge period.

The blower motor start circuit is deenergized at the end of the post purge cycle and the shutdown cycle is complete.

The program relay is now ready for subsequent recycling, and when steam pressure or water temperature drops to close the contacts of the operating control, the burner again goes through its normal starting and operating cycle.

D. FLAME LOSS SEQUENCE

The program relay will recycle automatically each time the operating control closes, or after a power failure. It will lockout following a safety shutdown caused by failure to ignite the pilot, or the main flame, or by loss of flame. Lockout will also occur if flame or flame simulating condition occurs during the prepurge period.

The control will prevent start-up or ignition if limit circuit controls or fuel valve interlocks are open. The control will lock out upon any abnormal condition affecting air supervisory controls wired in the running interlock circuit.

 CAUTION

The lockout switch must be manually reset following a safety shutdown. The cause for loss of flame or any unusual condition should be investigated and corrected before attempting to restart. Failure to follow these instructions could cause damage to the equipment.

1. No pilot flame

The pilot flame must be ignited and proven within a 10-second period after the ignition cycle begins. If not proven within this period, the main fuel valve circuit will not be powered and the fuel valve(s) will not be energized. The ignition circuit is immediately deenergized and the pilot valve closes, the reset switch lights and lockout occurs immediately.

The blower motor will continue to operate. The flame failure light and the alarm bell (optional) are energized 10 seconds later.

The blower motor will be deenergized. The lockout switch must be manually reset before operation can be resumed. (Refer to the previous caution.)

2. Pilot but no main flame

When the pilot flame is proven, the main fuel valve circuit is energized. Depending upon the length of the trial-for-ignition period, the pilot flame will be extinguished 10 or 15 seconds later. The flame detecting circuit will respond to deenergize the main fuel valve circuit within 2 to 4 seconds to stop the flow of fuel. The reset switch lights and lockout occurs immediately. The blower motor will continue to operate.

The flame failure light and alarm bell (optional) are energized 10 seconds later.

The blower motor will be then deenergized. The lockout switch must be manually reset before operation can be resumed. (Refer to the previous caution.)

3. Loss of flame

If a flame outage occurs during normal operation and/or the flame is no longer sensed by the detector, the flame relay will trip within 2 to 4 seconds to deenergize the fuel valve circuit and shut off the fuel flow. The reset switch lights and lockout occurs immediately. The blower motor continues operation. The flame failure light and alarm bell (optional) are energized 10 seconds later.

The blower motor will be deenergized. The lockout switch must be manually reset before operation can be resumed. (Refer to the previous caution.)

If the burner will not start, or upon a safety lockout, the trouble shooting section in the operating manual and the technical bulletin should be referred to for assistance in pinpointing problems that may not be readily apparent.

The program relay has the capability to self-diagnose and to display a code or message that indicates the failure condition. Refer to the control bulletin for specifics and suggested remedies. Familiarity with the program relay and other controls in the system can be obtained by studying the contents of the manual and this bulletin.

Knowledge of the system and its controls will make troubleshooting much easier. Costly down time or delays can be prevented by systematic checks of the actual operation against the normal sequence to determine the stage at which performance deviates from normal. Following a routine may possibly eliminate overlooking an obvious condition, often one that is relatively simple to correct.

Remember, a safety device, for the most part, is doing its job when it shuts down or refuses to operate. Never attempt to circumvent any of the safety features.

Preventive maintenance and scheduled inspection of all components should be followed. Periodic checking of the relay is recommended to see that a safety lockout will occur under conditions of failure to ignite either pilot or main flame, or from loss of flame.

Table: 4-1 Electrical Nomenclature

MNEMONIC	DESCRIPTION
A	
A	Amber (Color Of Pilot Light)
AAFL	Atomizing Air Failure Light
AAFR	Atomizing Air Failure Relay
AAPL	Atomizing Air Proven Light
AAPS	Atomizing Air Proving Switch
AAPS-B	Atomizing Air Proving Switch- Burner
AAPS-C	Atomizing Air Proving Switch- Compressor
AASS	Atomizing Air Selector Switch
AB	Alarm Bell
ACCR	Air Compressor Control Relay
ACM	Air Compressor Motor
ACMCB	Air Compressor Motor Circuit Breaker
ACMF	Air Compressor Motor Fuses
ACMS	Air Compressor Motor Starter
ACMSI	Air Compressor Motor Starter Interlock
AH	Alarm Horn
ALFR	Assured Low Fire Relay
ALWCO	Auxiliary Low Water Cutoff
AM	Ammeter
AMS	Atomizing Media Switch
AOV	Auxiliary Oil Valve
APR	Air Purge Relay
APV	Air Purge Valve
AR	Alarm Relay
AS	Auxiliary Switch (Suffix)
ASR	Alarm Silencing Relay
ASS	Alarm Silencing Switch
ASV	Atomizing Steam Valve
AT	Annunciator Transformer
AWCBDS	Auxiliary Water Column Blowdown Switch
B	
B	Blue (Color of Pilot Light)
BC	Bias Control
BDCS	Breeching Damper Closed Switch
BDOS	Breeching Damper Open Switch
BDRS	Blowdown/Reset Switch
BFPL	Boiler Feed Pump Light
BFPM	Boiler Feed Pump Motor
BFPMCB	Boiler Feed Pump Motor Circuit Breaker
BFPMF	Boiler Feed Pump Motor Fuses
BFPMS	Boiler Feed Pump Motor Starter
BFPS	Boiler Feed Pump Switch
BFTS	Back Flow Temperature Switch
BHS	Boiler - Header Switch
BIOL	Boiler in Operation Light
BIOR	Boiler In Operation Relay
BM	Blower Motor
BMCB	Blower Motor Circuit Breaker
BMCR	Blower Motor Control Relay
BMF	Blower Motor Fuses
BMPR	Blower Motor Power Relay
BMPS	Blower Motor Purge Switch
BMR	Blower Motor Relay

Table: 4-1 Electrical Nomenclature (Continued)

MNEMONIC	DESCRIPTION
BMS	Blower Motor Starter
BMSI	Blower Motor Starter Interlock
BMSS	Boiler Master Selector Switch
BS	Burner Switch
BSS	Boiler Selector Switch
BWPM	Booster Water Pump Motor
BWT	Booster Water Thermostat
C	
CAFL	Combustion Air Failure Light
CAFR	Combustion Air Failure Relay
CAP	Capacitor
CAPS	Combustion Air Proving Switch
CCCB	Control Circuit - Circuit Breaker
CCF	Control Circuit Fuse
CCRS	Control Circuit Reset Switch
CCT	Control Circuit Transformer
CIPL	Changeover In Progress Light
CL	Canopy Light
CLS	Canopy Light Switch
COPS	Changeover Pressure Switch
COR	Changeover Relay
COTD	Changeover Time Delay
CPOL	Control Power on Light
CR	Control Relay
CSSS	Control System Selector Switch
CWPM	Circulating Water Pump Motor
CWPMCB	Circulating Water Pump Motor Circuit Breaker
CWPMF	Circulating Water Pump Motor Fuses
CWPMS	Circulating Water Pump Motor Starter
CWPMSI	Circulating Water Pump Motor Starter Interlock
CWPR	Circulating Water Pump Relay
CWPS	Circulating Water Pump Switch
CWSV	Cooling Water Solenoid Valve
D	
D	Denotes Digester Gas Equipment (Prefix)
DCVM	Direct Current Voltmeter
DG	Draft Gauge
DGHPV	Digester Gas Housing Purge Valve
DHWC	Deaerator High Water Control
DHWL	Deaerator High Water Light
DHWR	Deaerator High Water Relay
DISC	Disconnect (Entrance Switch)
DLWC	Deaerator Low Water Control
DLWL	Deaerator Low Water Light
DLWR	Deaerator Low Water Relay
DM	Damper Motor
DMT	Damper Motor Transformer
DNS	Day-Night Switch
DODE	Delay On Deenergization (Timer)
DOE	Delay On Energization (Timer)
DPS	Damper Positioning Switch
DS	Door Switch
E	
EDS	Emergency Door Switch
ESS	Emergency Stop Switch
ETM	Elapsed Time Meter

Table: 4-1 Electrical Nomenclature (Continued)

MNEMONIC	DESCRIPTION
F	
FADM	Fresh Air Damper Motor
FADR	Fresh Air Damper Relay
FD	Flame Detector
FDJB	Flame Detector Junction Box
FDPS	Flow Differential Pressure Switch
FFA	Flame Failure Alarm
FFL	Flame Failure Light
FFR	Flame Failure Relay
FGR	Flue Gas Recirculation
FGRCDTD	Flue Gas Recirculation Cool Down Time Delay
FGRCPSS	Flue Gas Recirculation Cam Position Switch
FGRFM	Flue Gas Recirculation Fan Motor
FGRFMS	Flue Gas Recirculation Fan Motor Starter
FGRFMSI	Flue Gas Recirculation Fan Motor Starter Interlock
FGRMVLS	Flue Gas Recirculation Manual Valve Limit Switch
FGRTD	Flue Gas Recirculation Time Delay
FORS	First Out Reset Switch
FPM	Feed Pump Motor
FPMS	Feed Pump Motor Starter
FPR	Feed Pump Relay
FPS	Feed Pump Switch
FRI	Firing Rate Interface
FRP	Firing Rate Potentiometer (O2 Trim)
FS	Flow Switch
FSS	Fuel Selector Switch
FSSM	Flame Signal Strength Meter
FVEL	Fuel Valve Energized Light
FVL	Fuel Valve Light
FVR	Fuel Valve Relay
FWC	Feed Water Control
FWVT	Feed Water Valve Transformer
G	
G	Green (Color Of Pilot Light)
GGL	Gauge Glass Light
GOL	Gas Operation Light
GOR	Gas-Oil Relay
GOS	Gas-Oil Switch
GOR	Gas-Oil Relay
GPS	Gas Pressure Sensor
GPV	Gas Pilot Valve
GPVV	Gas Pilot Vent Valve
GR	Gas Relay
GSSV	Gas Sensor Solenoid Valve
GVEL	Gas Valve Energized Light
GVTSS	Gas Valve Test Switch
H	
HATC	High Ambient Temperature Control
HBWTC	High Boiler Water Temperature Control
HBWTL	High Boiler Water Temperature Light
HFAV	High Fire Air Valve
HFGV	High Fire Gas Valve
HFL	High Fire Light
HFOV	High Fire Oil Valve
HFPS	High Furnace Pressure Switch
HFS	High Fire Switch

Table: 4-1 Electrical Nomenclature (Continued)

MNEMONIC	DESCRIPTION
HFS-A	High Fire Switch - Air
HGPL	High Gas Pressure Light
HGPR	High Gas Pressure Relay
HGPS	High Gas Pressure Switch
HHFL	Header High Fire Light
H/LWA	High Low Water Alarm
HLC	High Limit Control
HLFC	High-Low Fire Control
HLPC	High Limit Pressure Control
HLTC	High Limit Temperature Control
HMC	Header Modulating Control
HOPL	High Oil Pressure Light
HOPR	High Oil Pressure Relay
HOPS	High Oil Pressure Switch
HOLC	Header Operating Limit Control
HOTL	High Oil Temperature Light
HOTR	High Oil Temperature Relay
HOTS	High Oil Temperature Switch
HPCO	High Pressure Cutoff
HSPC	High Steam Pressure Control
HSPL	High Steam Pressure Light
HSPR	High Steam Pressure Relay
HSTC	High Stack Temperature Control
HSTL	High Stack Temperature Light
HSTS	High Stack Temperature Switch
HWAR	High Water Alarm Relay
HWC	High Water Control
HWCO	High Water Cutoff
HWL	High Water Light
I	
(I.C.)	Instantaneously Closed
(I.O.)	Instantaneously Open
IL	Ignition Light
INT	Interval (Timer)
IR	Ignition Relay
IT	Ignition Transformer
J	
JPP	Jackshaft Position Potentiometer
L	
LAMPS	Low Atomizing Media Pressure Switch
LASPS	Low Atomizing Steam Pressure Switch
LDL	Load Demand Light
LDPS	Low Differential Pressure Switch
LDS	Low Draft Switch
LFAV	Low Fire Air Valve
LFGV	Low Fire Gas Valve
LFHTD	Low Fire Hold Time Delay
LFL	Low Fire Light
LFOV	Low Fire Oil Valve
LFPS	Low Fire Pressure Switch
LFR	Low Fire Relay
LFS	Low Fire Switch
LFS-A	Low Fire Switch - Air
LFS-F	Low Fire Switch - Fuel
LFS-G	Low Fire Switch - Gas
LFS-O	Low Fire Switch - Oil

Table: 4-1 Electrical Nomenclature (Continued)

MNEMONIC	DESCRIPTION
LFTC	Low Fire Temperature Control
LGPL	Low Gas Pressure Light
LGPR	Low Gas Pressure Relay
LGPS	Low Gas Pressure Switch
LIAPS	Low Instrument Air Pressure Switch
LLPC	Low Limit Pressure Control
LLPR	Low Limit Pressure Relay
LLR	Lead Lag Relay
LLTC	Low Limit Temperature Control
LLTR	Low Limit Temperature Relay
LOPL	Low Oil Pressure Light
LOPR	Low Oil Pressure Relay
LOPS	Low Oil Pressure Switch
LOTL	Low Oil Temperature Light
LOTR	Low Oil Temperature Relay
LOTS	Low Oil Temperature Switch
LPAPS	Low Plant Air Pressure Switch
LPCO	Low Pressure Cutoff
LPS	Low Pressure Switch
LSPAR	Low Steam Pressure Alarm Relay
LSPC	Low Steam Pressure Control
LSPL	Low Steam Pressure Light
LSPR	Low Steam Pressure Relay
LSPS	Low Steam Pressure Switch
LTS	Lamp Test Switch
LWA	Low Water Alarm
LWAR	Low Water Alarm Relay
LWCO	Low Water Cutoff
LWFL	Low Water Flow Light
LWL	Low Water Light
LWR	Low Water Relay
LWRR	Low Water Reset Relay
M	
MA	Milli-amp
MAS	Manual - Automatic Switch
MAM	Micrometer
MC	Modulating Control
MCS	Manual Control Switch
MDM	Modulating Damper Motor
MDMAS	Modulating Damper Motor Auxiliary Switch
MFC	Manual Flame Control (Potentiometer)
MFGRTS	Minimum Flue Gas Recirculation Temperature Switch
MFVL	Main Fuel Valve Light
MFWV	Motorized Feed Water Valve
MGV	Main Gas Valve
MGVAS	Main Gas Valve Auxiliary Switch
MGVEL	Main Gas Valve Energized Light
MGVV	Main Gas Vent Valve
MLC	Modulating Level Control
(MOM)	Momentary
MOV	Main Oil Valve
MOVAS	Main Oil Valve Auxiliary Switch
MOVEL	Main Oil Valve Energized Light
MPC	Modulating Pressure Control
MPCB	Main Power Circuit Breaker
MPP	Manual Positioning Potentiometer

Table: 4-1 Electrical Nomenclature (Continued)

MNEMONIC	DESCRIPTION
(MR)	Manual Reset
MTC	Modulating Temperature Control
MVA	Make-Up Valve Actuator
N	
N	Denotes Natural Gas Equipment (Prefix)
(N.C.)	Normally Closed
(N.O.)	Normally Open
NFL	No Flow Light
NFR	No Flow Relay
NGHPV	Natural Gas Housing Purge Valve
O	
ODA	Outlet Damper Actuator
ODM	Outlet Damper Motor
ODMAS	Outlet Damper Motor Auxiliary Switch
ODMT	Outlet Damper Motor Transformer
ODS	Oil Drawer Switch
OH	Oil Heater
OHCB	Oil Heater Circuit Breaker
OHF	Oil Heater Fuses
OHR	Oil Heater Relay
OHS	Oil Heater Switch
OHT	Oil Heater Thermostat
OLC	Operating Limit Control
OLPC	Operating Limit Pressure Control
OL'S	Thermal Overloads
OLTC	Operating Limit Temperature Control
OMPM	Oil Metering Pump Motor
OMPMF	Oil Metering Pump Motor Fuse
OOL	Oil Operation Light
OPM	Oil Pump Motor
OPMCB	Oil Pump Motor Circuit Breaker
OPMF	Oil Pump Motor Fuses
OPMS	Oil Pump Motor Starter
OPPM	Oil Purge Pump Motor
OPR	Oil Purge Relay
OPRL	Oil Pump Running Light
OPRS	Oil Pressure Sensor
OPS	Oil Pump Switch
OPSPM	Oil Pump Supply Pump Motor
OPV	Oil Purge Valve
OR	Oil Relay
ORV	Oil Return Valve
OSOV	Oil Shutoff Valve
OSPS	O2 Set Point Switch
OSS	Oil Selector Switch
OT	Outdoor Thermostat
OTS	Oil Temperature Sensor
OV	Oil Valve
OVAS	Oil Valve Auxiliary Switch
OVEL	Oil Valve Energized Light
P	
P	Denotes Propane Gas Equipment (Prefix)
PAASV	Plant Air Atomizing Solenoid Valve
PAPS	Purge Air Proving Switch
PC	Pump Control
PCL	Purge Complete Light

Table: 4-1 Electrical Nomenclature (Continued)

MNEMONIC	DESCRIPTION
PCR	Pump Control Relay
PFCC	Power Factor Correction Capacitor
PFFL	Pilot Flame Failure Light
PFFR	Pilot Flame Failure Relay
PFPS	Positive Furnace Pressure Switch
PHGPS	Pilot High Gas Pressure Switch
PIPL	Purge in Progress Light
PIS	Pilot Ignition Switch
PLC	Programmable Logic Controller
PLGPS	Pilot Low Gas Pressure Switch
POL	Power On Light
POV	Pilot Oil Valve
PPL	Pre-Purging Light
PPR	Post Purge Relay
PPTD	Post Purge Time Delay
PR	Program Relay
PRL	Purge Ready Light
PRPTD	Pre-Purge Time Delay
PR	Program Relay
PRPTD	Per-Purge Time Delay
PS	Power Supply
PSF	Power Supply Fuse
PSS	Pump Selector Switch
PSV	Purge Solenoid Valve
PT	Purge Timer
PTS	Pump Transfer Switch
PUCR	Purge Complete Relay
PUR	Purge Relay
R	
R	Red (Color of Pilot Light)
RAR	Remote Alarm Relay
RATD	Remote Alarm Time Delay
RES	Resistor
RML	Run Mode Light
RMR	Release To Modulate Relay
RS	Range Switch
RSR	Remote Start Relay
RTD	Resistance Temperature Detector
S	
SBFPL	Stand By Feed Pump Light
SBFPM	Stand By Feed Pump Motor
SBFPMCB	Stand By Feed Pump Motor Circuit Breaker
SBFPMF	Stand By Feed Pump Motor Fuses
SBFPMS	Stand By Feed Pump Motor Starter
SBOV	Surface Blow Off Valve
SBPS	Sootblower Pressure Switch
SBR	Sootblower Relay
SC	Scanner
SCTS	Supervisory Cock Test Switch
SDL	Steam Demand Light
SHT	Steam Heater Thermostat
SHV	Steam Heater Valve
SLCL	Safety Limits Complete Light
SPIR	System Pump Interlock Relay
SPS	Steam Pressure Sensor
SS	Selector Switch

Table: 4-1 Electrical Nomenclature (Continued)

MNEMONIC	DESCRIPTION
SSC	Sequencing Step Controller
SSL	Safety Shutdown Light
SSR	Solid State Relay
SSV	SpanSolenoid Relay
STHWC	Surge Tank High Water Control
STHWL	Surge Tank High Water Light
STHWR	Surge Tank High Water Relay
STLWC	Surge Tank Low Water Control
STLWL	Surge Tank Low Water Light
STLWR	Surge Tank Low Water Relay
T	
(T.C.)	Timed Closed
(T.O.)	Timed Open
TB	Terminal Block
T/C	Thermocouple
TC	Time Clock
TCR	Time Clock Relay
TD	Time Delay
TDAS	Time Delay Auxiliary Switch
TFWR	Transistorized Feedwater Relay
TPL	Transfer Pump Light
TPM	Transfer Pump Motor
TPMCB	Transfer Pump Motor Circuit Breaker
TPMF	Transfer Pump Motor Fuses
TPMS	Transfer Pump Motor Starter
TPS	Transfer Pump Switch
U	
UVFD	Ultra-Violet Flame Detector
V	
V	Voltmeter
VDR	Voltage Differential Relay
W	
W	White (Color of Pilot Light)
WC	Water Column
WCBDS	Water Column Blow Down Switch
WF	Water Feeder
WFNL	Water Flow Normal Light
WLC	Water Level Control
WO	Denotes Waste Oil Equipment (Prefix)
WTS	Water Temperature Sensor
Y	
Y	Yellow (Color of Pilot Light)

CHAPTER 5

Adjustment Procedures

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A. GENERAL

Each Cleaver-Brooks boiler is tested for correct operation before shipment from the factory. However, variable conditions such as burning characteristics of the fuel and operating load conditions may require further adjustment after installation to assure maximum operating efficiency and economy.

A combustion efficiency analysis made during the initial start-up will help to determine what additional adjustments are required in a particular installation.

Prior to placing the boiler into service, a complete inspection should be made of all controls, connecting piping, wiring, and all fastenings such as nuts, bolts and setscrews to be sure that no damage has occurred, or that adjustments have not changed during shipment and installation.

The adjustment procedures in Chapter 6 apply to standard components furnished on steam or hot water boilers fired with gas and/or the various grades of oil.

B. LINKAGE - MODULATING MOTOR AND AIR DAMPER

The linkage consists of various arms, connecting rods, and swivel ball joints that transmit motion from the modulating motor to the metering valve, to the air damper, and to the gas butterfly valve, if used.

When properly adjusted, a coordinated movement of the damper and metering valves within the limits of the modulating motor travel is attained to provide proper fuel-air ratios through the firing range.

In linkage adjustments there are several important factors that must serve as guides.

1. The modulating motor must be able to complete its full travel range.

CAUTION

Do not restrict the full travel of the modulating motor. Failure to follow these instructions could result in equipment damage.

2. Initial adjustment should be made with the motor in full closed position, that is with the shaft on the power end of the motor in its most counterclockwise position.
3. The closer the linkage rod connector is to the drive shaft, the less the arm will travel; the closer the connector is to the driven shaft, the farther that arm will travel.

Prior to initially firing a boiler it is advisable to check for free movement of the linkage. The damper motor must be allowed to complete its full stroke and the damper must move freely from low to high fire position.

C. MODULATING MOTOR

The modulating motor has a 90° shaft rotation. The motor manufacturer also provides a 160° stroke model for other applications. If a replacement is obtained from someone other than a Cleaver-Brooks Service or Parts representative, it may have an incorrect stroke. To prevent damage, verify the 90° stroke prior to installing a replacement.

The stroke may be determined by powering the motor and connecting terminals R-B to actually determine the stroke as motor drives to an open position.

D. MODULATING MOTOR SWITCHES - LOW FIRE AND HIGH FIRE

The modulating motor contains either one or two internal switches depending upon application. The microswitches are actuated by adjustable cams attached to the motor shaft.

Factory replacement motors have the cams preset. The low fire start switch is set to make the red and yellow leads at approximately 8° on motor closing. The high fire purge air proving switch (located in the modulating motor) is set to make red and blue tracer leads at approximately 60° the on motor opening. Normally the settings are left as is, but job conditions may require readjustment. If the cams require adjustment or resetting, follow the instructions in the manufacturer's technical manual.

E. BURNER OPERATING CONTROLS - GENERAL

Note: Adjustments to the boiler operating controls should be made by an authorized Cleaver-Brooks Service Technician. Refer to the appropriate boiler Operation and Maintenance manual for specific information on boiler startup and operation.

The standard boiler operating control package consists of three separate controls, the High Limit Control, Operating Limit Control and the Modulating control.

The High Limit Control senses the hot water temperature or steam pressure. It is used as a safety limit to turn the burner off in the event the operating limit control fails. The high limit control should be set sufficiently above the operating limit control to avoid nuisance shutdowns.

The Operating Limit Control senses temperature or pressure and automatically turns the burner on to initiate the start-up sequence when required and turns the burner off to initiate the shutdown sequence when the demand is satisfied. The control must be set to initiate startup only at the low fire position.

The Modulating Control senses changes in the hot water temperature or steam pressure and signals the modulating motor to control the flow of fuel and air to the burner. With either steam or hot water boilers, the modulating control must be set to ensure the burner is at its minimum low fire position before the operating limit control either starts or stops the burner.

When adjusting or setting controls, first be sure all control devices are securely mounted and level. With the temperature sensing control, make sure the sensing bulb is properly bottomed in its well and is secured against movement. Be sure the connecting tubing is not kinked.

The dial settings are generally accurate; although it is not unusual to have a slight variation between a scale setting and an actual pressure gauge or thermometer reading. Always adjust control setting to agree with pressure gauge or thermometer readings. Accurate instrument readings are required. When necessary use auxiliary test equipment to set controls.

Burner controls correctly set to match load demands will provide operational advantages and achieve the following desirable objectives:

- The burner will be operating in low fire position prior to shut down.
- The burner will operate at low fire for a brief period on each start during normal operation.
- Eliminates frequent burner on-off cycling.

Separate and independent controls affect modulated firing and burner on-off cycling. Figure 5-3 depicts a typical setting relationship of the operating limit control, modulating control and the high limit control.

The burner will be “on” whenever the pressure or temperature is less than point **B** and “off” whenever pressure or temperature is greater than point **A**. The distance between points **A** and **B** represents the “on-off” differential of the operating limit control.

In normal operation, the burner will shut down whenever the pressure or temperature rises above setting **A**. At that point the switch in the operating limit control will open. As the pressure or temperature drops back to **B**, the operating limit control closes and the burner will restart. The modulating control will signal the modulating motor to be in a low fire position. If the load demands exceed the low fire input potential, the modulating control will increase the firing rate proportionately as pressure or temperature falls toward point **D**. The modulating motor will stop at any intermediate point between **C** and **D** whenever the fuel input balances the load requirement.

As the load requirement changes, the firing rate will change accordingly. Thus it is referred to as **modulated firing**.

Point **D** represents the maximum firing rate of the burner, or highfire. In the event pressure or temperature drops while the burner is firing at highfire, it indicates that the load exceeds the capacity of the boiler.

The firing graph (Figure 5-1) shows that point **B** and point **C** do not coincide. Extreme load conditions could require the points be closely matched.

When set as shown, with a time lag between **B** and **C**, the burner will be in a low fire position upon a restart and will fire at that rate for a short period of time before falling pressure or temperature requires an increase in the firing rate.

CAUTION

Excessive cycling increases the potential and severity of internal condensation. On-Off cycling should be limited to eight (8) cycles or less per hour to keep the blower motor from overheating and excessive wear on the switch gear and pilot. Failure to follow these instructions could result in damage and premature failure of the equipment.

If points B and C overlap when restart occurs, the burner would drive to a higher firing position immediately after the main flame was proven.

Note: It is not recommended that the boiler controls be set so as to overlap the modulating control range and operating control range.

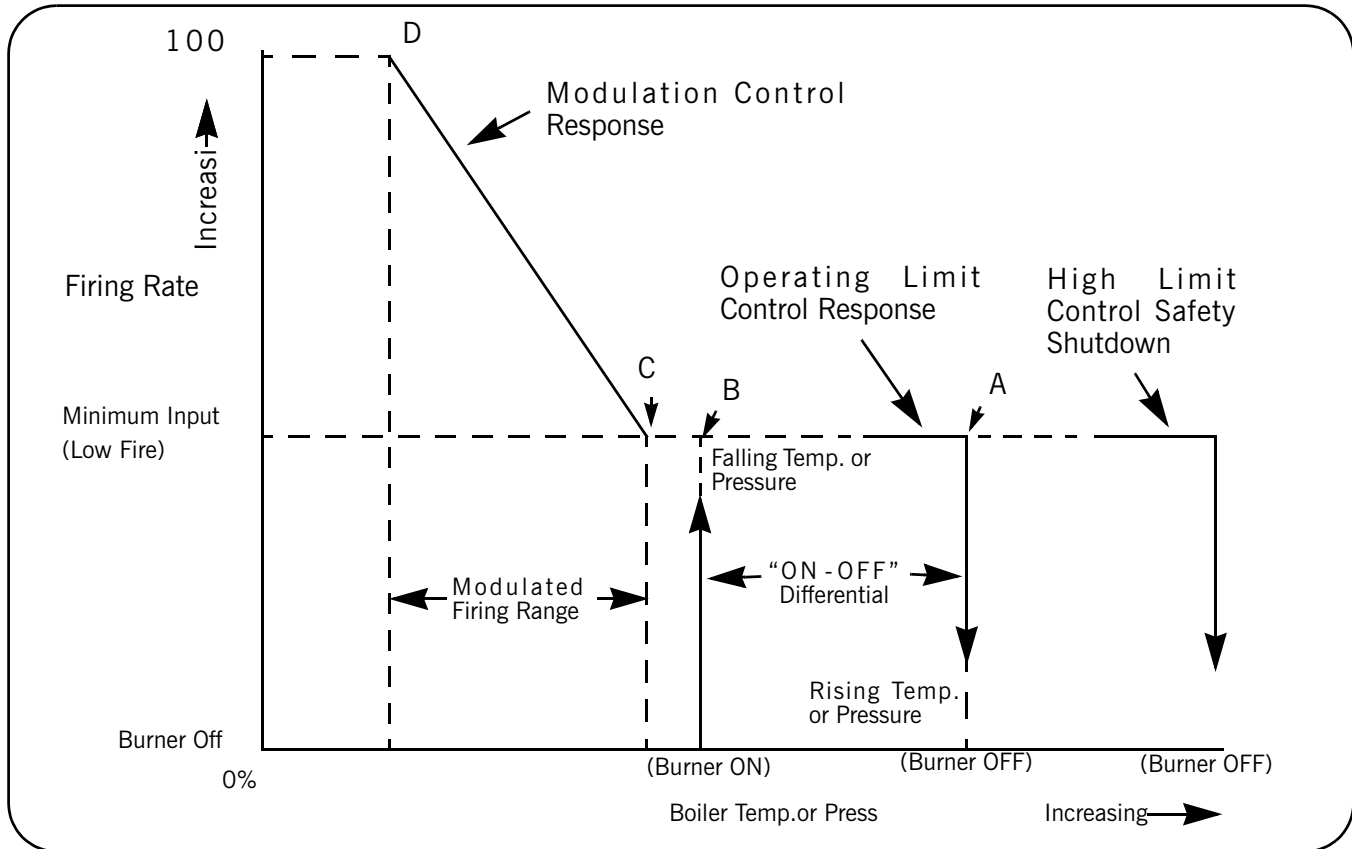


Figure 5-1: Firing Graph

When firing a cold boiler, it is recommended that the burner be kept at low fire, under manual flame control, until normal operating pressure or temperature is reached. If the burner is not under manual control on a cold start, it will immediately move toward high fire as soon as the program control releases the circuit that holds the burner in low fire. The modulating control will be calling for high fire and the burner will move to that position as rapidly as the damper motor can complete its travel.

Note: Rapid heat input can subject the pressure vessel metal and refractory to undesirable conditions.

Do not operate the boiler in excess of 90% of the safety valve relief setting. The closer the operating pressure is to the safety valve relief pressure, the greater the possibility of valve leakage. Continued leakage, however slight, will cause erosion and necessitate early safety valve replacement. The control settings on a hot water boiler must be within the temperature limits of the boiler.

Ideally, the boiler operating controls should be set under actual load conditions. Especially under new construction conditions, the boiler is initially started and set to operate under less than full load requirements. As soon as possible thereafter, the controls should be reset to provide maximum utilization of the modulating firing system. To accomplish maximum utilization, and assuming that air/fuel combustion ratios have been set, make the required adjustments to the controls to bring the boiler pressure or temperature up to meet the load requirements.

To properly set the modulating control, carefully adjust it under load conditions, until the load is maintained with the burner firing at a steady rate. The firing rate at that point may be full high fire or slightly less, depending upon the relationship of the boiler size to the load.

When the modulating control is set and the burner is in full high fire, the scale setting of the modulating pressure control on a steam boiler will indicate the low point of the modulating range. The scale setting of the modulating temperature control on a hot water boiler will have a reading that indicates the midpoint of the modulating range.

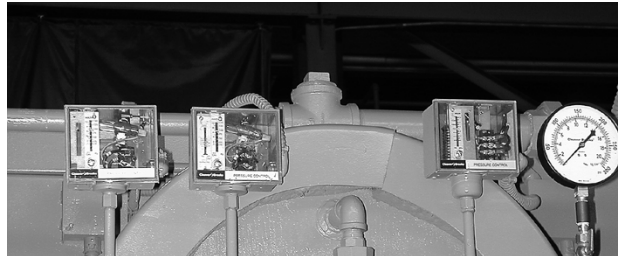
The operating limit control should now be adjusted and the differential established. In an installation that does not require a very close control of steam pressure or water temperature the adjustable differential (Figure 5-3 A to B) should be set as wide as conditions permit, since a wide setting will provide less frequent burner cycling.

The high limit control provides a safety factor to shut the burner off in the event the operating limit control should fail. The setting of the control should be sufficiently above the operating limit control to avoid nuisance shutdowns. The setting, however, must be within the limits of the safety valve settings and should not exceed 90% of the valve setting. The control requires manual resetting after it shuts off the burner.

In the setting of the controls, consideration must be given to the time required for a burner restart. Each start, requires a prepurge period, plus the fixed time required for proving the pilot and main flame. In addition, approximately one-half minute is required for the damper motor to travel from low to high fire. The time lag may allow pressure or temperature to drop below desirable limits.

F. MODULATING PRESSURE CONTROL (Steam)

Turn the adjusting screw until the indicator is opposite the low point of the desired modulating range. Modulated firing will range between the low point and a higher point equal to the modulating range of the particular control. In 0-15 psi controls the range is 1/2 psi.



⚠ CAUTION

To prevent burner shutdown at other than low-fire setting, adjust the modulating pressure control to modulate to low fire BEFORE the operating limit pressure control shuts off the burner. Failure to follow these instructions could result in damage to the equipment

Figure 5-2: Steam Controls

G. OPERATING LIMIT PRESSURE CONTROL (Steam)

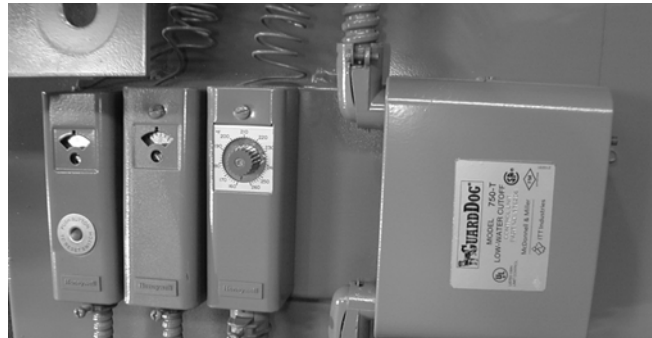
Set the “cut-out” (burner-off) pressure on the main scale using the large adjusting screw. Set the differential on the short scale by turning the small adjusting screw until the indicator points to the desired difference between cut-out and cut-in pressures. The “cut-in” (burner-on) pressure is the cut-out pressure MINUS the differential. The cut-out pressure should not exceed 90% of the safety valve setting.

H. HIGH LIMIT PRESSURE CONTROL (Steam)

Set “cut-out” (burner off) pressure on the main scale using the adjusting screw. The control will break a circuit when pressure reaches this point. The setting should be sufficiently above the operating limit pressure control to avoid shutdowns, and preferably not exceed 90% of safety valve setting. The control requires manual resetting after tripping on a pressure increase. To reset, allow pressure to return to normal and then press the reset button.

I. MODULATING TEMPERATURE CONTROL (Hot Water)

Turn the knob on the front of the case until the pointer indicates the desired setpoint temperature. The desired set point is the center point of a proportional range. The control has a 3 to 30° differential and may be adjusted to vary the temperature range within which modulating action is desired. With the cover off, turn the adjustment wheel until pointer indicates desired range.



⚠ CAUTION

To prevent burner shutdown at other than low-fire setting adjust modulating temperature control to modulate low fire BEFORE operating limit temperature control shuts off burner. Failure to follow these instructions could result in damage to the equipment.



Figure 5-3: Hot Water Controls

J. OPERATING LIMIT TEMPERATURE CONTROL (Hot Water)

Set “cut-out” (burner off) temperature on the scale by inserting a screwdriver through the cover opening to engage the slotted head adjusting screw. The “cut-in” (burner on) temperature is the cut-out temperature MINUS the differential. The differential is adjusted from 5 to 30° F.

K. HIGH LIMIT TEMPERATURE CONTROL (Hot Water)

Set the “cut-out” (burner off) temperature on scale using the adjusting screw. The control will break the circuit and lock out on a rise in water temperature above the setting. The setting should be sufficiently above the operating limit temperature to avoid unnecessary shutdowns. The control requires manual resetting after tripping on a temperature increase. To reset, allow the water temperature to drop below the cut-out setting less differential, and then press the manual reset button.

L. LOW WATER CUTOFF DEVICES (Steam and Hot Water)

No adjustment is required since LWCO controls are preset by the original manufacturer. However, if the water level is not maintained, inspect the devices immediately and replace as required.

M. COMBUSTION AIR PROVING SWITCH

Air pressure against the diaphragm actuates the switch which, when made, completes a circuit to prove the presence of combustion air. Since the pressure of the combustion air is at its minimum value when the damper is full closed, the switch should be adjusted under that situation. It should be set slightly below the minimum pressure, but not too close to that point to cause nuisance shutdowns.

The run/test switch on the program relay should be set to TEST. Turn the burner switch on. The blower will start (provided that all limit circuits are completed) and the programmer will remain in the low-fire (damper closed) portion of the prepurge.

Slowly turn down the air switch adjusting screw until it breaks the circuit. Here the programmer will lock out and must be manually reset before it can be restarted. Add a half turn or so to the adjusting screw to remake its circuit.

Recycle the program relay to be sure that normal operation is obtained. Return the test switch to the RUN position.

N. GAS PILOT FLAME ADJUSTMENT

The size of the gas pilot flame is regulated by adjusting the gas flow through the pilot gas regulator. The flame must be sufficient to ignite the main flame and to be seen by the flame detector. But an extremely large flame is not required. An overly rich flame can cause sooting or carbon buildup on the igniting electrode. Too small a flame can cause ignition problems.

Although it is possible to visibly adjust the size of the pilot flame, it is preferable to obtain a microamp or voltage reading of the flame signal.

The correct voltage or microamp readings can be found in the information supplied with the flame safeguard system.

The program relay used may be of the type that provides message information that includes a constant flame signal of dc voltage. In this case a separate dc voltmeter is not required.

O. GAS PRESSURE AND FLOW INFORMATION

Because of variables in both the properties of gas and the supply system, it will be necessary to regulate the pressure of the gas to a level that produces a steady, dependable flame that yields highest combustion efficiency at rated performance yet prevents overfiring. Once the optimum pressure has been established, it should be recorded and periodic checks made to verify that the regulator is holding the pressure at this level. Occasional modification in fuel composition or pressure by the supplier may, at times, require readjustment to return the burner to peak efficiency.

Pressure

The gas supplied must provide not only the quantity of gas demanded by the unit, but must also be at a pressure high enough to overcome the pressure-loss due to the frictional resistance imposed by the burner system and the control valves.

The pressure required at the entrance to the burner gas train for rated boiler output is termed "inlet pressure." The gas pressure regulator must be adjusted to achieve the pressure to assure full input.

The inlet pressure requirement varies with boiler size, and types of gas train. Refer to Table 6-3 for pressure requirements.

The pressures listed are based on 1000 Btu/cu-ft natural gas at elevations up to 700 feet above sea level.

The volume of gas flow is measured in terms of cubic feet and is determined by a meter reading. The gas flow rate required for maximum boiler output depends on the heating value (Btu/cu-ft) of the gas supplied (Table 5-1).

Pressure Correction

The flow rate outlined in Section P is based on a "base" pressure, which is usually atmospheric or 14.7 psia.

Meters generally measure gas in cubic feet at "line" or supply pressure. The pressure at which each cubic foot is measured and the correction factor for the pressure must be known in order to convert the quantity indicated by the meter into the quantity which would be measured at "base" pressure.

To express the volume obtained from an actual meter reading into cubic feet at base pressure, it is necessary to multiply the meter index reading by the proper pressure factor obtained from Table 6-2

As An Example:

Assume that a 500Flextube boiler is rated for 5MMBtu/hr input is installed and equipped with a standard gas train; and that 1,000 Btu natural gas is available with an incoming gas pressure of 3 psig. The flow requirements can be determined as follows:

Flow

Since the gas flow rate is based on standard conditions of flow, correction must be made for the supply pressure through the meter of 3 psig. Determine the flow rate by dividing the Btu content of the gas into the burner input (Table 6-1) and “correct” this answer by applying the correction factor for 3 psig (Table 6-2).

$$\frac{\text{Btu/hr Input}}{\text{Btu/cu-ft}} = \text{CFH (Cubic feet/hour) Required}$$

OR

$$\frac{5,000,000}{1.18} = 5,000 \text{ CFH (At 14.7 lb-atmospheric base 1,000 pressure)}$$

THEN

$$\frac{5,000}{1.18} = 4237 \text{ CFH}$$

This is the CFH (at line pressure) that must pass through the meter so that the equivalent full input requirement of 5,000 CFH (at base pressure) will be delivered.

Checking Gas Flow

Your gas supplier can generally furnish a gas meter flow chart from which gas flow can be determined. After a short observation period, the information aids in adjusting the regulator to increase or decrease flow as required to obtain the rating.

Final adjustment of the gas fuel is carried out by means of Fine tuning the linkage adjustments, while performing a combustion efficiency analysis. See Section O for details.

Note: The information given in this section is for all practical purposes sufficient to set and adjust controls for gas input. Your gas supplier can, if necessary, furnish exact correction factors that take into consideration Btu content, exact base pressure, specific gravity, temperature, etc., of the gas used.

P. GAS FUEL COMBUSTION ADJUSTMENT

After operating for a sufficient period of time to assure a warm boiler, adjustments should be made to obtain efficient combustion.

Burner efficiency is measured by the amount or percentage of O₂ present in the flue gas. O₂ readings determine the total amount or excess air in the combustion process, above the point of stoichiometric combustion or perfect combustion. Stoichiometric combustion is a term used to describe a condition when there is the exact amount, molecule for molecule, of air for the fuel attempting to be burned. This can be accomplished under laboratory conditions, however it's not practical to attempt to meet this condition in a boiler. Stoichiometric combustion however, is the reference point used when setting fuel/air ratios in a boiler.

There must always be excess air in the combustion process to account for changes in boiler room temperature and atmospheric conditions, and to ensure the combustion is on the proper side of the combustion curve.

Proper setting of the air/fuel ratios at all rates of firing must be established by the use of a combustion or flue gas analyzer. The appearance or color of the gas flame is not an indication of its efficiency, because an efficient gas flame will vary from transparent blue to translucent yellow.

Most flue gas analyzers in use today measure the content, by percentage of oxygen (O₂) and carbon monoxide (CO) either by percent or parts per million (ppm). Carbon dioxide (CO₂) is not normally measured with today's flue gas analyzers, but may be displayed via a calculation.

The O₂ levels through the entire firing range of the burner, low fire to high fire should be tested. Cleaver-Brooks recommendations on turndown should also be followed and the turndown range of the burner should not be exceeded.

It's important to understand what the readings shown on an instrument refer to when setting combustion in a boiler. To assist with this understanding Figure 5-5 shows the relationship between O₂ levels (excess air) and the products of combustion for a typical flue gas analysis (natural gas).

One of the products of combustion is CO₂ (Carbon Dioxide). This is shown in percentage.

Another product of combustion is CO (carbon monoxide) and is shown in both percentage and parts per million (ppm). The maximum CO level standardly allowed is less than 400 ppm. However, this may change subject to local regulations.

The percent O₂ recorded on an instrument equates to percent excess air, I.E. 3% O₂ is approximately 15% excess air and 4% O₂ is approximately 20% excess air. The exact percentage of excess air is a mathematical calculation based on an ultimate fuel analysis of the fuel being fired.

It is generally recommended that O₂ readings of between 3% to 5% be attained with less than 400 ppm CO, at high fire.

Using information from Section O, determine the standard conditions of gas pressure and flow for the size boiler and the gas train on it. Calculate the actual pressure and flow through the use of correction factors that compensate for incoming gas pressure and altitude.

Basically, gas adjustments are made with a gas pressure regulator, which controls the pressure and with the butterfly gas valve which directly controls the rate of flow.

The low fire setting should be regarded as tentative until the proper gas pressure for high fire operation is established.

To reach the high fire rate, turn the manual flame control switch toward "OPEN" in minor increments while monitoring combustion for overly rich or lean conditions.

At high fire, the gas butterfly valve should be open as wide as indicated by the slot on the end of the shaft.

Determine the actual gas flow from a meter reading. (See Section O). With the butterfly valve open and with regulated gas pressure set at the calculated pressure, the actual flow rate should be close to the required input. If corrections are necessary, increase or decrease the gas pressure by adjusting the gas pressure regulator, following the manufacturer's directions for regulator adjustment.

When proper gas flow is obtained, take a flue gas reading. The O₂ should be between 3% and 5% at high fire.

If the fuel input is correct, but the O₂ values do not fall within this range, the air damper settings may need to be adjusted. Adjustment of the air damper linkage is described in Section B of Chapter 6.

With the high-fire air/fuel ratio established, the gas pressure regulator needs no further adjusting.

After being certain that the air control damper and its linkage are correctly adjusted to provide the proper amount of secondary air, and after adjusting the gas pressure regulator, final adjustment can be made, if necessary obtain a constant air/fuel ratio throughout the entire firing range.

Input of combustion air is ordinarily fixed at any given point in the modulating cycle, the flue gas reading is determined by varying the input of gas fuel at that setting. Standard Burner Low Fire Adjustment

The fuel input should be adjusted using the linkage to approximately 33% of that at high fire. At low fire the O₂ flue gas reading should be between 3-5%.

If the air damper needs to be adjusted in order to provide the correct low fire air/fuel ratio, combustion must be rechecked at higher firing rates and adjusted as required.

Q. LOW GAS PRESSURE SWITCH

Adjust the scale setting to slightly below the normal burning pressure. The control circuit will be broken when pressure falls below this point. Since gas line distribution pressure may decrease under some conditions, shutdowns may result if the setting is too close to normal. However, regulations require that the setting may not be less than 50% of the rated pressure downstream of the regulator.

Manual resetting is necessary after a pressure drop. Press the reset lever after pressure is restored. Be sure that the mercury switch equipped control is level.

R. HIGH GAS PRESSURE SWITCH

Adjust the scale setting to slightly above the normal burning pressure. The control circuit will be broken when pressure exceeds the normal operating pressure. Unnecessary shutdowns may result if the setting is too close to normal; however, regulations require that the setting may not be greater than 150% of rated pressure.

Manual resetting is necessary after a pressure rise. Press the reset lever after pressure falls. Be sure that the mercury switch equipped control is level.

S. FUEL OIL PRESSURE AND TEMPERATURE - GENERAL

Variations in burning characteristics of the fuel oil may occasionally require adjustments to assure highest combustion efficiency. The handling and burning characteristics may vary from one delivery of oil to another. Therefore, it is recommended that the oil system be inspected from time to time to verify that pressures and viscosity are at the proper operating levels.

Because of variation in oils, including chemical content, source, blends, and viscosity characteristics, the temperatures and pressures listed in Chapter 5, and mentioned in the adjusting of the controls in the following paragraphs, will vary and thus may be regarded as tentative and to be changed to provide best firing conditions. Review of the applicable maintenance instructions given in Chapter 8 will aid in maintaining an efficient fuel system.

Table: 5-1 Fuel Consumption (Natural Gas)

MODEL NO.	150	200	250	300	350	400	450	500	550	600	700	800	900	1000	1100	1200
Fuel Consumption Gas (cfh) ^A	1500	2000	2500	3000	3500	4000	4500	5000	5500	6000	7000	8000	9000	10000	11000	12000

A. Natural Gas @ 1000 Btu/cu-ft.

REGULATOR INLET PRESSURE (PSIG)	PRESSURE FACTOR
1	1.05
2	1.11
3	1.18
4	1.25
5	1.32
6	1.39
7	1.45
8	1.53
9	1.59
10	1.66
11	1.72
12	1.81
13	1.86
14	1.93
15	2.00

MODEL NO.	STD GAS TRAIN SIZE (IN.) Note 3	MIN. GAS PRES- SURE (IN.W.C.) Note 4	MIN. GAS PRES- SURE (IN.W.C.) Note 5	BURNER MODEL
FLX-150	1	11.2	12.5	PFVG-15
FLX-200	1	19.4	21.7	PFVG-20
FLX-250	1.5	12.4	15.7	PFVG-25
FLX-300	1.5	15.9	20.7	PFVG-30
FLX-350	1.5	15.5	22.0	PFVG-35
FLX-400	1.5	18.7	27.2	PFVG-40
FLX-450	2	16.0	26.7	PFVG-45
FLX-500	2	17.6	21.0	PFVG-50
FLX-550	2	22.9	27.1	PFVG-55
FLX-600	2	20.0	24.9	PFVG-60
FLX-700	2	25.2	31.9	PFVG-70
FLX-800	2.5	19.9	22.2	PFVG-80
FLX-900	2.5	24.7	27.7	PFVG-90
FLX-1000	2.5	31.6	31.6	PFVG-100
FLX-1100	2.5	37.3	37.3	PFVG-110
FLX-1200	2.5	38.2	38.2	PFVG-120

Notes:

1. Table is based on 1,000 Btu/cu.ft natural gas and elevation to 1000 feet.
2. Minimum gas pressure also applies to 200 fuel series.
3. As an option, the standard gas train can be replaced with an oversized design to reduce inlet gas pressure requirements.
4. Use this column for all U.S. Installations.
5. Use this column for all Canadian Installations.

T. FUEL OIL COMBUSTION ADJUSTMENT

After operating for a sufficient period of time to assure a warm boiler, adjustments should be made to obtain efficient combustion.

Burner efficiency is measured by the amount or percentage of O_2 present in the flue gas. O_2 readings determine the total amount or excess air in the combustion process, above the point of stoichiometric combustion or perfect combustion. Stoichiometric combustion however, is the reference point used when setting fuel/air ratios in a boiler.

There must always be excess air in the combustion process to account for changes in boiler room conditions and to ensure the combustion is on the proper side of the combustion curve .

Proper setting of the air/fuel ratios at all rates of firing must be established by the use of a combustion gas analyzer. Efficient combustion cannot be solely judged by flame condition or color, although they may be used in making approximate settings. Combustion settings should be done so that there is a bright sharp flame with no visible haze.

Most flue gas analyzers in use today measure the content, by percentage, of oxygen (O_2) and in some cases, smoke. Carbon dioxide (CO_2) is not normally measured with modern gas analyzers, but may be displayed as a calculation.

The O_2 levels through the entire firing range of the burner, low fire to high fire should be tested. Cleaver-Brooks recommendations on turndown should also be followed and the turndown range of the burner should not be exceeded.

It is required to set the burner to operate with a reasonable amount of excess air to compensate for minor variations in the pressure, temperature, or burning properties of oil. Fifteen to 20% excess air is considered reasonable. This would result in an O_2 reading of 3% to 4%, at high fire.

Final adjustment to fuel input must be made to produce a minimum of smoke. A maximum smoke spot density of a No. 2 for light oil, as measured in conformance to ASTM D 2156-63T.

Through the use of the manual flame control, slowly bring the unit to high fire by stages while monitoring combustion for overly rich or lean conditions. At the high fire position, the air damper should be fully opened.

U. LOW OIL PRESSURE SWITCH

The L.O.P.S. prevents burner ignition, or stops its operation, when the oil pressure is below the setpoint. Adjust the control by turning the screw on top of control case to an indicated pressure 10 psi below the established primary oil pressure setting indicated on the oil supply pressure gauge. The switch will remain in a closed position as long as the oil pressure exceeds this setting. The control normally used automatically resets when pressure is restored after a drop.

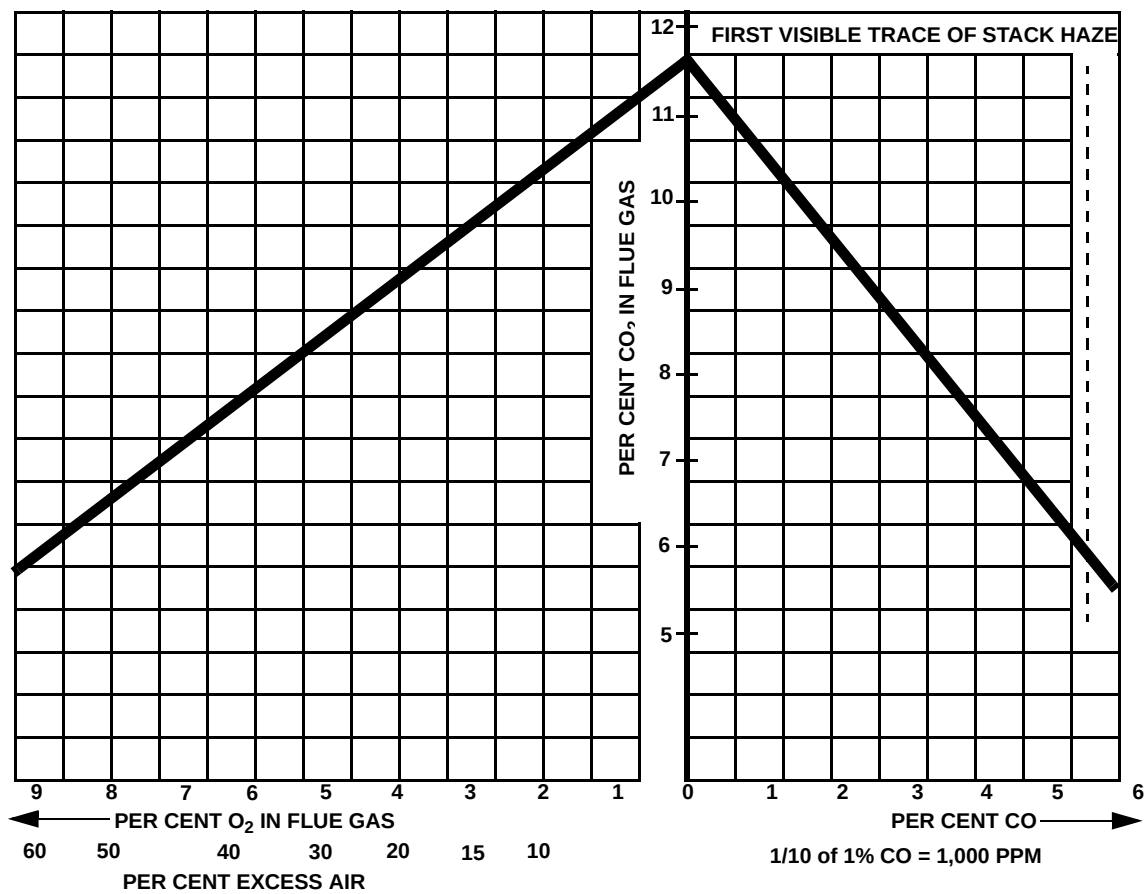


Figure 5-4: Flue Gas Analysis Chart for Natural Gas

CHAPTER 6

Troubleshooting



Troubleshooting should be performed only by personnel who are familiar with the equipment and who have read and understand the contents of this manual. Failure to follow these instructions could result in serious personal injury or death.



Disconnect and lock out the main power supply in order to avoid the hazard of electrical shock. Failure to follow these instructions could result in serious personal injury or death.

Chapter 7 assumes that the unit has been properly installed and adjusted, and that it has been running for some time. It is further assumed that the operator has become thoroughly familiar with both burner and manual by this time. The points under each heading are set down briefly as possible causes, suggestions or clues to simplify locating the source of trouble. Methods of correcting the trouble, once it has been identified, may be found elsewhere in this manual.

If the burner will not start or operate properly, the trouble shooting chapter should be referred to for assistance in pinpointing problems that may not be readily apparent.

The program relay has the capability to self-diagnose and to display a code or message that indicates the failure condition. Refer to the control bulletin for specifics and suggested remedies.

Familiarity with the programmer and other controls in the system may be obtained by studying the contents of this manual. Knowledge of the system and its controls will make trouble shooting much easier. Costly down-time or delays can be prevented by systematic checks of actual operation against the normal sequence to determine the stage at which performance deviates from normal. Following a routine may possibly eliminate overlooking an obvious condition, often one that is relatively simple to correct.

If an obvious condition is not apparent, check the continuity of the circuits with a voltmeter or test lamp. Each circuit can be checked and the fault isolated and corrected. Most circuitry checking can be done between appropriate terminals on the terminal boards in the control cabinet or the entrance box. Refer to the schematic wiring diagram for terminal identification.

Problem	Solution
BURNER DOES NOT START	- No voltage at program relay power input terminals. - Main disconnect switch open. - Blown control circuit fuse. - Loose or broken electrical connection. - Program relay safety switch requires resetting. - Limit circuit not completed—no voltage at end of limit circuit program relay terminal. - Pressure or temperature is above setting of operation control. (Load demand light will not glow.) - Water below required level. - Low-water light (and alarm horn) should indicate this condition. - Check manual reset button, if provided, on low-water control. - Fuel pressure must be within settings of low pressure and high pressure switches. - Fuel valve interlock circuit not completed. - Fuel valve auxiliary switch not enclosed.
NO IGNITION	- Lack of spark. - Electrode grounded or porcelain cracked. - Improper electrode setting. - Loose terminal on ignition cable; cable shorted. - Inoperative ignition transformer. - Insufficient or no voltage at pilot ignition circuit terminal. - Spark but no flame. - Lack of fuel - no gas pressure, closed valve, empty tank, broken line, etc. - Inoperative pilot solenoid. - Insufficient or no voltage at pilot ignition circuit terminal. - Too much air. - Low fire switch open in low fire proving circuit. - Damper motor not closed, slipped cam, defective switch. - Damper jammed or linkage binding. - Running interlock circuit not completed. - Combustion air proving switch defective or not properly set. - Motor starter interlock contact not closed. - Flame detector defective, sight tube obstructed, or lens dirty.

Problem	Solution
PILOT FLAME, BUT NO MAIN FLAME	1. Insufficient pilot flame.
	2. Gas Fired Unit. A. Manual gas cock closed. B. Main gas valve inoperative. C. Gas pressure regulator inoperative.
	3. Oil fired unit. A. Oil supply cut off by obstruction, closed valve, or loss of suction. B. Supply pump inoperative. C. No fuel. D. Main oil valve inoperative. E. Check oil nozzle, gun and lines.
	4. Flame detector defective, sight tube obstructed or lens dirty.
	5. Insufficient or no voltage at main fuel valve circuit terminal.
BURNER STAYS IN LOW FIRE	1. Pressure or temperature above modulating control setting.
	2. Manual-automatic switch in wrong position.
	3. Inoperative modulating motor.
	4. Defective modulating control.
	5. Binding or loose linkage, setscrews, etc.
SHUTDOWN OCCURS DURING FIRING	1. Loss or stoppage of fuel supply.
	2. Defective fuel valve; loose electrical connection.
	3. Flame detector weak or defective.
	4. Lens dirty or sight tube obstructed.
	5. If the programmer lockout switch has not tripped, check the limit circuit for an opened safety control.
	6. If the programmer lockout switch has tripped: A. Check fuel lines and valves. B. Check flame detector. C. Check for open circuit in running interlock circuit. D. The flame failure light is energized by ignition failure, main flame failure, inadequate flame signal, or open control in the running interlock circuit.

Problem	Solution
SHUTDOWN OCCURS DURING FIRING cont'd	7. Improper air/fuel ratio (lean fire). A. Slipping linkage. B. Damper stuck open. C. Fluctuating fuel supply. 1). Temporary obstruction in fuel line. 2). Temporary drop in gas pressure. 8. Interlock device inoperative or defective.
MODULATING MOTOR DOES NOT OPERATE	1. Manual-automatic switch in wrong position.
	2. Linkage loose or jammed.
	3. Motor does not drive to open or close during pre-purge or close on burner shutdown. A. Motor defective. B. Loose electrical connection. C. Damper motor transformer defective.
	4. Motor does not operate on demand. A. Manual/automatic switch in wrong position. B. Modulating control improperly set or inoperative. C. Motor defective. D. Loose electrical connection. E. Damper motor transformer defective.
EXCESSIVE RUST ON TUBES	1. Condensation of the flue gases on cool tubes is causing rust. A. Change system so return temperatures are above 120 °F or install blend pump to assure water temperatures entering boiler are above 120 °F.
	2. Open stack or condensate running down stack or breeching. A. Stack should be offset. Insulate and drain stack.
	3. Frequent cold starts. A. Reset controls for less cycling.

Problem	Solution
WATER ON BASE	1. A cold environment and/or intermittent firing may allow inner casing to heat up above the condensation temperature of the flue gasses. A. Increase temperature of the cold boiler room if possible. B. Verify insulation is in place between inner and outer casing and replace if missing. C. Reset controls for less cycling to allow boiler to run for longer periods of time to heat inner casing above condensation temperature.
	2. Cold system startup. A. Any time a boiler is started with a cold system, it will produce condensate until internal surface temperatures exceed 130 °F. Internal condensation will not be produced once a boiler has warmed up. Condensate will dry up after a short time. Limit number of cold starts.
	3. Cold return temperatures. A. Return temperatures below 120 °F. will continually produce condensation. Raise return temperatures above 120 °F.
	4. Gasket leaks allow gases to escape and condense on relatively cool base. A. Gasket may need to be replaced or inner casing not installed per instructions. Install inner casing and gasket per instructions outlined in Chapter 8, Section D.

CHAPTER 7

Inspection and Maintenance

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A. General

A well-planned maintenance program will help to avoid unnecessary downtime or costly repairs, promote safety, and aid boiler inspectors in performing required periodic inspections. An inspection schedule with a listing of procedures should be established. It is recommended that a boiler room log or record be maintained. Recording of daily, weekly, monthly, and yearly maintenance activities provides a valuable guide and aids in obtaining safe, economical and lengthy service from your Cleaver-Brooks equipment. It is important to realize that the frequency of inspection will depend on variable conditions such as load, fuel, system requirements, boiler environment, etc.



Shut off electrical power to the boiler when performing any service or maintenance work or work that requires removal of covers or component parts. Failure to heed this warning could result in electrical shock, serious personal injury or death.

Good housekeeping practices help maintain a professional appearing boiler room. Only trained and authorized personnel should be permitted to operate, adjust, or repair the boiler and related equipment. The boiler room should be kept free of all material and equipment not necessary to the operation of the boiler or heating system.

Even though the boiler has electrical and mechanical devices that make it automatic or semiautomatic in operation, the devices require systematic and periodic maintenance. Any “automatic” feature does not relieve the operator from responsibility. Automatic features do free the operator of certain repetitive chores, thus providing more time to devote to upkeep and maintenance.

Alertness in recognizing an unusual noise, improper gauge reading, leaks, etc., can make the operator aware of a developing malfunction, permitting prompt corrective action that may prevent extensive repairs or unexpected downtime. Any leaks - fuel, water, steam combustion gases - should be investigated and repaired with all due consideration of the necessary safety precautions.

Preventative maintenance measures such as regularly checking the tightness of connections, locknuts, setscrews, packing glands, etc., should be included in regular maintenance activities.



Inspection and maintenance should be performed only by trained personnel who are familiar with the equipment. Failure to heed this warning could result in serious personal injury or death.

B. Periodic Inspection

Insurance regulations or local codes may require a periodic inspection of the pressure vessel by an authorized inspector. Inspections are usually scheduled for periods of normal boiler downtime such as during an off season. The major inspection can often be used to accomplish maintenance, replacement, or repair tasks that cannot easily be done at other times. This also serves as a good basis for establishing a schedule for annual, monthly, or other periodic maintenance programs.

While the inspection pertains primarily to the waterside and fireside surfaces of the pressure vessel, it provides the operator with an excellent opportunity to perform a detailed check of all components of the boiler, including piping, valves, pumps, gaskets, refractory, etc. Complete cleaning, spot painting or repainting, and the replacement of expendable items, should be planned for and taken care of during this time. If possible, any major repairs or replacements that may be required should be taken care of during the boiler shutdown.

Replacement spare parts, if not on hand, should be ordered well in advance of a shutdown.

Note: Cleaver-Brooks genuine parts should be used to ensure proper operation and to avoid damage to the equipment.

Cleaver-Brooks boilers are designed, engineered and built to give long life and excellent service. Good operating practices and consistent maintenance and care will promote efficiency and economy of operation and contribute to many years of reliable performance from the equipment.

Cleaver-Brooks offers a Planned Maintenance Program that covers many of the items included on this chapter. For more information on the Planned Maintenance Program, contact your local Cleaver-Brooks authorized representative.

C. Fireside Cleaning

Soot and other noncombustible deposits are effective insulators and, if allowed to accumulate on boiler heat exchanger surfaces, will reduce heat transfer to the water and increase fuel consumption. Soot and other deposits can absorb moisture and may attract moisture in the form of corrosive acids that will deteriorate fireside metal.

Inspection and cleanout should be performed at frequent intervals, depending upon the boiler's load, type and quality of fuel, internal boiler temperature, and combustion efficiency. Stack temperature can be used as a guide to determine cleanout intervals, since an accumulation of soot deposits will raise the stack temperature.

Access to the furnace for tube and refractory cleaning is provided through a hinged burner door at the front of the boiler. When opening the burner door, first shut off the electrical and fuel supplies and then disconnect all fuel lines at the burner watching to see that there is no interference with field installed piping, wiring, or other obstructions. A temporary platform must be placed inside the furnace in order to protect the bottom drum insulating refractory when working inside the furnace.



To avoid the hazard of electrical shock, which could cause serious personal injury or death, the use of a low voltage flashlight is recommended when working inside the boiler furnace area.

Tubes should be brushed with a wire brush to remove any soot or other accumulations. Refractory surfaces should be cleaned, if necessary, with a soft bristle brush. Loose material should be vacuumed from the bottom of the furnace.

D. Upper Pass Cleaning

Upper pass access is gained through removal of the inner and outer side casing. To remove the outer casing panels, first disconnect and remove any electrical conduit, boxes and brackets attached to the side outer casing. Match mark the outer panels for repositioning. Remove screw (if installed) from frame above each outer panel. Starting with center panel, slide panel up, swing bottom of panel away from boiler and then slide down from the upper frame and set panel aside. After the center panel(s) are removed, the end panels can be slid (approximately 1") towards the center until they free from the corner frame and then removed in the same manner as the center panel(s). If there are only two outer panels (Models 150 through 350), then slide one end panel further into the corner frame to allow the other panel to slide free from the corner frame. If obstructions are present, such as the gas train, there may not be enough room to slide the panel out from under the upper frame. In this case, unscrew the upper frame from the roof and side frames and remove it also.

Match mark all inner casing panels for repositioning later. Inner casing panels must be removed in sequence starting from either end. Remove nuts, washers and clamp angles from the end and bottom of panels. Remove nuts, washers and bolt bars from vertical seams. Loosen nuts on top clamp angles but don't remove until panel is ready to be removed. Inner casing panels can not be removed by pulling panel straight out from boiler because of a 1" gasket retaining strip that overlaps behind the panels. Remove inner casing panels by sliding or angling panel away from remaining panels until the 1" retaining strip has cleared panel and then panel can be removed and set aside.

After removing the inner side casing, the pass cover plates (2nd pass only) must be removed. The cover plates are screwed together and are held in place by tabs inserted between the tubes. Remove the insulation by starting at one end and carefully rolling it up. The insulation blocks can now be removed from the pass opening. Keep the insulation blocks in order once they have been removed so they can be re-installed in the same position. Insulation is removed from the 4th pass in the same manner.

Now that the 2nd (left side) and 4th (right side) pass openings are exposed, cleaning can be done in the same way as the furnace area. Since the 3rd pass is only open on the ends, cleaning is done by pushing a wire brush mounted on a long handle through from each end. Since the arc of movement is restricted, cleaning the 3rd pass must be done from both sides of the boiler. The fifth pass is cleaned from above the tubes. As in the furnace, loose material should be removed by vacuuming after brushing. The pressure vessel should be inspected for any signs of deterioration after cleaning.

The flue outlet and stack should also be inspected annually and cleaned as necessary. Commercial firms are available to perform this work. The stack should also be inspected for damage and repaired as required.

Once everything has been cleaned and inspected the boiler can be put back together. Install insulation blocks in the 2nd and 4th pass openings in their previous positions. Spray adhesive on tubes above and below pass opening and install blanket insulation over opening. Install cover plates on 2nd pass (left) side only. If any insulation was removed from under the tubes at bottom of boiler it should be replaced at this time.

Prior to installing the inner casing, inspect studs on boiler and bolt bars for any thread damage. Any damaged threads should be cleaned and chased with a 3/8"-16 die. Apply a small amount of Cleaver-Brooks "Never-Seez" (p.n. 797-1814 or 797-1816) on each stud.

Before the inner casing can be installed, the old gaskets must be removed from the panels and around the perimeter of the boiler and replaced with new ones. After removing the gaskets, the surfaces should be cleaned to allow the new gasket to seal properly. The gasket around the perimeter of the boiler should be one piece with the ends overlapping side by side somewhere along the upper (roof) surface. A small amount of silicone will be required to fill gaps and valleys where the gasket crosses. This includes the roof to end wall seams and the base angle to end wall gaps. It is important that the entire gap between the end wall and the base angle be completely sealed. The seal along the base of the end wall should also be checked and resealed if necessary. The gasket should be positioned to the inside of the studs with a 1/4" gap between the studs and the gasket.

Install gasket on side casing panels so it extends past the top and bottom by 1/4" or more and 1/16" to 1/8" out the back at the top and bottom of the panel. (See Figure 7-1). Starting from one end, set panel edge 1/8" to 1/4" from the studs on the end wall. Install the first lower clamp angle over the respective studs, install washers and start nuts. Any nuts that are difficult to install should be replaced. Place the upper clamp angle

over the top studs and install washers and nuts but don't tighten. The end clamp can now be installed and nuts on the end clamp can be snugged up but not completely tightened. Before installing the next panel, apply a small amount of teflon paste to the area where the vertical gasket and the horizontal gaskets will overlap at the top and bottom. This will help ensure an air tight seal. Install the next panel in line being careful to slide the 1" gasket retaining strip behind the panel but under the insulation. Install the bottom and top clamp angles to hold panel in place, but don't tighten. Install the bolt strips, washers and nuts which clamp the panels together. Pull panels together evenly and tighten nuts to 250 to 300 in-lbs. Repeat until all panels are installed and securely bolted together. Now panels can be evenly pulled toward boiler with clamp angles. Tighten all nuts to 250 to 300 in-lbs.

The outer casing panels can now be installed starting with the end panels. Slide each end panel under the upper frame and push the bottom section into the boiler and allowing it to slide down to catch the bottom clamp angle. Then slide the end panels under the corner frames and install any remaining center panels.

The fireside should be thoroughly cleaned prior to any extended layup of the boiler. Depending upon circumstances, a protective coating may be required. See Chapter 3, Section J "Preparation for Extended Layup".

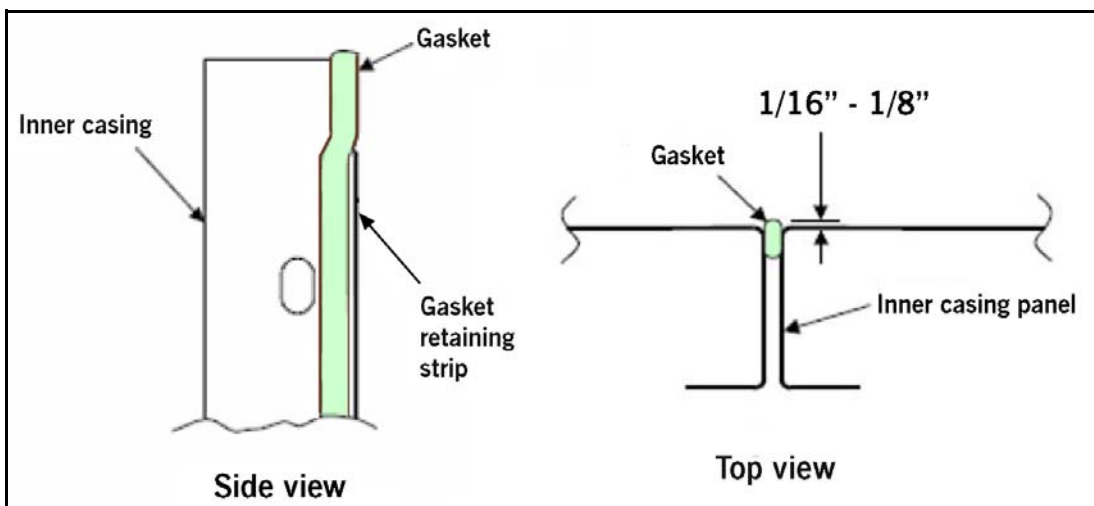


Figure 7-1: Gasket application to inner casing

E. Controls

Relief Valves

The relief valve is a very important safety device and deserves attention accordingly. Proper removal, installation or handling of a relief valve is of primary importance. Exercise care when removing, installing or handling a relief valve to ensure proper operation, long service life, and to ensure that the valve functions as designed.

⚠ WARNING

Improper removal, handling or installation of a relief valve may adversely affect the valve's operation, resulting in serious personal injury or death.

Observe the following precautions when removing, handling or installing relief valves.

- Use only flat jawed wrenches on the flats of the valve
- Do not use a pipe threaded into the outlet to turn a valve
- Apply only a moderate amount of pipe compound to male threads
- Avoid over tightening, which can distort valve seating surfaces

- Do not paint, oil or otherwise cover any interior or working parts of the valve. A relief valve does not require any lubrication or protective coating to work properly.
- Discharge piping must be properly arranged and supported so that its weight does not bear on the relief valve.
- Handle with care a valve that has been removed from the boiler. A dropped valve should be considered as damaged until it has been inspected and passed by the valve manufacturer's authorized representative.

 WARNING

Only properly certified personnel such as the relief valve manufacturer's representative should adjust or repair the boiler relief valves. Failure to heed this warning could result in serious personal injury or death.

Relief valves should be operated only often enough to assure that they are in good working order. Follow the recommendations of your boiler inspector regarding valve inspection and testing. The frequency and method of testing should be based on the recommendation of your boiler inspector and/or the valve manufacturer, and should be in accordance with Section IV of the ASME Boiler and Pressure Vessel Code.

Low Water Controls (Hot Water)

Most instances of major boiler damage result from operating with low water. Since low water cutoff devices are set by the original manufacturer, no attempt should be made to adjust these controls in order to alter the point of low water cutoff. If a low water cutoff should become erratic in operation, immediately replace it or contact your local Cleaver-Brooks authorized representative for assistance.

It is essential to verify proper operation of low water cutoff devices as frequently as possible. However, it is impractical to perform daily and monthly maintenance on some models of the low water cutoff devices on a hot water boiler. Hot water systems are fully closed. Daily or monthly maintenance on some models of the low water cutoff devices would involve draining the entire water content of the system and would require makeup and additional feedwater treatment that might not otherwise be necessary.

To verify the proper operation of float style low water cutoff devices, the system must be drained. Remove the operating mechanism from the bowl and check and clean the float ball, internal moving parts, and the bowl housing. Also, check the cross-connecting piping to make certain that it is clean and free of obstruction.

It is impractical to blowdown the low water cutoff devices on a hot water boiler, since the entire water content of the system would become involved. Many hot water systems are fully closed and any loss of water will require makeup and additional feedwater treatment that might not otherwise be necessary. Since the boiler and system arrangement usually make it impractical to perform daily and monthly maintenance of the low water cutoff devices, it is essential to remove the operating mechanism from the bowl annually or more frequently, if possible, to check and clean float bowl, internal moving parts, and the bowl housing. Also check the cross- connecting piping to make certain that it is clean and free of obstruction.

 WARNING

Safe operation of your boiler demands periodic inspection and maintenance of all low water cutoff devices. If controls do not shut off the burner when the water level drops below the safe operating level, or if controls appear in poor physical condition, or become erratic in operation, they must be repaired or replaced at once. Failure to heed this warning could result in serious personal injury or death.

If test-n-check valves are installed on the float style low water cutoff devices, these controls can be tested by opening the blow down valve. The test-n-check valves restrict water flow when the blow down valve is open allowing water to drain from the control. The test-n-check valves permit testing of the control without draining the entire system therefore allowing regularly scheduled verification of float style low water cutoff.

Low Water Controls (Steam Boilers)

The need to periodically check water level controls and the waterside of the pressure vessel cannot be overemphasized. Most instances of major boiler damage are the result of operating with low water or the use of untreated (or incorrectly treated) water.

Always be sure of the boiler water level. The water column should be blown down routinely. Check samples of boiler water and condensate in accordance with procedures recommended by your water consultant. Refer to sections E and I in Chapter 3 for blowdown instructions and internal inspection procedures.

A typical water level control is mounted in the water column and has float actuated mercury switches. One switch is connected to the burner limit circuit and will stop the burner if a low water condition occurs. The other switch is connected to the feedwater circuit to energize a water pump or feeder valve to maintain water at the proper operating level.

Usually, the control is of the automatic reset type and will remake the limit circuit when the water level is restored. Some applications require that a control be equipped with a manual reset mechanism that must be manually reset before the burner can be restarted. This is usually accomplished with the use of a second or auxiliary control that has this feature.

Since low water cutoff devices are generally set by the original manufacturer, no attempt should be made to adjust these controls to alter the point of low water cutoff or point of pump cut-in or cut-out. If a low water device should become erratic in operation or if its setting changes from previous established levels, check for reasons and correct: Repair or replace as required.

These controls normally function for long periods of time, which may lead to laxity in testing on the assumption that normal operation will continue indefinitely.

The controls' operation may be checked by stopping the water supply to the boiler while the burner is operating at low fire. While under constant attendance, allow the water level to drop at a normal rate. Check for proper operation of the feedwater controller and the low water cutoffs.

CAUTION

If a control does not break the circuit to stop the burner at the proper point then shut down the burner immediately. Failure to do so may result in damage to the equipment.

Do not restart until all cross-connecting piping is checked for obstructions. Also check the float bowl. If these are clean, repair or replace the control. Repeat the above test to ensure proper operation prior to returning the boiler to service.

On a steam boiler, the head mechanism of the low water cutoff device(s) should be removed from the bowl at least once a month to check and clean the float ball, the internal moving parts, and the bowl or water column.

Remove the pipe plugs from the tees or crosses and make certain the cross- connecting piping is clean and free of obstructions. Controls must be mounted in a plumb position for proper performance. Determine that piping is vertically aligned after shipment and installation and throughout the life of the equipment.

A scheduled blowdown of the water controls on a steam boiler should be maintained.

Water Gauge Glass

A broken or discolored glass must be replaced at once. Periodic replacement should be a part of the maintenance program. Always use new gaskets when replacing a glass. Use a proper size rubber packing. Do not use "loose packing," which could be forced below the glass and possibly plug the valve opening.

Close the valves when replacing the glass. Slip a packing nut, a packing washer, and packing ring onto each end of the glass. Insert one end of the glass into the upper gauge valve body far enough to allow the lower end to be dropped into the lower body. Slide the packing nuts onto each valve and tighten.

If the glass is replaced while the boiler is in service, open the blowdown and slowly bring the glass to operating temperature by cracking the gauge valves slightly. After glass is warmed up, close the blowdown valve and open the gauge valves completely.

Check trycocks and gauge cocks for freedom of operation and clean as required.

It is imperative that the gauge cocks are mounted in exact alignment. If they are not, the glass will be strained and may fail prematurely.

A blowdown cock is provided on the lower gauge glass fitting and a daily blowdown is recommended.

Electrical Controls

The operating controls should be inspected monthly. Examine the tightness of electrical connections and keep the controls clean. Remove any dust that accumulates on the interior of the controls using low pressure air that is free of moisture and oil. Take care not to damage the mechanism.

Examine any mercury tube switches for damage or cracks. Dark scum over the normally bright surface of the mercury indicates a damaged tube that may lead to erratic switching action. Make certain that controls are correctly leveled. Covers should remain on controls and panels at all times. Dust and dirt can cause excessive wear or overheating of the motor stator and the relay contacts, and affect operation of other controls. The power supply to the boiler must be protected with dual element fuses (fusetrans) or circuit breakers. Similar fuses should be used in branch circuits. Standard one-shot fuses are not recommended.

Flame Safeguard Control

This control requires minimal maintenance because the safety and logic sections are integral and inaccessible, with no accessible contacts. Regularly check to see that the retaining screws holding the chassis to the mounting base are secure, and that the amplifier and the program module are securely inserted.

It is recommended that a spare control be kept on hand and service be rotated between the active and the spare control (programmer).

Note: Be sure that the connecting contacts on the control and the base are not bent out of position.



When replacing a control, be sure to lock out the main power supply, since the control is “hot” even though the burner switch is off. Failure to heed this warning could result in serious personal injury or death.

Your spare control should be wrapped in plastic and stored in a dry atmosphere. During an extended shutdown (for example, a seasonal shutdown), the active control should be removed and stored in a dry atmosphere. Moisture can cause problems with control operation.

The flame detector lens should be cleaned as often as operating conditions demand. Use a soft cloth moistened with detergent to clean the lens.

A safety check procedure should be established to test the complete flame safeguard system at least once a month. Tests should verify safety shutdown and a safety lockout upon failure to ignite the main flame and upon loss of flame. Each of these conditions should be checked on a scheduled basis. Refer to the burner manual for information regarding tests of the flame safeguard system. Contact your local Cleaver- Brooks authorized representative for assistance, if required.

Checking Loss of Flame

With the burner in normal operation at the low fire rate, shut off the main burner fuel valve to interrupt the fuel supply and extinguish the main flame.

The relay must signal the loss of flame, resulting in the fuel valve(s) being deenergized. The control will lock out on a safety shutdown. The flame failure light (and optional alarm) will be activated. The blower motor will stop.

Turn the burner switch off. Reset the safety switch. Reestablish the main fuel supply.

F. Oil Burner Maintenance

Refer to the burner sections for specific information regarding operation and maintenance of the burner.

Oil strainers should be serviced frequently in order to maintain a free and full flow of fuel to the burner. Installation of a vacuum gauge in the burner supply line between the burner oil pump and the strainer is strongly recommended. Regular observation and recording of the gauge indication will assist in determining when the strainer needs servicing.

Strainer Servicing

The fuel oil strainer element must be removed and cleaned or replaced at regular intervals, or when a rising trend in the burner supply pump suction indicates blockage. When servicing the strainer, fuel supply and return line valves should be shut off. The strainer should be drained of oil and any sediment collected at the bottom of the canister. Remove the cover and withdraw the strainer element. Replaceable elements should be disposed of properly. Reusable elements may be cleaned by immersing them in solvent until attached deposits have been loosened, and then shaking them dry.



Use only safety type solvents such as Cleaver-Brooks "Safety Solvent" for cleaning strainers or other components. Work only in a well ventilated area. Do not use gasoline or other flammable liquids as a solvent. Do not dry the strainer elements with compressed air. Failure to heed this warning could result in serious personal injury or death.

Reassemble the strainer, taking care to seal the canister properly to avoid air infiltration and resulting loss of suction. Open the fuel supply and the return line valves.

G. Gas Burner Maintenance

Refer to the burner sections for specific information regarding operation and maintenance of the burner. The motorized gas valve requires little maintenance, as the operating mechanism is immersed in oil and completely sealed. However, proper operation should be checked on a routine basis.

Keep the outer parts of the valve(s) clean, especially the stem between the operator and the valve. A nicked, scored, or otherwise damaged valve stem can cause leakage. Do not remove dust covers if installed.

The stem packing gland is the O-ring type. If oil is noticed around the operator base, or if leakage occurs, the valve must be repaired. If the actuator is sluggish or fails to operate, and the oil level is known to be correct, the operator portion should be replaced.

Solenoid Valves

Foreign matter between the valve seat and the seat disc will cause leakage. Valves are readily disassembled; however, care must be taken to see that internal parts are not damaged during removal and that reassembly is in the proper order.

A low hum or buzzing will normally be audible when the solenoid coil is energized. If the valve emits a loud buzzing or a chattering noise, check for proper voltage. If voltage is correct, clean the plunger assembly and interior plunger tube thoroughly. Do not use any oil. Make sure that the plunger tube and solenoid are tight when assembled. Take care not to nick, dent, or damage the plunger tube.

Solenoid coils can be replaced without removing the valve from the line.



Be sure to disconnect the main power supply to the boiler in order to prevent the possibility of electrical shock, which could result in serious personal injury or death.

Check the coil position and make sure that any insulating washers or retaining springs are reinstalled in the proper order.

H. Refractory

The boiler is shipped with completely installed refractory. High temperature refractory lines the burner door and floor of the boiler. Front and rear walls, side casing panels, the roof section, the bottom drum and the drum vent are protected with high temperature insulation. Preventive maintenance through periodic inspection will keep the operator aware of the condition of the refractory and insulation and will guard against unexpected downtime for repairs.

I. Casing Seals

The most obvious indication of a problem is the appearance of discolored paint on the casing or soot and hot gases escaping at seal joints. It is important that at start-up any problems are noted and corrected before the boiler is put back into operation. The following are areas requiring inspection.

Burner Door

Inspect the area around the door and look for discolored paint or evidence of combustion gas leakage. If a problem is noted or the door is being opened for scheduled maintenance look for warped sealing surfaces and make sure that the insulation on the front wall around the door has not pushed away from the wall. Cracks may appear in the burner door refractory as a result of expansion and contraction from operation. If cracks are larger than 1/8" when the refractory is cooled, the cracks should be filled with a high temperature bonding air-dry mortar such as Cleaver- Brooks "Corline."



Disconnect main power to the boiler and the pilot fuel supply to the burner before the burner door is opened. Electrical power and fuel supply must remain shut off at all times when the burner door is open. Failure to heed this warning could result in serious personal Injury or death.

Access to the boiler furnace area is gained through the burner door opening at the front of the boiler. Whenever the burner is opened, the gasket and gasket surfaces of the burner door should be inspected. A good seal between the burner door and the boiler is necessary to prevent leakage of combustion gases and loss of efficiency. Combustion gas leaks can cause hot spots with subsequent damage to the burner door and surrounding refractory. Damaged or hardened gaskets must be replaced before the burner is put back in operation.

If a new gasket is necessary, remove the old gasket and clean the gasket surface on the wall and burner door. A spray adhesive is used to hold the rope gasket in place around the burner opening. A high temperature silicone may be needed to seal under the rope gasket at the wall seams. The rope gasket should wrap around the opening at least two times.

Before the burner door is closed, inspect studs and clean threads if necessary with 1/2"-13 die. Apply a small amount of Cleaver-Brooks "Never-Seez" (p.n. 797-1814 or 797-1816) to the studs. Any nuts that are difficult to thread on studs should be replaced. Door fasteners should be run in and tightened evenly to avoid distorting the door or damaging the gasket. Start tightening at the top and proceed around the door, alternately tightening opposite fasteners until all are snug. After the boiler is back in operation, check for gas leaks around the door opening, and retighten the fasteners as required to provide a gas-tight seal.

Drum Seals

Inspect the areas around the drum seals and look for soot or hot gas leaks. If a problem is noted look for the source of the leak. Remove the old insulation and sealant from around the drum. Using a pumpable insulation material (p.n. 872-680), fill the void flush with the outside of the wall. Allow the area to set up and apply a thick bead of high temperature silicone around the drum and install the cover plates.

Sight Port

Inspect the area around the sight port for paint discoloration. A hot spot around the rear sight port is caused by either a poor seal between the sight port insulator and the wall, a cracked insulator or a flue gas leak at the sight port cap.

Check the threads of the cap and sight tube. If necessary, clean the threads and/or replace the cap. If the screws that hold the sight glass retainer in place are leaking tighten the screws or replace the cap.

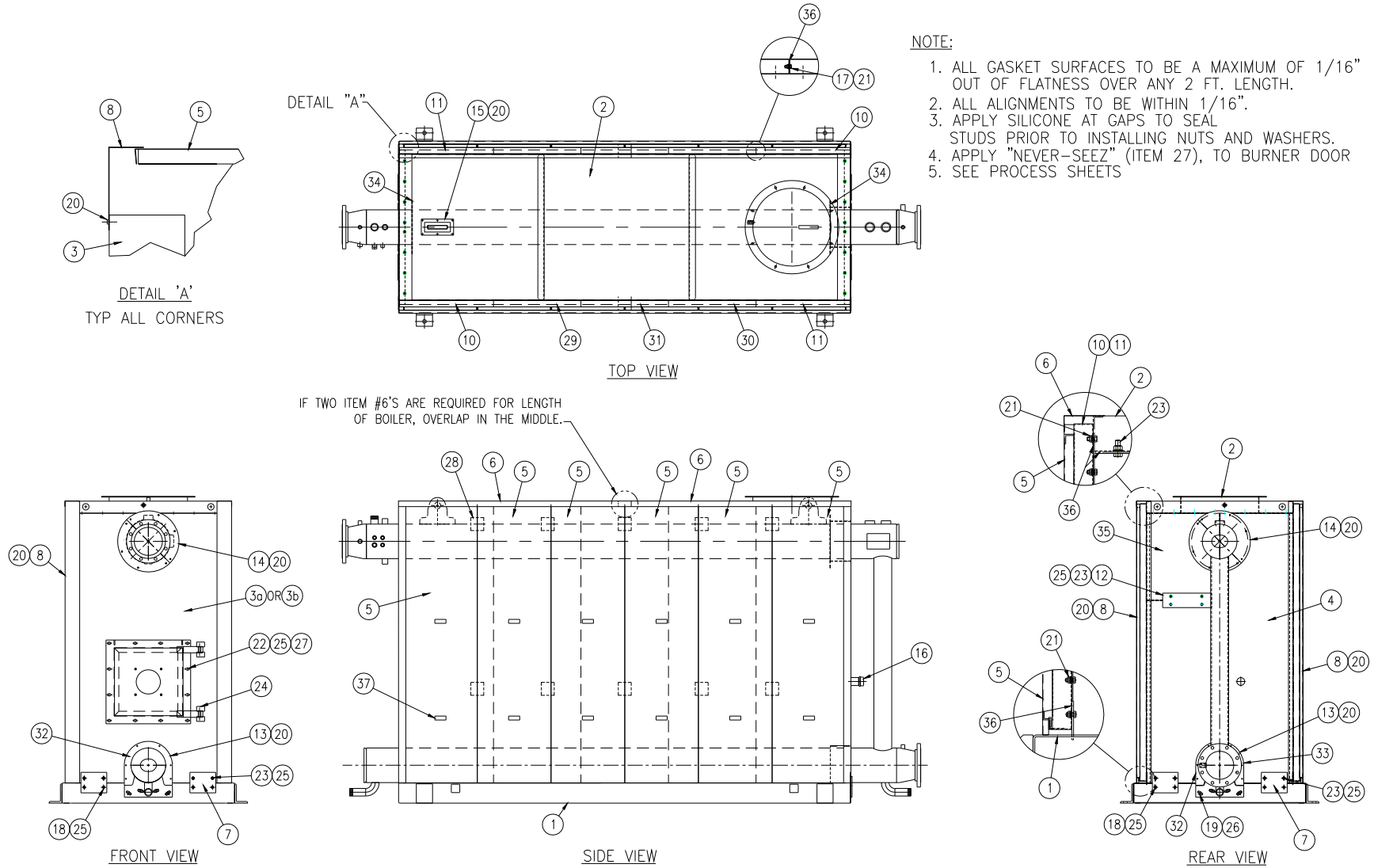
CHAPTER 8

PARTS



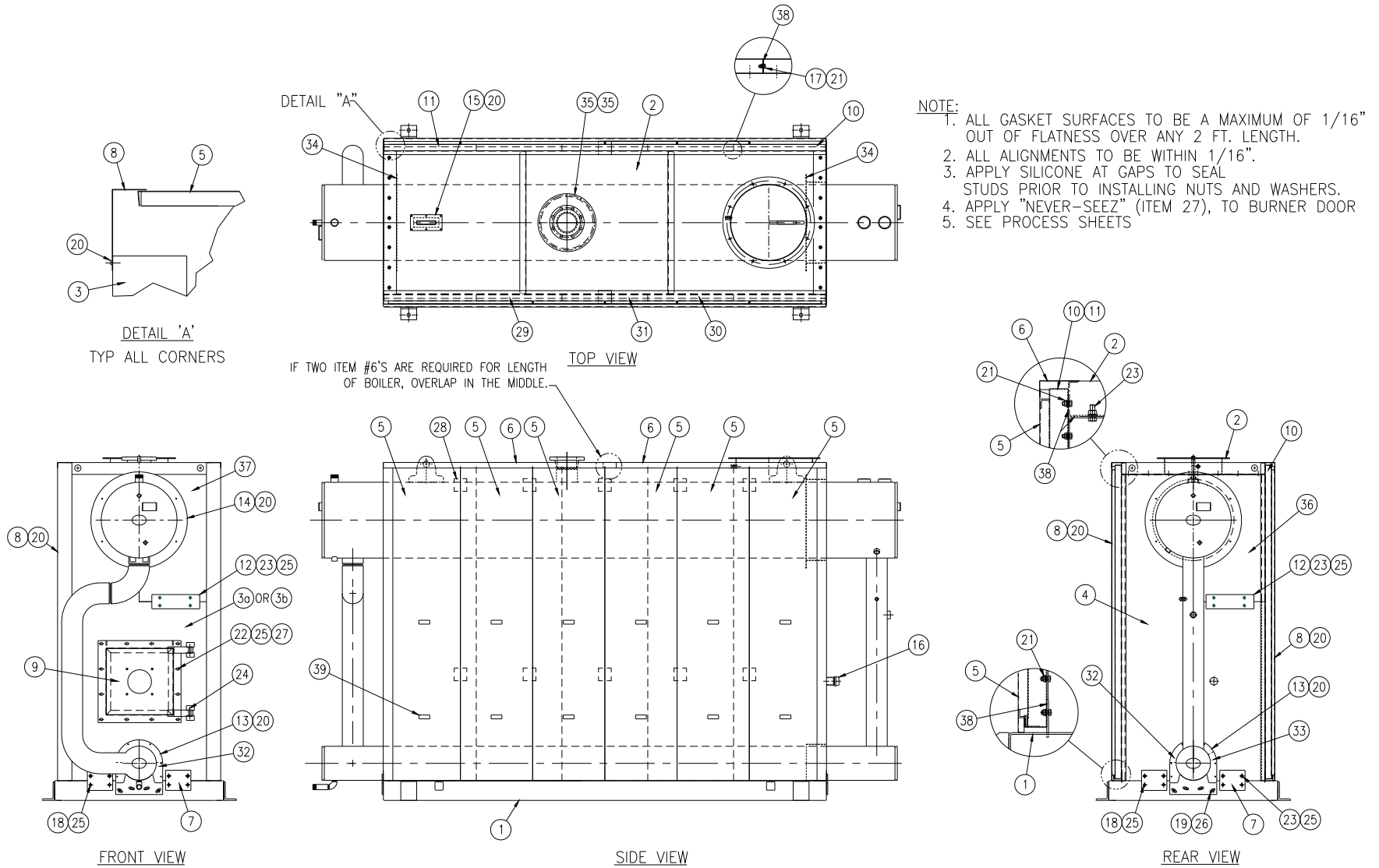
Flextube Casing, Hot Water	8-2
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Figure: 8-1 Typical Hot Water Flextube Casing



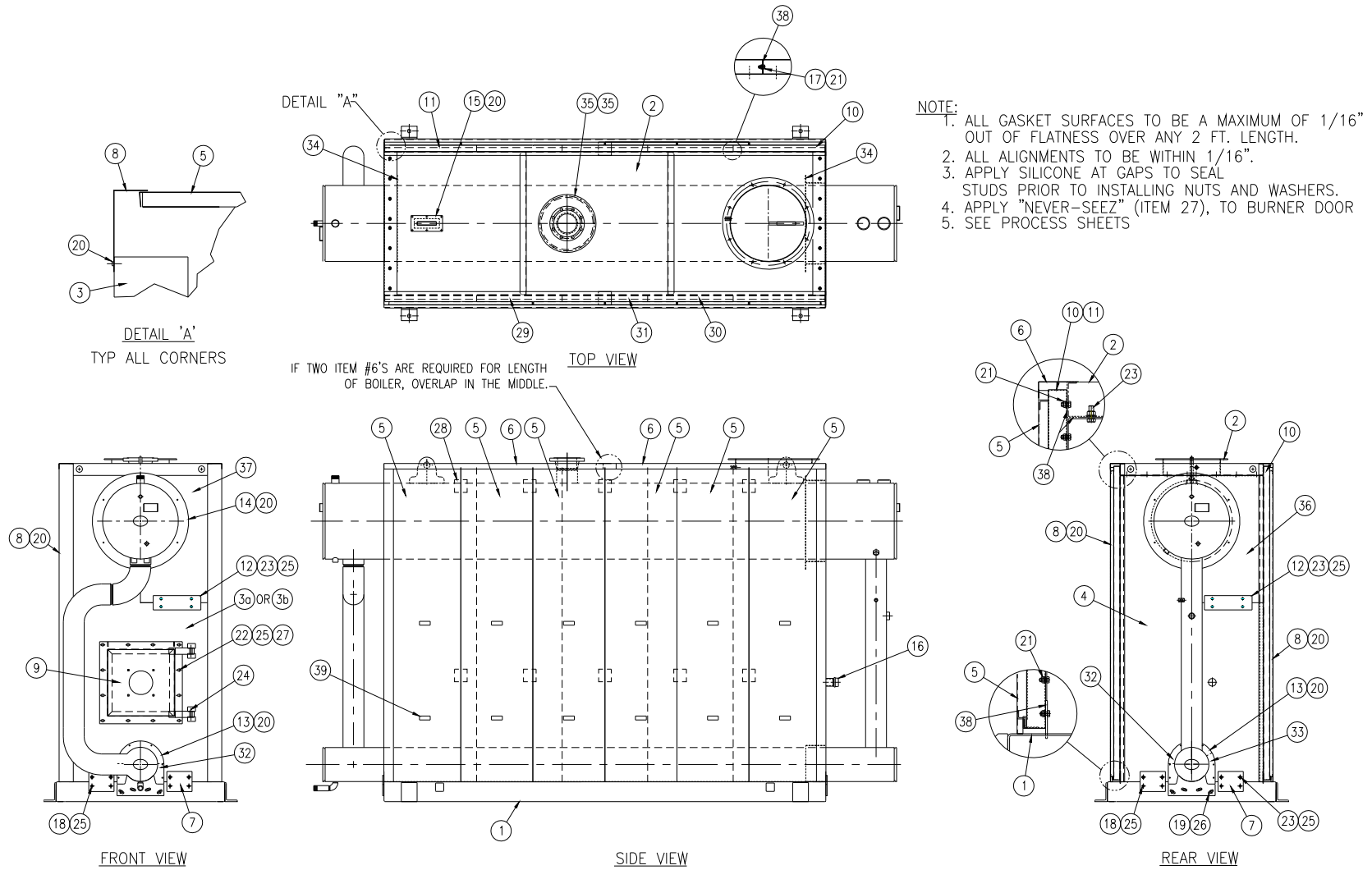
Part List, Hot Water		250		350		500		800		1100	
ITEM	DESCRIPTION	PART #	REQ	PART #	REQ	PART #	REQ	PART #	REQ	PART #	REQ
1.	Base	315-1124	1	315-1169	1	315-1180	1	315-1194	1	315-1203	1
2.	Roof	315-1127	1	315-1167	1	315-1178	1	315-1192	1	315-1202	1
3.a	Front wall, w/o Hinge	315-1262	1	315-1265	1	n/a		n/a		n/a	
3.b	Front wall w Hinge	315-1128	1	315-1166	1	315-1177	1	315-1191	1	315-1201	1
4.	Rear wall-large piece	315-1129	1	315-1165	1	315-1176	1	315-1190	1	315-1190	1
5.	Outer casing panel	315-1130	6	315-1164	6	315-1175	8	315-1189	10	315-1198	12
6.	Outer casing strips-top	315-1131	2	315-1163	2	315-1174	2	315-1188	2	315-1197	4
7.	Plate, base to wall	315-1132	4	315-1132	4	315-1132	4	315-1132	4	315-1132	4
8.	Outer casing strips corner strip	315-1133	4	315-1162	4	315-1173	4	315-1187	4	315-1187	4
9.	Burner plate	Note 5	1	Note 5	1	Note 5	1	Note 5	1	Note 5	1
10.	Inner side panel Left Hand	315-1135	2	315-1161	2	315-1172	2	315-1186	2	315-1196	2
11.	Inner side panel Right Hand	315-1136	2	315-1160	2	315-1171	2	315-1185	2	315-1195	2
12.	Mounting Plate	315-1143	1	315-1143	1	315-1143	1	315-1143	1	315-1143	1
13.	Plate, Collar, Lower Outer	315-694	2	315-694	2	315-695	2	315-695	2	315-695	2
14.	Plate, Collar, Upper Outer	315-1159	2	315-1159	2	315-1183	2	315-1183	4	315-1210	2
15.	Plate, Cover, Lug, Lifting	315-1100	1	315-1100	1	315-1100	1	315-1099	1	315-1099	1
16.	Cap, sight	550-42	1	550-42	1	550-42	1	550-42	1	550-42	1
17.	Capscrew, hex hd. 3/8"-16x 3/4"lg	868-1506	26	868-1506	28	868-1506	60	868-1506	96	868-1506	128
18.	Capscrew, hex hd. 1/2"-13x 1-1/2"lg	868-102	8	868-102	8	868-102	8	868-102	8	868-102	8
19.	Capscrew, hex hd. 5/8"-11x 1-1/2"lg	868-188	8	868-188	8	868-188	8	868-188	8	868-188	8
20.	Screw, self tapping, 1/4" x 1"lg	841-423	50	841-423	50	841-423	50	841-423	50	841-423	54
21.	Locknut, hex hd., 3/8"	869-510	118	869-510	124	869-510	180	869-510	232	869-510	284
22.	Nut, hex hd., 1/2" brass	869-27	12	869-27	12	869-27	12	869-27	12	869-27	12
23.	Nut, hex hd., 1/2"	869-144	24	869-144	24	869-144	24	869-144	28	869-144	28
24.	Capscrew, Hex hd 3/4"-10 x 6" LG	868-600	2	868-600	2	868-600	2	868-600	2	868-600	2
25.	Washer, flat, 1/2"	952-286	44	952-286	44	952-286	44	952-286	48	952-286	48
26.	Washer, flat, 5/8"	952-321	8	952-321	8	952-321	8	952-321	8	952-321	8
27.	Never-Seez	797-1816	1	797-1816	1	797-1816	1	797-1816	1	797-1816	1
28.	Inner Casing Spacer Block	315-1336	8	315-1336	8	315-1336	12	315-1336	16	315-1336	20
29.	Inner Side Panel Mid Left	n/a		n/a		n/a		315-1294	2	315-1294	2
30.	Inner Side Panel Mid Right	n/a		n/a		n/a		315-1208	2	315-1208	2
31.	Inner Side Panel Mid	n/a		n/a		315-1206	2	n/a		315-1209	2
32.	Retaining Plates, Lower, Inner, Small	315-1178	3	315-1178	3	315-1280	3	315-1280	3	315-1280	3
33.	Retaining Plates, Lower, Inner, Large	315-1158	1	315-1158	1	315-1182	1	315-1182	1	315-1182	1
34.	Plate, collar, upper, inner	315-1204	2	315-1204	2	315-1207	2	n/a		315-1183	2
35.	Assembly, rear wall corner piece	315-1140	1	315-1279	1	315-1281	1	315-1282	1	315-1282	1
36.	Gasket, Expanded PTFE 3/8" x 3/16"	32-2560	70 ft	32-2560	75 ft	32-2560	99 ft	32-2560	127ft	32-2560	149ft
37.	Handle, Flush Mount, Snap In	865-68	12	865-68	12	865-68	16	865-68	16	865-68	24

Figure: 8-2 Typical Low Pressure Steam Flextube Casing



Part List, LP Steam		250		350		500		800		1100	
ITEM	DESCRIPTION	PART #	REQ	PART #	REQ	PART #	REQ	PART NO.	REQ	PART #	REQ
1.	Base	315-1124	1	315-1169	1	315-1180	1	315-1194	1	315-1203	1
2.	Roof	315-1215	1	315-1230	1	315-1239	1	315-1250	1	315-1260	1
3.a	Front wall, w/o Hinge	315-1263	1	315-1264	1	n/a		n/a		n/a	
3.b	Front wall w Hinge	315-1216	1	315-1229	1	315-1138	1	315-1249	1	315-1249	1
4.	Rear wall-large piece	315-1217	1	315-1228	1	315-1237	1	315-1248	1	315-1248	1
5.	Outer casing panel	315-1218	6	315-1227	6	315-1236	8	315-1247	10	315-1257	12
6.	Outer casing strips-top	315-1131	2	315-1163	2	315-1174	2	315-1188	2	315-1197	4
7.	Plate, base to wall	315-1132	4	315-1132	4	315-1132	4	315-1132	4	315-1132	4
8.	Outer casing strips corner strip	315-1219	4	315-1226	4	315-1235	4	315-1246	4	315-1246	4
9.	Burner plate	Note 5	1	Note 5	1	Note 5	1	Note 5	1	Note 5	1
10.	Inner side panel Left Hand	315-1220	2	315-1225	2	315-1234	2	315-1245	2	315-1256	2
11.	Inner side panel Right Hand	315-1221	2	315-1224	2	315-1233	2	315-1244	2	315-1255	2
12.	Mounting Plate	315-1143	1	315-1143	2	315-1143	2	315-1143	2	315-1143	2
13.	Plate, Collar, Lower Outer	315-694	2	315-694	2	315-695	2	315-695	2	315-695	2
14.	Plate, Collar, Upper Outer	315-1222	2	315-1222	2	315-1222	2	315-1243	2	315-1243	2
15.	Plate, Cover, Lug, Lifting	315-1100	1	315-1100	1	315-1100	1	315-1099	1	315-1099	1
16.	Cap, sight	550-42	1	550-42	1	550-42	1	550-42	1	550-42	1
17.	Capscrew, hex hd. 3/8"-16x 3/4"lg	868-1506	28	868-1506	30	868-1506	64	868-1506	108	868-1506	144
18.	Capscrew, hex hd. 1/2"-13x 1-1/2"lg	868-102	8	868-102	8	868-102	8	868-102	8	868-102	8
19.	Capscrew, hex hd. 5/8"-11x 1-1/2"lg	868-188	8	868-188	8	868-188	8	868-188	8	868-188	8
20.	Screw, self tapping, 1/4" x 1"lg	841-423	56	841-423	56	841-423	56	841-423	56	841-423	60
21.	Locknut, hex hd., 3/8"	869-510	128	869-510	130	869-510	188	869-510	252	869-510	308
22.	Nut, hex hd., 1/2" brass	869-27	12	869-27	12	869-27	12	869-27	12	869-27	12
23.	Nut, hex hd., 1/2"	869-144	28	869-144	28	869-144	28	869-144	32	869-144	32
24.	Capscrew, Hex hd 3/4"-10 x 6" LG	868-600	2	868-600	2	868-600	2	868-600	2	868-600	2
25.	Washer, flat, 1/2"	952-286	48	952-286	48	952-286	48	952-286	52	952-286	52
26.	Washer, flat, 5/8"	952-321	8	952-321	8	952-321	8	952-321	8	952-321	8
27.	Never-Seez	797-1816	1	797-1816	1	797-1816	1	797-1816	1	797-1816	1
28.	Inner Casing Spacer Block	315-1336	8	315-1336	8	315-1336	12	315-1336	16	315-1336	20
29.	Inner Side Panel Mid Left	n/a		n/a		n/a		315-1295	2	315-1295	2
30.	Inner Side Panel Mid Right	n/a		n/a		n/a		315-1253	2	315-1253	2
31.	Inner Side Panel Mid	n/a		n/a		315-1242	2	n/a		315-1261	2
32.	Retaining Plates, Lower, Inner, Small	315-1278	3	315-1278	3	315-1280	3	315-1280	3	315-1280	3
33.	Retaining Plates, Lower, Inner, Large	315-1158	1	315-1158	1	315-1282	1	315-1182	1	315-1182	1
34.	Plate, collar, upper, inner	315-1223	2	315-1223	2	315-1223	2	351-1254	1	315-1254	2
35.	Ring Seal, Outlet Steam #15	315-219	1	315-220	1	315-221	1	315-1057	1	315-1058	1
36.	Assembly, rear wall corner piece	315-1286	1	315-1287	1	315-1289	1	315-1291	1	315-1291	1
37.	Assembly, front wall corner piece	315-1285	1	315-1288	1	315-1290	1	315-1292	1	315-1292	1
38.	Gasket, Expanded PTFE 3/8" x 3/16"	32-2560	79 ft	32-2560	86 ft	32-2560	110 ft	32-2560	144ft	32-2560	168ft
39.	Handle, Flush Mount, Snap In	865-68	12	865-68	12	865-68	16	865-68	20	865-68	24

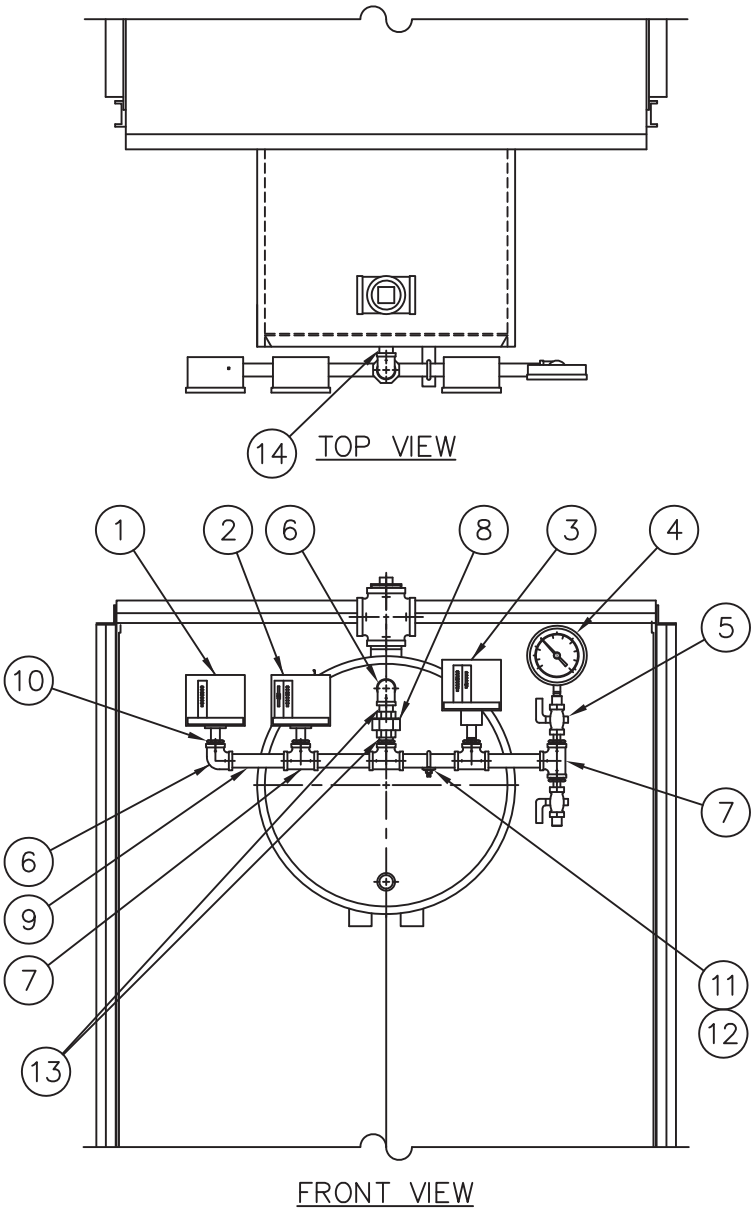
Figure: 8-3 Typical High Pressure Steam Flextube Casing



Parts List, HP Steam		250		350		500		800		1100	
ITEM	DESCRIPTION	PART #	REQ	PART #	REQ	PART #	REQ	PART #	REQ	PART #	REQ
1.	Base	315-1124	1	315-1169	1	315-1180	1	315-1194	1	315-1203	1
2.	Roof	315-1215	1	315-1230	1	315-1239	1	315-1250	1	315-1260	1
3.a	Front wall w/o Hinge	315-1263	1	315-1264	1	n/a		n/a		n/a	
3.b	Front wall w Hinge	315-1216	1	315-1229	1	315-1238	1	315-1249	1	315-1249	1
4.	Rear wall-large piece	315-1217	1	315-1228	1	315-1237	1	315-1248	1	315-1248	1
5.	Outer casing panel	315-1218	6	315-1227	6	315-1236	8	315-1247	10	315-1257	12
6.	Outer casing strips-top	315-1131	2	315-1163	2	315-1174	2	315-1188	2	315-1197	4
7.	Plate, base to wall	315-1132	4	315-1132	4	315-1132	4	315-1132	4	315-1132	4
8.	Outer casing strips corner strip	315-1219	4	315-1226	4	315-1235	4	315-1246	4	315-1246	4
9.	Burner plate	Note 5	1	Note 5	1	Note 5	1	Note 5	1	Note 5	1
10.	Inner side panel Left Hand	315-1220	2	315-1225	2	315-1234	2	315-1245	2	315-1256	2
11.	Inner side panel Right Hand	315-1221	2	315-1224	2	315-1233	2	315-1244	2	315-1255	2
12.	Mounting Plate	315-1143	2	315-1143	2	315-1143	2	315-1143	2	315-1143	2
13.	Plate, Collar, Lower Outer	315-694	2	315-694	2	315-695	2	315-695	2	315-695	2
14.	Plate, Collar, Upper Outer	315-1222	2	315-1222	2	315-1222	2	315-1243	2	315-1243	2
15.	Plate, Cover, Lug, Lifting	315-1100	1	315-1100	1	315-1100	1	315-1099	1	315-1099	1
16.	Cap, sight	550-42	1	550-42	1	550-42	1	550-42	1	550-42	1
17.	Capscrew, hex hd. 3/8"-16x 3/4"lg	868-1506	28	868-1506	30	868-1506	64	868-1506	108	868-1506	144
18.	Capscrew, hex hd. 1/2"-13x 1-1/2"lg	868-102	8	868-102	8	868-102	8	868-102	8	868-102	8
19.	Capscrew, hex hd. 5/8"-11x 1-1/2"lg	868-188	8	868-188	8	868-188	8	868-188	8	868-188	8
20.	Screw, self tapping, 1/4" x 1"lg	841-423	50	841-423	56	841-423	56	841-423	56	841-423	60
21.	Locknut, hex hd., 3/8"	869-510	118	869-510	130	869-510	188	869-510	252	869-510	308
22.	Nut, hex hd., 1/2" brass	869-27	12	869-27	12	869-27	12	869-27	12	869-27	12
23.	Nut, hex hd., 1/2"	869-144	24	869-144	28	869-144	28	869-144	32	869-144	32
24.	Capscrew, Hex hd 3/4"-10 x 6" LG	868-600	2	868-600	2	868-600	2	868-600	2	868-600	2
25.	Washer, flat, 1/2"	952-286	44	952-286	48	952-286	48	952-286	52	952-286	52
26.	Washer, flat, 5/8"	952-321	8	952-321	8	952-321	8	952-321	8	952-321	8
27.	Never-Seez	797-1816	1	797-1816	1	797-1816	1	797-1816	1	797-1816	1
28.	Inner Casing Spacer Block	315-1336	8	315-1336	8	315-1336	12	315-1336	16	315-1336	20
29.	Inner Side Panel Mid Left	n/a	2	n/a		n/a		315-1295	2	315-1295	2
30.	Inner Side Panel Mid Right	n/a	2	n/a		n/a		315-1253	2	315-1253	2
31.	Inner Side Panel Mid	n/a	2	n/a		315-1242	2	n/a		315-1261	2
32.	Retaining Plates, Lower, Inner, Small	315-1178	3	315-1278	3	315-1280	3	315-1280	3	315-1280	3
33.	Retaining Plates, Lower, Inner, Large	315-1158	1	315-1158	1	315-1282	1	315-1182	1	315-1182	1
34.	Plate, collar, upper, inner	315-1223	2	315-1223	2	315-1223	2	315-1254	1	315-1254	2
35.	Ring Seal, Outlet Steam #150	315-517	1	315-518	1	315-519	1	315-550	1	315-221	1
36.	Assembly, rear wall corner piece	315-1286	1	315-1287	1	315-1289	1	315-1291	1	315-1291	1
37.	Assembly, front wall corner piece	315-1285	1	315-1288	1	315-1290	1	315-1292	1	315-1292	1
38.	Gasket, Expanded PTFE 3/8" x 3/16"	32-2560	79 ft	32-2560	86 ft	32-2560	110 ft	32-2560	114ft	32-2560	168ft
39.	Handle, Flush Mount, Snap In	865-68	12	865-68	12	865-68	16	865-68	16	865-68	16

Steam Pressure Controls

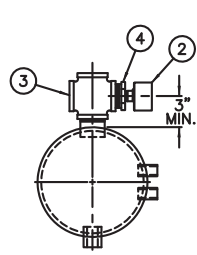
ITEM	QTY	PART NO.		DESCRIPTION
		15# STEAM	150# STEAM	
1	1	817-04095	817-04093	CONTROL,PRESSURE,OPERATING AUTO RESET
2	1	817-04094	817-04092	CONTROL, PRESSURE,HIGH LIMIT MANUAL RESET
3	1	817-00251	817-00204	CONTROL, PRESSURE, MODULATING
4	1	850-00243	850-00122	GAUGE, PRESSURE
5	2	941-00055		VALVE, BALL
6	2	859-00081		ELBOW, FEMALE
7	4	859-00025		TEE, 3/4" NPT
8	1	858-00165		UNION, FEMALE, 3/4" NPT
9	4	857-00683		NIPPLE, PIPE
10	6	847-00422		BUSHING, REDUCING
11	1	008-03183		BRACKET, PRESSURETROLS
12	1	993-08928		U-BOLT
13	2	857-00708		NIPPLE, CLOSE </td
14	1	857-00658		NIPPLE, PIPE



Water Level Controls

ITEM	REQ.	PART NO.	DESCRIPTION	ITEM	REQ.	PART NO.	DESCRIPTION
1	1	817-2349	LOW WATER CUTOFF, MCM&M 750-T-120, AR	1	1	817-740	CONTROL, LIQUID LEVEL, WARRICK 3E2B
	1	817-2305	LOW WATER CUTOFF, MCM&M 750-MT-120, MR		1	817-1020	CONTROL, LIQUID LEVEL, WARRICK 3E3B
2	1	817-2351	PROBE, REMOTE, MCM&M RS-1-LP	2	3	67-536	1/4" BRASS ROD X 4 1/8" LG.
3	1	859-267	CROSS, 2"	3	1	859-267	CROSS, 2"
4	1	847-440	BUSHING, REDUCING, 2" X 3/4"				

MAXIMUM DESIGN PRESSURE - 160 P.S.I. H.W.



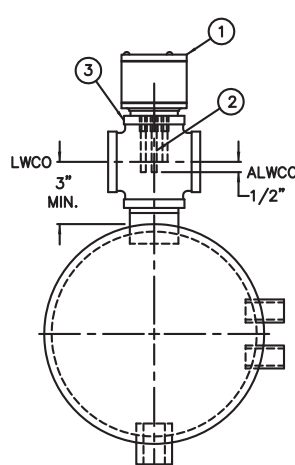
NOTES:

1.) DO NOT ATTACH ANY ROD FOR PROBE LENGTH TO ITEM #2.

2.) INSURE MINIMUM CLEARANCE OF 1/4" BETWEEN PROBE END AND PIPING.

ITEM	REQ.	PART NO.	DESCRIPTION
1	1	817-740	CONTROL, LIQUID LEVEL, WARRICK 3E2B
	1	817-1020	CONTROL, LIQUID LEVEL, WARRICK 3E3B
2	3	67-536	1/4" BRASS ROD X 4 1/8" LG.
3	1	859-267	CROSS, 2"

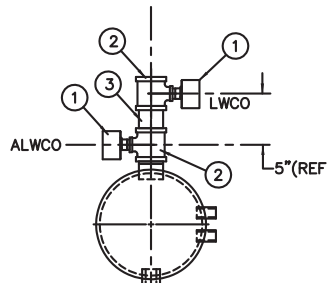
MAXIMUM DESIGN PRESSURE - 250 P.S.I. H.W.



SCALE: 2X

ITEM	REQ.	PART NO.	DESCRIPTION	ITEM	REQ.	PART NO.	DESCRIPTION
1	2	817-2351	PROBE, REMOTE, MCM&M RS-1-LP	1	1	817-740	CONTROL, LIQUID LEVEL, WARRICK 3E2B
2	2	847-311	REDUCING TEE, 2" NPT X 3/4" NPT.	2	2	67-536	1/4" BRASS ROD X 4 1/8" LG.
3	1	857-298	NIPPLE, 2" NPT X 3" LG. SCH. 80	3	1	817-2349	LOW WATER CUTOFF, MCM&M 750-T-120, AR
				3	1	817-2305	LOW WATER CUTOFF, MCM&M 750-MT-120, MR
				4	1	817-2351	PROBE, REMOTE, MCM&M RS-1-LP
				5	2	859-28	TEE, 2"
				6	1	847-440	BUSHING, REDUCING, 2" X 3/4"

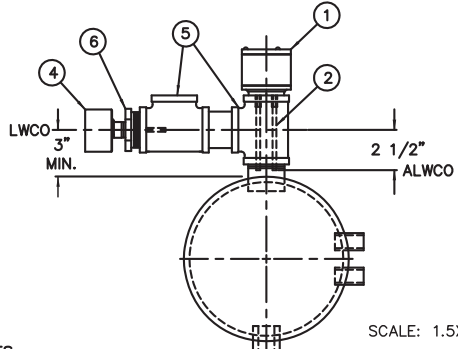
MAXIMUM DESIGN PRESSURE - 160 P.S.I. H.W.



NOTES:

- DO NOT ATTACH ANY ROD FOR PROBE LENGTH TO ITEM #1.
- INSURE MINIMUM CLEARANCE OF 1/4" BETWEEN PROBE END AND PIPING.

MAXIMUM DESIGN PRESSURE - 160 P.S.I. H.W.



SCALE: 1.5X

NOTES:

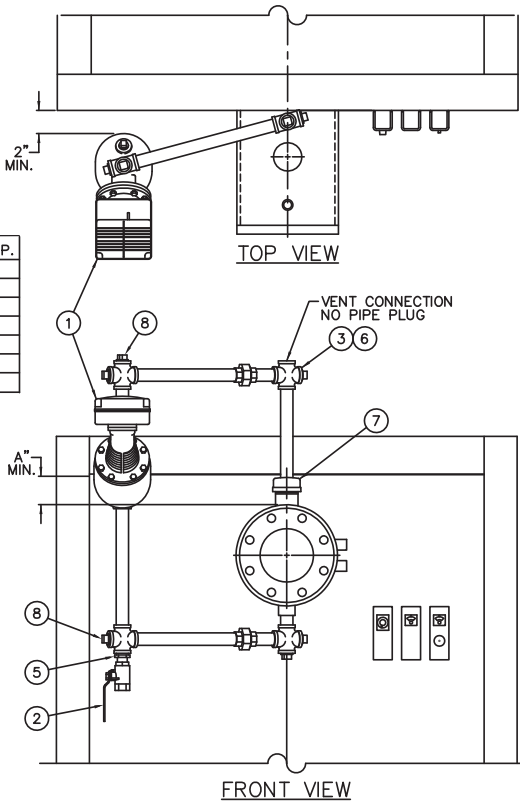
- DO NOT ATTACH ANY ROD FOR PROBE LENGTH TO ITEM #1.
- INSURE MINIMUM CLEARANCE OF 1/4" BETWEEN PROBE END AND PIPING.

Water Level Controls continued

ITEM	PART NO.	DESCRIPTION	MAX. D.P.
1	817-746	McDONNELL & MILLER 63B LWCO CONTROL	50#
	817-777	McDONNELL & MILLER 64B LWCO CONTROL	50#
	817-2408	McDONNELL & MILLER 150S LWCO CONTROL	150#
	SEE NOTE 2	MAGNETROL B24 LIQUID LEVEL CONTROL	250#
	SEE NOTE 2	MAGNETROL B29 LIQUID LEVEL CONTROL	250#
	SEE NOTE 2	MAGNETROL B73 LIQUID LEVEL CONTROL	250#
	817-163	MAGNETROL W25 LIQUID LEVEL CONTROL	250#
2	941-1790	VALVE, BALL, 3/4"	
3	859-264	CROSS, 1"	
4	858-166	UNION, FEMALE, 1"	
5	847-426	BUSHING, REDUCING, 1" TO 3/4"	
6	858-93	PLUG, 1"	
7	858-66	CAP, PIPE, 2"	
8	941-2223	McD-M TEST-N-CHECK VALVES #TC-4 CONSIST OF VALVES #317350 & #317353	

DIM. "A"	LWCO & ALWCO CONFIGURATIONS
3"	SINGLE FLOAT STYLE LWCO
3 1/2"	FLOAT STYLE LWCO & PROBE ALWCO
2 1/2"	PROBE STYLE LWCO & FLOAT STYLE ALWCO

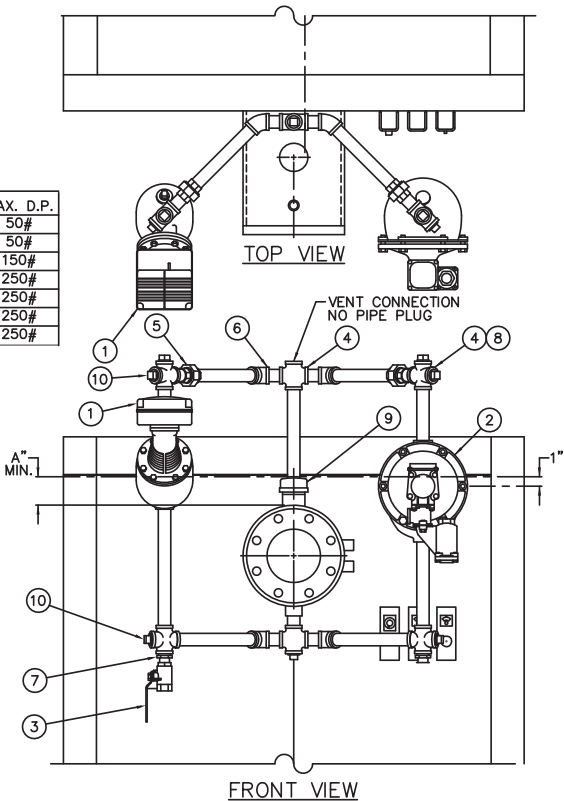
- NOTES:
- 1.) USE 1" MIN. PIPE SIZE & PLUG
ALL UNUSED CROSS OPENINGS.
- 2.) FOR PART NO., SEE PROCESS SHEET.



ITEM	PART NO.	DESCRIPTION	MAX. D.P.
1	817-746	McDONNELL & MILLER 63B LWCO CONTROL	50#
	817-777	McDONNELL & MILLER 64B LWCO CONTROL	50#
	817-2408	McDONNELL & MILLER 150S LWCO CONTROL	150#
	SEE NOTE #2	MAGNETROL B24 LIQUID LEVEL CONTROL	250#
	SEE NOTE #2	MAGNETROL B29 LIQUID LEVEL CONTROL	250#
	SEE NOTE #2	MAGNETROL B73 LIQUID LEVEL CONTROL	250#
	817-163	MAGNETROL W25 LIQUID LEVEL CONTROL	250#
2	817-453	McDONNELL & MILLER 53B WATER FEEDER	
3	941-1790	VALVE, BALL, 3/4"	
4	859-264	CROSS, 1"	
5	858-166	UNION, FEMALE, 1"	
6	859-96	ELBOW, 45°, 1"	
7	847-426	BUSHING, REDUCING, 1" TO 3/4"	
8	858-93	PLUG, 1"	
9	858-66	CAP, PIPE, 2"	
10	941-2223	McD-M TEST-N-CHECK VALVES #TC-4 CONSIST OF VALVES #317350 & #317353	

DIM. "A"	LWCO & ALWCO CONFIGURATIONS
3"	SINGLE FLOAT STYLE LWCO
3 1/2"	FLOAT STYLE LWCO & PROBE ALWCO
2 1/2"	PROBE STYLE LWCO & FLOAT STYLE ALWCO

- NOTES:
- 1.) USE 1" MIN. PIPE SIZE & PLUG
ALL UNUSED CROSS OPENINGS.
- 2.) FOR PART NO., SEE PROCESS SHEET.



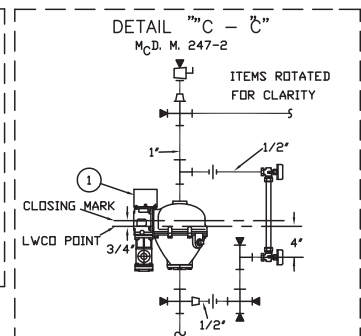
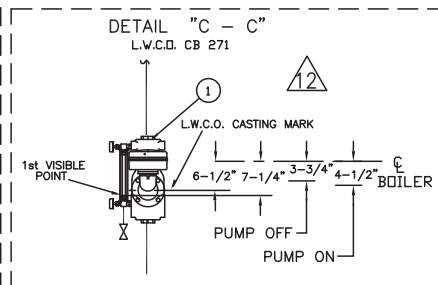
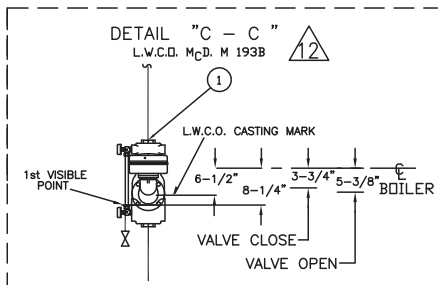
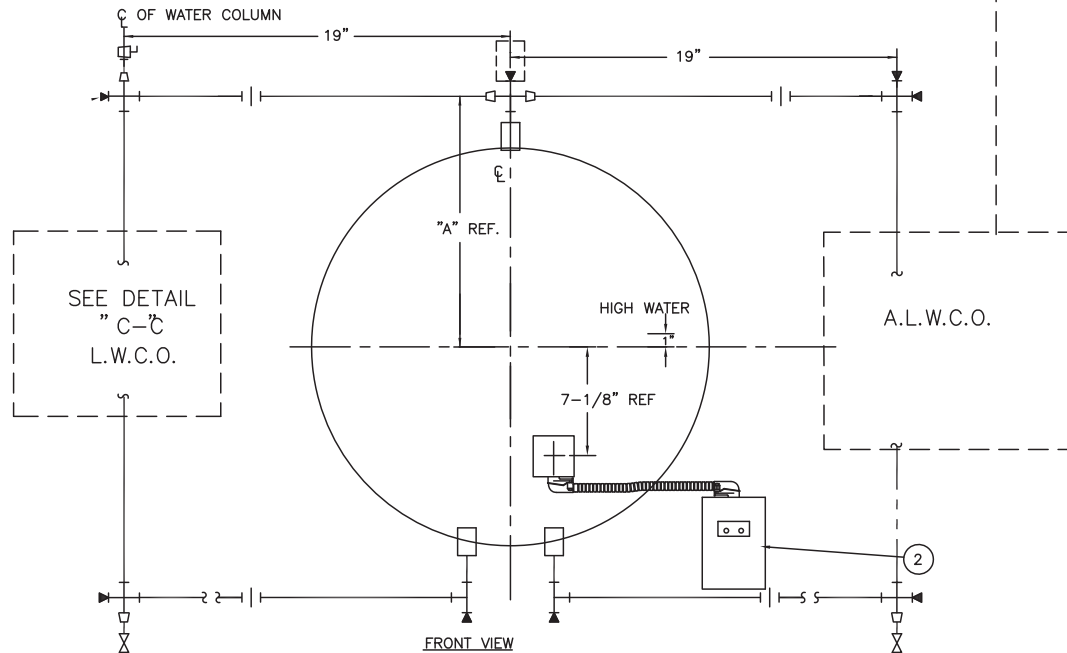
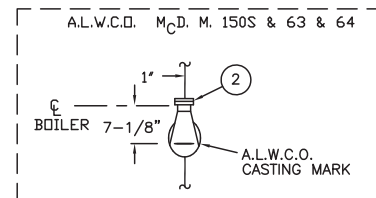
Water Column, Main and Aux. - 15# Steam

ITEM	QTY	PART NO.	DESCRIPTION	USED ON
1	1	100-271	LOW WATER CUT-OFF W/PUMP CONTROL (CB271)	STANDARD
	1	-----	-----	-----
	1	817-371	LOW WATER CUT-OFF W/FEEDER (McDM 247-2)	OPTIONAL
2	1	811-7307	LOW WATER CUT-OFF (McDM 193B)	OPTIONAL SEE NOTE No 3
	1	817-2305	McDM #750-MR CONTROL BOX	STANDARD
	1	817-2351	PROBE FOR McDM #750	
	1	817-740	AUX. LOW WATER CUT-OFF (WARRICK E2) **	OPTIONAL
	2	067-868	PROBES FOR WARRICK (TRIM PER "B" DIM.)	
	1	817-1020	AUX. LWCO (WARRICK E3 W/HIGH ALARM) **	OPTIONAL
	3	067-868	PROBES FOR WARRICK (TRIM 2 PER "B", 1 PER "C")	
	1	817-312	AUX. LOW WATER CUT-OFF (McDM 63-BM)	OPTIONAL
	1	817-777	AUX. LOW WATER CUT-OFF (McDM 64-B) *	OPTIONAL
	1	817-2407	AUX. LOW WATER CUT-OFF (McDM 150S-BM)	OPTIONAL

* NOTE: WHEN USING McD-M 64, WIRE AS MANUAL RESET THROUGH FLAME SAFEGUARD.

** NOTE: ADD APPROPRIATE WARRICK RELAYS TO BURNER CONTROL PANEL.

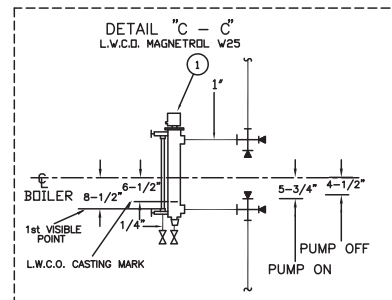
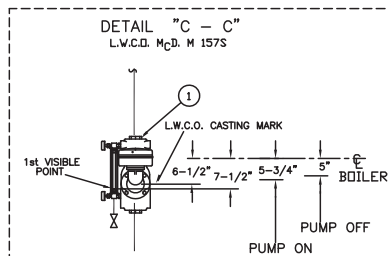
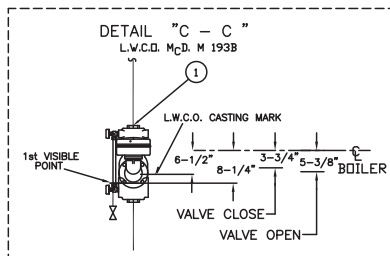
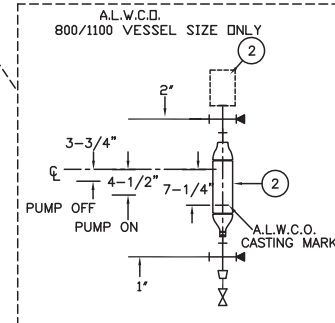
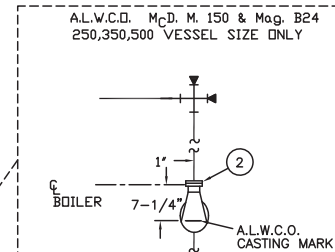
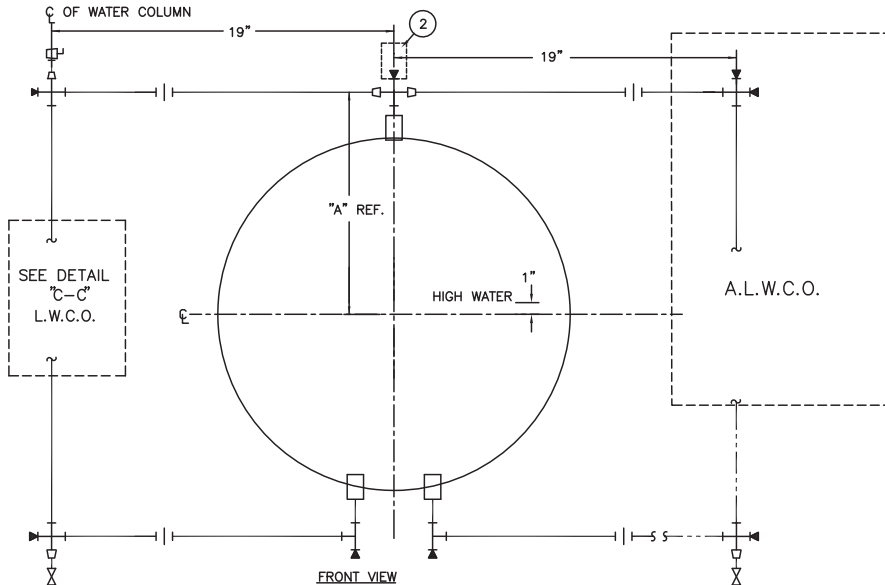
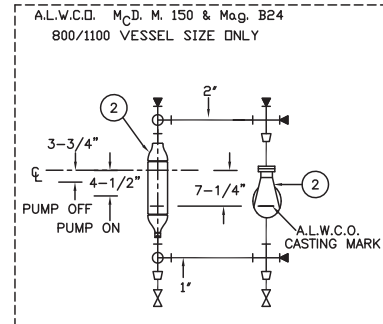
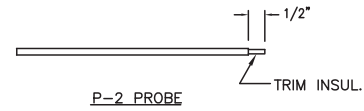
SIZE	A.L.W.C.O. PROBE LENGTHS		H.W. PROBE LENGTHS
	"A"	"B"	"C"
250	13-3/4"	22-3/8"	14-1/4"
350	13-3/4"	22-3/8"	14-1/4"
500	13-3/4"	22-3/8"	14-1/4"
800	15-3/4"	24-3/8"	16-1/4"
1100	15-3/4"	24-3/8"	16-1/4"



Water Column, Main and Aux. - 150# Steam

ITEM	QTY	PART NO.	DESCRIPTION	USED ON VESSEL SIZE
1	1	817-2411	LOW WATER CUT-OFF W/PUMP CONTROL(McDM 157S-RD-MD)	250/350/500
	1	817-2406	LOW WATER CUT-OFF (McDM 157S-R)	800/1100
	1	817-621	LOW WATER CUT-OFF (McDM 193B)	OPTIONAL SEE NOTE No 3
	1	817-163	LOW WATER CUT-OFF W/PUMP CONTROL (Mag. W25)	OPTIONAL
2	1	817-2305	McDM #750-MR CONTROL BOX - A.L.W.C.O.	250/350/500
	1	817-2306	McDM SENSOR HEAD, RS-1-BR-1	
	1	817-2307	PROBE FOR McDM, P-2-SS(TRIM PER DETAIL & "B" LGTH)	
	1	817-2305	McDM #750-MR CONTROL BOX - A.L.W.C.O.	800/1100
	1	817-2307	PROBE FOR McDM, P-2-SS(TRIM PER DETAIL & "B" LGTH)	
	1	817-2397	McDM CONTROL BOX, PCH-G-M-3 - PUMP CONTROL	
	1	817-2387	McDM SENSOR HEAD, RS-3-BR-1	
	1	817-2388	PROBE FOR McDM, P-2-SS(TRIM PER DETAIL & "C" LGTH)	
	1	817-2388	PROBE FOR McDM, P-2-SS(TRIM PER DETAIL & "D" LGTH)	
	1	100-A-402	BODY,ALWCO FLEXTUBE 800, 150#	
	1	817-740	AUX. LOW WATER CUT-OFF (WARRICK E2) *	OPTIONAL
	2	067-868	PROBES FOR WARRICK (TRIM PER "B" DIM.)	OPTIONAL
	1	817-1020	AUX. LWCO (WARRICK E3 W/HIGH ALARM) *	OPTIONAL
	3	067-868	PROBES FOR WARRICK (TRIM 2 PER "B", 1 PER "E")	OPTIONAL
	1	817-97	AUX. LOW WATER CUT-OFF (McDM 150S-M)	OPTIONAL
	1	817-93	AUX. LOW WATER CUT-OFF (MAG. B24)	OPTIONAL

* - ADD APPROPRIATE WARRICK RELAYS TO BURNER CONTROL PANEL.



SIZE	"A"	PROBE LENGTHS				H.W. "E"
		A.L.W.C.O. "B"	PUMP ON "C"	PUMP OFF "D"		
250	13-3/4"	22-1/2"	-	-		14-1/4"
350	13-3/4"	22-1/2"	-	-		14-1/4"
500	13-3/4"	22-1/2"	-	-		14-1/4"
800	15-3/4"	24-1/2"	21-3/4"	21"		16-1/4"
1100	15-3/4"	24-1/2"	-	-		16-1/4"

Safety Valves

			H. P. STEAM							
Boiler Size	Min. Relieving Cap. (lbs/hr)		15 PSI	30 PSI	45 PSI	60 PSI	75 PSI	100 PSI	125 PSI	150 PSI
150-250	2125	Inlet (in') Outlet (in') P/N (940-)	2 @ 1.5 2 5332	2 2.5 5524	1.5 2 5338	1.5 2 5341	1.25 1.5 5391	1.25 1.5 5396	1 1.25 5068	1 1.25 5453
300-350	2975	Inlet (in') Outlet (in') P/N (940-)	2 @ 2 2.5 5521	2 @ 1.5 2 5335	2 2.5 5527	1.5 2 5341	1.5 2 5344	1.5 2 5349	1.25 1.5 5065	1.25 1.5 5405
400-600	5100	Inlet (in') Outlet (in') P/N (940-)		2 @ 2 2.5 5524	2 @ 2 2.5 5527	2 @ 1.5 2 5341	2 @ 1.5 2 5344	2 @ 1.25 1.5 5396	2 @ 1.25 1.5 5065	2 @ 1.25 1.5 5453
700-900	7650	Inlet (in') Outlet (in') P/N (940-)			2 @ 2 2.5 5527	2 @ 2 2.5 5530	2 @ 2 2.5 5533	2 @ 1.5 2 5349	2 @ 1.5 2 5074	2 @ 1.25 1.5 5405
1000-1200	10200	Inlet (in') Outlet (in') P/N (940-)					2 @ 2 2.5 5533	2 @ 2 2.5 5538	2 @ 1.5 2 5074	2 @ 1.5 2 5358

			LP ST
Boiler Size	Min. Relieving Cap. (lbs/hr)		15 PSI
150-250	3073	Inlet (in') Outlet (in') P/N (940-)	2 2 5297
300-350	3798	Inlet (in') Outlet (in') P/N (940-)	2.5 2.5 5632
400-600	5450	Inlet (in') Outlet (in') P/N (940-)	3 3 5298
700-900	7958	Inlet (in') Outlet (in') P/N (940-)	2 @ 2.5 2.5 5632
1000-1200	9749	Inlet (in') Outlet (in') P/N (940-)	2 @ 3 3 5298

			Hot Water							
Boiler Size	Min. Relieving Cap. (MBH)		30 PSI	50 PSI	60 PSI	75 PSI	100 PSI	125 PSI	150 PSI	160 PSI
150-250	2946	Inlet (in') Outlet (in') P/N (940-)	1.5 2 5143	1.25 1.5 5147	1.25 1.5 5818	1 1.25 6015	1 1.25 5806	.75 1 5150	.75 1 5153	.75 1 5155
300-350	3656	Inlet (in') Outlet (in') P/N (940-)	1.5 2 5143	1.25 1.5 5147	1.25 1.5 5818	1.25 1.5 6016	1 1.25 5806	1 1.25 5151	1 1.25 5154	.75 1 5155
400-600	5360	Inlet (in') Outlet (in') P/N (940-)	2 2.5 5144	1.5 2 5148	1.5 2 5766	1.5 2 5705	1.25 1.5 6017	1.25 1.5 5152	1 1.25 5154	1 1.25 5320
700-900	7729	Inlet (in') Outlet (in') P/N (940-)	2 @ 2 2.5 5144	2 2.5 5149	2 2.5 6018	2 2.5 6019	1.5 2 5704	1.25 1.5 5152	1.25 1.5 5327	1.25 1.5 5200
1000-1100	9360	Inlet (in') Outlet (in') P/N (940-)	2 @ 2 2.5 5144	2 @ 1.5 2 5148	2 2.5 6018	2 2.5 6019	1.5 2 5704	1.5 2 5324	1.25 1.5 5327	1.25 1.5 5200
1200	9600	Inlet (in') Outlet (in') P/N (940-)	2 @ 2 2.5 5144	2 @ 1.5 2 5148	2 2.5 6018	2 2.5 6019	1.5 2 5704	1.5 2 5324	1.25 1.5 5327	1.25 1.5 5200

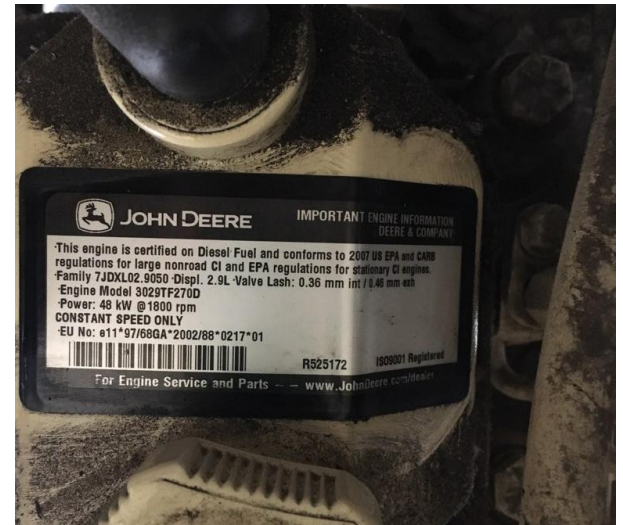
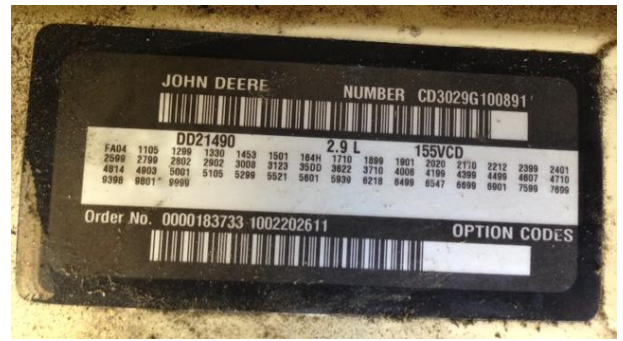
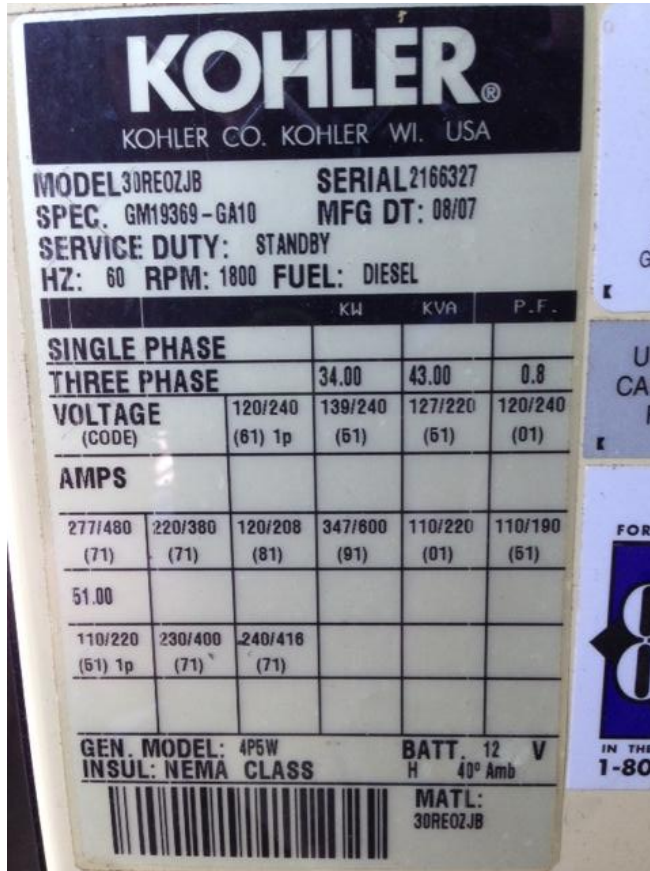
			High Temperature Hot Water										(KUNKLE # 927-SERIES ONLY)	
Boiler Size	Min. Relieving Cap. (#/hr)		30 PSI	50 PSI	60 PSI	65 PSI	75 PSI	100 PSI	125 PSI	150 PSI	160 PSI	200 PSI		
150-250	2, 947	Inlet (in') Outlet (in') P/N									1.25 2			
300-350		Inlet (in') Outlet (in') P/N												
400-600		Inlet (in') Outlet (in') P/N												
700-900	7, 729	Inlet (in') Outlet (in') P/N (940-)							2 @ 1.5 2.5 6674					
1000-1100		Inlet (in') Outlet (in') P/N												
1200	9, 600	Inlet (in') Outlet (in') P/N (940-)				2 @ 2.0 3.0 7057						1 @ 2.0 3.0 7136		



e-mail: info@cleaverbrooks.com

Web Address: <http://www.cleaverbrooks.com>

Guard Shack Emergency Generator



Plant Emergency Generator



SER. NO. 4ZR06850

ENGINE MODEL 3406

MODIFICATION NO. SEE ORDER

AR NO. 128-7027

CORE AR

OEM NO.

FULL LOAD
STATIC FUEL 4.29mm

PERF SPEC 2T-8186

MAX 3400 RPM
ALT 11319 FT

FULL TORQ. 4.54mm
STATIC FUEL

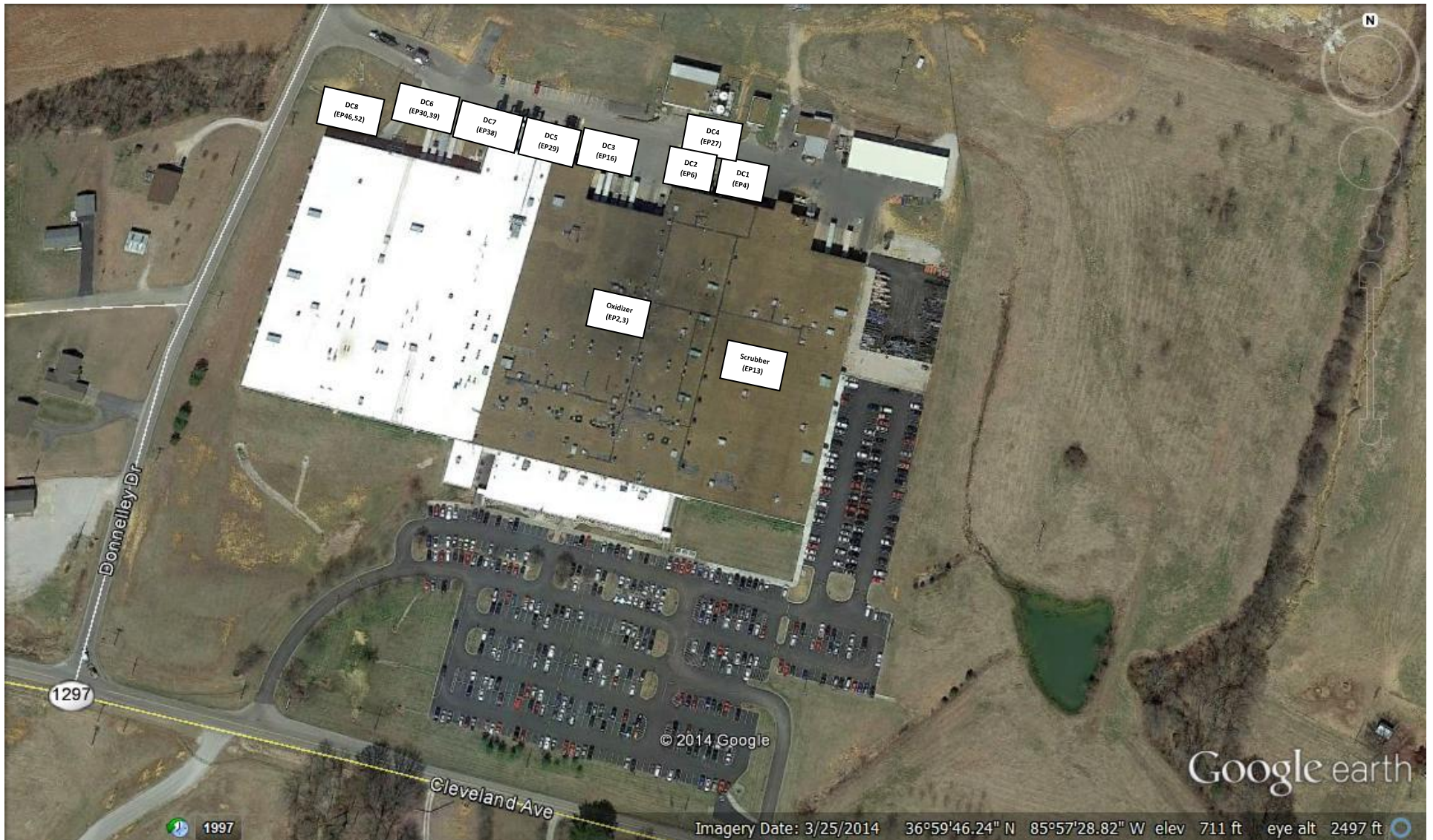
BARE ENG. HIGH

RATED 449 HP 335.0 kW AT 1800 RPM IDLE RPM 1839

FUEL TIMING 21.0BTC A/F RATIO DYNAMIC

115-5852 2

Akebono Brake
1765 Cleveland Ave.
Glasgow, KY
Location Map Showing Control Devices





SAFETY DATA SHEET

SDS ID NO.: 0290MAR019
Revision Date 06/01/2016

1. IDENTIFICATION

Product Name: Marathon Petroleum No. 2 Ultra Low Sulfur Diesel

Synonym: #2 Diesel; No. 2 Ultra Low Sulfur Diesel 15 ppm Sulfur Max; Ultra Low Sulfur Diesel No. 2 15 ppm Sulfur Max; Ultra Low Sulfur Diesel No. 2 15 ppm Sulfur Max with Polar Plus; No. 2 Diesel, Motor Vehicle Use, Undyed; No. 2 Diesel, Motor Vehicle Use, Undyed, with Polar Plus; ULSD No. 2 Diesel 15 ppm Sulfur Max; ULSD No. 2 Diesel 15 ppm Sulfur Max with Polar Plus; No. 2 NR 15 Diesel; No. 2 NR 15 Diesel with Polar Plus; No. 2 Ultra Low Sulfur Diesel Dyed 15 ppm Sulfur Max; Ultra Low Sulfur Diesel No. 2 Dyed 15 ppm Sulfur Max; Ultra Low Sulfur Diesel No. 2 Dyed 15 ppm Sulfur Max with Polar Plus; No. 2 Diesel, Tax Exempt-Motor Vehicle Use, Dyed; No. 2 Diesel, Tax Exempt-Motor Vehicle Use, Dyed, with Polar Plus; ULSD No. 2 Diesel Dyed 15 ppm Sulfur Max; ULSD No. 2 Diesel Dyed 15 ppm Sulfur Max, with Polar Plus; No. 2 NR 15 Diesel Dyed; #2 NR 15 CFI Diesel; #2 NR 15 CFI Diesel Dyed; No. 2 Low Sulfur Diesel (TxLED); No. 2 NR 15 Diesel Dyed, with Polar Plus; No. 2 NRLM 15 Diesel Dyed; No.2 NRLM Diesel Dyed; No. 2 NR 500 ppm TxLED; No.2 Low Emission Low Sulfur Diesel; No. 2 Low Sulfur Diesel (TxLED) 500 ppm Sulfur Max; No. 2 Heating Oil 5000 NMA Unmarked; NEMA No. 2 Heating Oil; Heating Oil, No. 2 Low Sulfur 5000 ppm; No. 2 Ultra Low Sulfur Diesel Dyed with <6% Renewable Diesel Fuel; Ultra Low Sulfur No. 2 Diesel Dyed with <6% Renewable Diesel Fuel; No. 2 Diesel Dyed with <6% Renewable Diesel Fuel 15 ppm Sulfur Max; No. 2 Ultra Low Sulfur Diesel with <6% Renewable Diesel Fuel; Ultra Low Sulfur No. 2 Diesel with <6% Renewable Diesel Fuel; No. 2 Diesel with <6% Renewable Diesel Fuel 15 ppm Sulfur Max; Garyville Export Diesel; Export Diesel, Garyville; Diesel Fuel, Export Garyville; #2 Motor Vehicle ULSD 15 ppm with 0-5% Renewable Diesel; Marathon No. 2 ULSD with 0-5% Renewable Fuel with R100; Marathon No. 2 ULSD with 0-5% Renewable Fuel with R99; No. 2 Heating Oil 2000 ppm Sulfur Max, Clear (Undyed) Unmarked; Ultra Low Sulfur Heating Oil 15 ppm Sulfur Max, Clear (Undyed) Unmarked; ULS Heating Oil 15 ppm Clear (Undyed) Unmarked; ULS HO 15 ppm CLR; Ultra-Low Sulfur Heating Oil (<= 15ppm, Undyed); No. 2 Heating Oil 2000 ppm Sulfur Max, Dyed Unmarked; No. 2 Heating Oil 2000 ppm Sulfur Max, Dyed Marked; Ultra Low Sulfur Heating Oil 15 ppm Sulfur Max, Dyed Unmarked; Ultra Low Sulfur Heating Oil 15 ppm Sulfur Max, Dyed Marked; 15 ppm Sulfur Heating Oil Grade 67; 15 PPM Heating Oil; 15 PPM Dyed Heating Oil; 0291MAR019; 0306MAR019; 0308MAR019; 0334MAR019; 0335MAR019; 0336MAR019; 0337MAR019; 0340MAR019;

Product Code: 0290MAR019
Chemical Family: Complex Hydrocarbon Substance

Recommended Use: Fuel.
Restrictions on Use: All others.

Manufacturer, Importer, or Responsible Party Name and Address:
MARATHON PETROLEUM COMPANY LP
539 South Main Street
Findlay, OH 45840

SDS information: 1-419-421-3070

Emergency Telephone: 1-877-627-5463

2. HAZARD IDENTIFICATION

Classification

OSHA Regulatory Status

This chemical is considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200)

Flammable liquids	Category 3
Acute toxicity - Inhalation (Dusts/Mists)	Category 4
Skin corrosion/irritation	Category 2
Carcinogenicity	Category 2
Specific target organ toxicity (single exposure)	Category 3
Specific target organ toxicity (repeated exposure)	Category 2
Aspiration toxicity	Category 1
Acute aquatic toxicity	Category 2
Chronic aquatic toxicity	Category 2

Hazards Not Otherwise Classified (HNOC)

Static accumulating flammable liquid

Label elements

EMERGENCY OVERVIEW

Danger

FLAMMABLE LIQUID AND VAPOR

May accumulate electrostatic charge and ignite or explode

May be fatal if swallowed and enters airways

Harmful if inhaled

Causes skin irritation

May cause respiratory irritation

May cause drowsiness or dizziness

Suspected of causing cancer

May cause damage to organs (thymus, liver, bone marrow) through prolonged or repeated exposure

Toxic to aquatic life with long lasting effects



Appearance Yellow to Red Liquid

Physical State Liquid

Odor Hydrocarbon

Precautionary Statements - Prevention

Obtain special instructions before use

Do not handle until all safety precautions have been read and understood

Keep away from heat/sparks/open flames/hot surfaces. - No smoking

Keep container tightly closed

Ground/bond container and receiving equipment

Use only non-sparking tools.

Use explosion-proof electrical/ventilating/lighting/equipment

Take precautionary measures against static discharge

Do not breathe mist/vapors/spray

Use only outdoors or in a well-ventilated area

Wear protective gloves/protective clothing/eye protection/face protection
Wash hands and any possibly exposed skin thoroughly after handling
Avoid release to the environment

Precautionary Statements - Response

IF exposed or concerned: Get medical attention
IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower
If skin irritation occurs: Get medical attention
Wash contaminated clothing before reuse
IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing
Call a POISON CENTER or doctor if you feel unwell
IF SWALLOWED: Immediately call a POISON CENTER or doctor
Do NOT induce vomiting
In case of fire: Use water spray, fog or regular foam for extinction
Collect spillage

Precautionary Statements - Storage

Store in a well-ventilated place. Keep container tightly closed
Keep cool
Store locked up

Precautionary Statements - Disposal

Dispose of contents/container at an approved waste disposal plant

3. COMPOSITION/INFORMATION ON INGREDIENTS

No. 2 Ultra Low Sulfur Diesel is a complex mixture of paraffins, cycloparaffins, olefins and aromatic hydrocarbon chain lengths predominantly in the range of eleven to twenty carbons. May contain up to 5% Renewable Diesel. May contain small amounts of dye and other additives (<0.15%) which are not considered hazardous at the concentration(s) used. May contain a trace amount of benzene (<0.01%). Contains a trace amount of sulfur (<0.0015%)

Composition Information:

Name	CAS Number	% Concentration
No. 2 Diesel Fuel	68476-34-6	50-100
Kerosine (petroleum)	8008-20-6	0-50
Alkanes, C10-C20 branched and linear	928771-01-1	0-5
Naphthalene	91-20-3	0.3-2.6

All concentrations are percent by weight unless material is a gas. Gas concentrations are in percent by volume.

4. FIRST AID MEASURES

First Aid Measures

General Advice:

In case of accident or if you feel unwell, seek medical advice immediately (show directions for use or safety data sheet if possible).

Inhalation:

Remove to fresh air. If not breathing, institute rescue breathing. If breathing is difficult, ensure airway is clear, give oxygen and continue to monitor. If heart has stopped, immediately begin cardiopulmonary resuscitation (CPR). Keep affected person warm and at rest. GET IMMEDIATE MEDICAL ATTENTION.

Skin Contact:

Immediately wash exposed skin with plenty of soap and water while removing contaminated clothing and shoes. May be absorbed through the skin in harmful amounts. Get medical attention if irritation persists. Any injection injury from high pressure equipment should be evaluated immediately by a physician as potentially serious (See NOTES TO PHYSICIAN).

Place contaminated clothing in closed container until cleaned or discarded. If clothing is to be laundered, inform the person performing the operation of contaminant's hazardous

properties. Destroy contaminated, non-chemical resistant footwear.

Eye Contact:

Flush immediately with large amounts of water for at least 15 minutes. Eyelids should be held away from the eyeball to ensure thorough rinsing. Gently remove contacts while flushing. Get medical attention if irritation persists.

Ingestion:

Do not induce vomiting because of danger of aspirating liquid into lungs, causing serious damage and chemical pneumonitis. If spontaneous vomiting occurs, keep head below hips, or if patient is lying down, turn body and head to side to prevent aspiration and monitor for breathing difficulty. Never give anything by mouth to an unconscious person. Keep affected person warm and at rest. GET IMMEDIATE MEDICAL ATTENTION.

Most important signs and symptoms, both short-term and delayed with overexposure

Adverse Effects:

Irritating to the skin and mucous membranes. Symptoms may include redness, itching, and inflammation. May cause nausea, vomiting, diarrhea, and signs of nervous system depression: headache, drowsiness, dizziness, loss of coordination, disorientation and fatigue. Aspiration hazard. May cause coughing, chest pains, shortness of breath, pulmonary edema and/or chemical pneumonitis. Repeated or prolonged skin contact may cause drying, reddening, itching and cracking. Prolonged or repeated exposure may cause adverse effects to the thymus, liver, and bone marrow.

Indication of any immediate medical attention and special treatment needed

Notes To Physician:

INHALATION: This material (or a component) sensitizes the myocardium to the effects of sympathomimetic amines. Epinephrine and other sympathomimetic drugs may initiate cardiac arrhythmias in individuals exposed to this material. Administration of sympathomimetic drugs should be avoided.

SKIN: Leaks or accidents involving high-pressure equipment may inject a stream of material through the skin and initially produce an injury that may not appear serious. Only a small puncture wound may appear on the skin surface but, without proper treatment and depending on the nature, original pressure, volume, and location of the injected material, can compromise blood supply to an affected body part. Prompt surgical debridement of the wound may be necessary to prevent irreversible loss of function and/or the affected body part. High pressure injection injuries may be SERIOUS SURGICAL EMERGENCIES.

INGESTION: This material represents a significant aspiration and chemical pneumonitis hazard. Induction of emesis is not recommended.

5. FIRE-FIGHTING MEASURES

Suitable extinguishing media

For small fires, Class B fire extinguishing media such as CO₂, dry chemical, foam (AFFF/ATC) or water spray can be used. For large fires, water spray, fog or foam (AFFF/ATC) can be used. Firefighting should be attempted only by those who are adequately trained and equipped with proper protective equipment.

Unsuitable extinguishing media

Do not use straight water streams to avoid spreading fire.

Specific hazards arising from the chemical

This product has been determined to be a flammable liquid per the OSHA Hazard Communication Standard and should be handled accordingly. May accumulate electrostatic charge and ignite or explode. Vapors may travel along the ground or be moved by ventilation and ignited by many sources such as pilot lights, sparks, electric motors, static discharge, or other ignition sources at locations distant from material handling. Flashback can occur along vapor trail. For additional fire related information, see NFPA 30 or the Emergency Response Guidebook 128.

Hazardous combustion products

Smoke, carbon monoxide, and other products of incomplete combustion.

Explosion data

Sensitivity to Mechanical Impact No.
Sensitivity to Static Discharge Yes.

Special protective equipment and precautions for firefighters

Firefighters should wear full protective clothing and positive-pressure self-contained breathing apparatus (SCBA) with a full face-piece, as appropriate. Avoid using straight water streams. Water spray and foam (AFFF/ATC) must be applied carefully to avoid frothing and from as far a distance as possible. Avoid excessive water spray application. Keep surrounding area cool with water spray from a distance and prevent further ignition of combustible material. Keep run-off water out of sewers and water sources.

Additional firefighting tactics

FIRES INVOLVING TANKS OR CAR/TRAILER LOADS: Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Cool containers with flooding quantities of water until well after the fire is out. Do not direct water at source of leak or safety devices; icing may occur. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. ALWAYS stay away from tanks engulfed in fire. For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn.

EVACUATION: Consider initial downwind evacuation for at least 1000 feet. If tank, rail car or tank truck is involved in a fire, ISOLATE for 5280 feet (1 mile) in all directions; also, consider initial evacuation of 5280 feet (1 mile) in all directions.

NFPA Health 1 Flammability 2 Instability 0 Special Hazard -

6. ACCIDENTAL RELEASE MEASURES

Personal precautions:	Keep public away. Isolate and evacuate area. Shut off source if safe to do so. Eliminate all ignition sources. All contaminated surfaces will be slippery.
Protective equipment:	Use personal protection measures as recommended in Section 8.
Emergency procedures:	Advise authorities and National Response Center (800-424-8802) if the product has entered a water course or sewer. Notify local health and pollution control agencies, if appropriate.
Environmental precautions:	Avoid release to the environment. Avoid subsoil penetration.
Methods and materials for containment:	Contain liquid with sand or soil. Prevent spilled material from entering storm drains, sewers, and open waterways.
Methods and materials for cleaning up:	Use suitable absorbent materials such as vermiculite, sand, or clay to clean up residual liquids. Recover and return free product to proper containers. When recovering free liquids ensure all equipment is grounded and bonded. Use only non-sparking tools.

7. HANDLING AND STORAGE

Safe Handling Precautions:	NEVER SIPHON THIS PRODUCT BY MOUTH. Use appropriate grounding and bonding practices. Static accumulating flammable liquid. Bonding and grounding may be insufficient to eliminate the hazard from static electricity. Do not expose to heat, open flames, strong oxidizers or other sources of ignition. Vapors may travel along the ground or be moved by ventilation. Flashback may occur along vapor trails. No smoking. Use only non-sparking tools. Avoid breathing fumes, gas, or vapors. Use only with adequate ventilation. Avoid repeated and prolonged skin contact. Use personal protection measures as recommended in Section 8. Exercise good personal hygiene including removal of soiled clothing and prompt washing with soap and water. Do not cut, drill, grind or weld on empty containers since explosive residues may remain. Refer to applicable EPA, OSHA, NFPA and consistent state and local requirements. Hydrocarbons are basically non-conductors of electricity and can become electrostatically charged during mixing, filtering, pumping at high flow rates or loading and transfer operations. If this charge reaches a sufficiently high level, sparks can form that may ignite
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the vapors of flammable liquids. Sudden release of hot organic chemical vapors or mists from process equipment operating under elevated temperature and pressure, or sudden ingress of air into vacuum equipment may result in ignition of vapors or mists without the presence of obvious ignition sources. Nozzle spouts must be kept in contact with the containers or tank during the entire filling operation.

Portable containers should never be filled while in or on a motor vehicle or marine craft. Containers should be placed on the ground. Static electric discharge can ignite fuel vapors when filling non-grounded containers or vehicles on trailers. The nozzle spout must be kept in contact with the container before and during the entire filling operation. Use only approved containers.

A buildup of static electricity can occur upon re-entry into a vehicle during fueling especially in cold or dry climate conditions. The charge is generated by the action of dissimilar fabrics (i.e., clothing and upholstery) rubbing across each other as a person enters/exits the vehicle. A flash fire can result from this discharge if sufficient flammable vapors are present. Therefore, do not get back in your vehicle while refueling.

Cellular phones and other electronic devices may have the potential to emit electrical charges (sparks). Sparks in potentially explosive atmospheres (including fueling areas such as gas stations) could cause an explosion if sufficient flammable vapors are present. Therefore, turn off cellular phones and other electronic devices when working in potentially explosive atmospheres or keep devices inside your vehicle during refueling.

High-pressure injection of any material through the skin is a serious medical emergency even though the small entrance wound at the injection site may not initially appear serious. These injection injuries can occur from high-pressure equipment such as paint spray or grease or guns, fuel injectors, or pinhole leaks in hoses or hydraulic lines and should all be considered serious. High pressure injection injuries may be SERIOUS SURGICAL EMERGENCIES (See First Aid Section 4).

Storage Conditions:

Store in properly closed containers that are appropriately labeled and in a cool, well-ventilated area. Do not store near an open flame, heat or other sources of ignition.

Incompatible Materials

Strong oxidizing agents.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Name	ACGIH TLV	OSHA PELs:	OSHA - Vacated PELs	NIOSH IDLH
No. 2 Diesel Fuel 68476-34-6	100 mg/m ³ TWA Skin - potential significant contribution to overall exposure by the cutaneous route	-	-	-
Kerosine (petroleum) 8008-20-6	200 mg/m ³ TWA Skin - potential significant contribution to overall exposure by the cutaneous route	-	-	-
Alkanes, C10-C20 branched and linear 928771-01-1	-	-	-	-
Naphthalene 91-20-3	10 ppm TWA Skin - potential significant contribution to overall exposure by the cutaneous route	TWA: 10 ppm TWA: 50 mg/m ³	10 ppm TWA 50 mg/m ³ TWA 15 ppm STEL 75 mg/m ³ STEL	250 ppm

Notes:

The manufacturer has voluntarily elected to provide exposure limits contained in OSHA's 1989 air contaminants standard in its SDSs, even though certain of those exposure limits were vacated in 1992.

Engineering measures:

Local or general exhaust required in an enclosed area or with inadequate ventilation. Use

mechanical ventilation equipment that is explosion-proof.

Personal protective equipment

Eye protection:	Use goggles or face-shield if the potential for splashing exists.
Skin and body protection:	Wear neoprene, nitrile or PVA gloves to prevent skin contact. Glove suitability is based on workplace conditions and usage. Contact the glove manufacturer for specific advice on glove selection and breakthrough times.
Respiratory protection:	Use a NIOSH approved organic vapor chemical cartridge or supplied air respirators when there is the potential for airborne exposures to exceed permissible exposure limits or if excessive vapors are generated. Observe respirator assigned protection factors (APFs) criteria cited in federal OSHA 29 CFR 1910.134. Self-contained breathing apparatus should be used for fire fighting.
Hygiene measures:	Handle in accordance with good industrial hygiene and safety practice. Avoid contact with skin, eyes and clothing.

9. PHYSICAL AND CHEMICAL PROPERTIES

Information on basic physical and chemical properties

Physical State	Liquid
Appearance	Yellow to Red Liquid
Color	Yellow to Red
Odor	Hydrocarbon
Odor Threshold	No data available.

<u>Property</u>	<u>Values (Method)</u>
Melting Point / Freezing Point	No data available.
Initial Boiling Point / Boiling Range	154-366 °C / 310-691 °F (ASTM D86)
Flash Point	58-76 °C / 136-168 °F (ASTM D93)
Evaporation Rate	No data available.
Flammability (solid, gas)	Not applicable.
Flammability Limit in Air (%):	
Upper Flammability Limit:	No data available.
Lower Flammability Limit:	No data available.
Explosion limits:	No data available.
Vapor Pressure	No data available.
Vapor Density	No data available.
Specific Gravity / Relative Density	0.82-0.86
Water Solubility	No data available.
Solubility in other solvents	No data available.
Partition Coefficient	No data available.
Decomposition temperature	No data available.
pH:	Not applicable
Autoignition Temperature	No data available.
Kinematic Viscosity	1.90-3.32 cSt @ 40°C (ASTM D445)
Dynamic Viscosity	No data available.
Explosive Properties	No data available.
VOC Content (%)	No data available.
Density	No data available.
Bulk Density	Not applicable.

10. STABILITY AND REACTIVITY

<u>Reactivity</u>	The product is non-reactive under normal conditions.
<u>Chemical stability</u>	The material is stable at 70°F (21°C), 760 mmHg pressure.

<u>Possibility of hazardous reactions</u>	None under normal processing.
<u>Hazardous polymerization</u>	Will not occur.
<u>Conditions to avoid</u>	Excessive heat, sources of ignition, open flame.
<u>Incompatible Materials</u>	Strong oxidizing agents.
<u>Hazardous decomposition products</u>	None known under normal conditions of use.

11. TOXICOLOGICAL INFORMATION

Potential short-term adverse effects from overexposures

Inhalation	Harmful if inhaled. May cause irritation of respiratory tract. May cause drowsiness or dizziness. Breathing high concentrations of this material in a confined space or by intentional abuse can cause irregular heartbeats which can cause death.
Eye contact	Exposure to vapor or contact with liquid may cause mild eye irritation, including tearing, stinging, and redness.
Skin contact	Irritating to skin. Effects may become more serious with repeated or prolonged contact. May be absorbed through the skin in harmful amounts.
Ingestion	May be fatal if swallowed or vomited and enters airways. May cause irritation of the mouth, throat and gastrointestinal tract.

Acute toxicological data

Name	Oral LD50	Dermal LD50	Inhalation LC50
No. 2 Diesel Fuel 68476-34-6	> 5000 mg/kg (Rat)	> 2000 mg/kg (Rabbit)	>1 - <5 mg/L (Rat) 4 h
Kerosine (petroleum) 8008-20-6	> 5000 mg/kg (Rat)	> 2000 mg/kg (Rabbit)	> 5.28 mg/L (Rat) 4 h
Alkanes, C10-C20 branched and linear 928771-01-1	-	-	>1 - <5 mg/l (Rat) 4 h
Naphthalene 91-20-3	490 mg/kg (Rat)	> 2000 mg/kg (Rabbit)	> 340 mg/m ³ (Rat) 1 h

Delayed and immediate effects as well as chronic effects from short and long-term exposure

MIDDLE DISTILLATES, PETROLEUM: Long-term repeated (lifetime) skin exposure to similar materials has been reported to result in an increase in skin tumors in laboratory rodents. The relevance of these findings to humans is not clear at this time. Altered mental state, drowsiness, peripheral motor neuropathy, irreversible brain damage (so-called Petrol Sniffer's Encephalopathy), delirium, seizures, and sudden death have been reported from repeated overexposure to some hydrocarbon solvents, naphthas, and gasoline.

MIDDLE DISTILLATES WITH CRACKED STOCKS: Light cracked distillates have been shown to be carcinogenic in animal tests and have tested positive with in vitro genotoxicity tests. Repeated dermal exposures to high concentrations in test animals resulted in reduced litter size and litter weight, and increased fetal resorptions at maternally toxic doses. Dermal exposure to high concentrations resulted in severe skin irritation with weight loss and some mortality. Inhalation exposure to high concentrations resulted in respiratory tract irritation, lung changes/infiltration/accumulation, and reduction in lung function.

ISOPARAFFINS: Studies in laboratory animals have shown that long-term exposure to similar materials (isoparaaffins) can cause kidney damage and kidney cancer in male laboratory rats. However, in-depth research indicates that these findings are unique to the male rat, and that these effects are not relevant to humans.

NAPHTHALENE: Severe jaundice, neurotoxicity (kernicterus) and fatalities have been reported in young children and infants as a result of hemolytic anemia from overexposure to naphthalene. Persons with glucose 6-phosphate dehydrogenase (G6PD) deficiency are more prone to the hemolytic effects of naphthalene. Adverse effects on the kidney have been reported in persons overexposed to naphthalene but these effects are believed to be a consequence of hemolytic anemia, and not a direct effect. Hemolytic anemia has been observed in laboratory animals exposed to naphthalene. Laboratory rodents exposed to naphthalene vapor for 2 years (lifetime studies) developed non-neoplastic and neoplastic tumors and inflammatory lesions of the nasal and respiratory tract. Cataracts and other adverse effects on the eye have been observed in laboratory animals exposed to high levels of naphthalene. Findings from a large number of bacterial and mammalian cell mutation assays have been negative. A few studies have shown chromosomal effects (elevated levels of Sister Chromatid Exchange or chromosomal aberrations) in vitro. Naphthalene has been classified as Possibly Carcinogenic to Humans (2B) by IARC, based on findings from studies in laboratory animals.

DIESEL EXHAUST: The combustion of diesel fuels produces gases including carbon monoxide, carbon dioxide, oxides of nitrogen and/or sulfur, and hydrocarbons that can be irritating and hazardous with overexposure. Long-term occupational overexposure to diesel exhaust and diesel exhaust particulate matter has been associated with an increased risk of respiratory disease, including lung cancer, and is characterized as a "known human carcinogen" by the International Agency for Research on Cancer (IARC), as "a reasonably anticipated human carcinogen" by the National Toxicology Program, and as "likely to be carcinogenic to humans" by the EPA, based upon animal and occupational exposure studies. However, uncertainty exists with these classifications because of deficiencies in the supporting occupational exposure/epidemiology studies, including reliable exposure estimates. Lifetime animal inhalation studies with pulmonary overloading exposure concentrations of diesel exhaust emissions have produced tumors and other adverse health effects. However, in more recent long-term animal inhalation studies of diesel exhaust emissions, no increase in tumor incidence and in fact a substantial reduction in adverse health effects along with significant reductions in the levels of hazardous material emissions were observed and are associated with fuel composition alterations coupled with new technology diesel engines.

Adverse effects related to the physical, chemical and toxicological characteristics

Signs and Symptoms	Irritating to the skin and mucous membranes. Symptoms may include redness, itching, and inflammation. May cause nausea, vomiting, diarrhea, and signs of nervous system depression: headache, drowsiness, dizziness, loss of coordination, disorientation and fatigue. Aspiration hazard. May cause coughing, chest pains, shortness of breath, pulmonary edema and/or chemical pneumonitis. Repeated or prolonged skin contact may cause drying, reddening, itching and cracking. Prolonged or repeated exposure may cause damage to organs.
Skin corrosion/irritation	Causes skin irritation.
Serious eye damage/eye irritation	None known.
Sensitization	None known.
Mutagenic effects	None known.
Carcinogenicity	Suspected of causing cancer.

Cancer designations are listed in the table below

Name	ACGIH (Class)	IARC (Class)	NTP	OSHA
No. 2 Diesel Fuel 68476-34-6	Confirmed animal carcinogen (A3)	Not Classifiable (3)	Not Listed	Not Listed
Kerosine (petroleum) 8008-20-6	Confirmed animal carcinogen (A3)	Not Classifiable (3)	Not Listed	Not Listed
Alkanes, C10-C20 branched and linear	Not Listed	Not Listed	Not Listed	Not Listed

928771-01-1				
Naphthalene 91-20-3	Confirmed animal carcinogen (A3)	Possible human carcinogen (2B)	Reasonably anticipated to be a human carcinogen	Not Listed

Reproductive toxicity None known.

Specific Target Organ Toxicity (STOT) - single exposure Respiratory system. Central nervous system.

Specific Target Organ Toxicity (STOT) - repeated exposure Thymus. Liver. Bone marrow.

Aspiration hazard May be fatal if swallowed or vomited and enters airways.

12. ECOLOGICAL INFORMATION

Ecotoxicity This product should be considered toxic to aquatic organisms, with the potential to cause long lasting adverse effects in the aquatic environment.

Name	Algae/aquatic plants	Fish	Toxicity to Microorganisms	Crustacea
No. 2 Diesel Fuel 68476-34-6	-	96-hr LC50 = 35 mg/l Fathead minnow (flow-through)	-	48-hr EL50 = 6.4 mg/l Daphnia magna
Kerosine (petroleum) 8008-20-6	72-hr EL50 = 5.0-11 mg/l Algae	96-hr LL50 = 18-25 mg/l Fish	-	48-hr EL50 = 1.4-21 mg/l Invertebrates
Alkanes, C10-C20 branched and linear 928771-01-1	-	-	-	-
Naphthalene 91-20-3	-	96-hr LC50 = 0.91-2.82 mg/l Rainbow trout (static) 96-hr LC50 = 1.99 mg/l Fathead minnow (static)	-	48-hr LC50 = 1.6 mg/l Daphnia magna

Persistence and degradability Expected to be inherently biodegradable.

Bioaccumulation Has the potential to bioaccumulate.

Mobility in soil May partition into air, soil and water.

Other adverse effects No information available.

13. DISPOSAL CONSIDERATIONS

Description of Waste Residues

This material may be a flammable liquid waste.

Safe Handling of Wastes

Handle in accordance with applicable local, state, and federal regulations. Use personal protection measures as required. Use appropriate grounding and bonding practices. Use only non-sparking tools. Do not expose to heat, open flames, strong oxidizers or other sources of ignition. No smoking.

Disposal of Wastes / Methods of Disposal

The user is responsible for determining if any discarded material is a hazardous waste (40 CFR 262.11). Dispose of in accordance with federal, state and local regulations.

Methods of Contaminated Packaging Disposal

Empty containers should be completely drained and then discarded or recycled, if possible. Do not cut, drill, grind or weld on empty containers since explosive residues may be present. Dispose of in accordance with federal, state and local regulations.

14. TRANSPORT INFORMATION

DOT (49 CFR 172.101):

UN Proper Shipping Name:	Fuel Oil, No. 2
UN/Identification No:	NA 1993
Class:	3
Packing Group:	III

TDG (Canada):

UN Proper Shipping Name:	Diesel Fuel
UN/Identification No:	UN 1202
Transport Hazard Class(es):	3
Packing Group:	III

15. REGULATORY INFORMATION**US Federal Regulatory Information:**

US TSCA Chemical Inventory Section 8(b):

This product and/or its components are listed on the TSCA Chemical Inventory.

EPA Superfund Amendment & Reauthorization Act (SARA):**SARA Section 302:** This product does not contain any component(s) included on EPA's Extremely Hazardous Substance (EHS) List.

Name	CERCLA/SARA - Section 302 Extremely Hazardous Substances and TPQs
No. 2 Diesel Fuel	NA
Kerosine (petroleum)	NA
Alkanes, C10-C20 branched and linear	NA
Naphthalene	NA

SARA Section 304: This product may contain component(s) identified either as an EHS or a CERCLA Hazardous substance which in case of a spill or release may be subject to SARA reporting requirements:

Name	Hazardous Substances RQs
No. 2 Diesel Fuel	NA
Kerosine (petroleum)	NA
Alkanes, C10-C20 branched and linear	NA
Naphthalene	100 lb final RQ 45.4 kg final RQ

SARA Section 311/312: The following EPA hazard categories apply to this product:

Acute Health Hazard
Fire Hazard
Chronic Health Hazard

SARA Section 313: This product may contain component(s), which if in exceedance of the de minimus threshold, may be subject to the reporting requirements of SARA Title III Section 313 Toxic Release Reporting (Form R).

Name	CERCLA/SARA 313 Emission reporting:
No. 2 Diesel Fuel	None
Kerosine (petroleum)	None
Alkanes, C10-C20 branched and linear	None
Naphthalene	0.1 % de minimis concentration

State and Community Right-To-Know Regulations:

The following component(s) of this material are identified on the regulatory lists below:

No. 2 Diesel Fuel

Louisiana Right-To-Know:	Not Listed
California Proposition 65:	Not Listed
New Jersey Right-To-Know:	SN 2444
Pennsylvania Right-To-Know:	Not Listed
Massachusetts Right-To Know:	Not Listed
Florida Substance List:	Not Listed
Rhode Island Right-To-Know:	Not Listed
Michigan Critical Materials Register List:	Not Listed
Massachusetts Extraordinarily Hazardous Substances:	Not Listed
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Not Listed
New Jersey - Special Hazardous Substances:	Not Listed
New Jersey - Environmental Hazardous Substances List:	SN 2444 TPQ: 10000 lb (Under N.J.A.C. 7:1G, environmental hazardous substances in mixtures such as gasoline or new and used petroleum oil may be reported under these categories)
Illinois - Toxic Air Contaminants:	Not Listed
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	Not Listed

Kerosine (petroleum)

Louisiana Right-To-Know:	Not Listed
California Proposition 65:	Not Listed
New Jersey Right-To-Know:	SN 1091
Pennsylvania Right-To-Know:	Present
Massachusetts Right-To Know:	Present
Florida Substance List:	Not Listed
Rhode Island Right-To-Know:	Not Listed
Michigan Critical Materials Register List:	Not Listed
Massachusetts Extraordinarily Hazardous Substances:	Not Listed
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Not Listed
New Jersey - Special Hazardous Substances:	Not Listed
New Jersey - Environmental Hazardous Substances List:	SN 1091 TPQ: 10000 lb (Under N.J.A.C. 7:1G, environmental hazardous substances in mixtures such as gasoline or new and used petroleum oil may be reported under these categories)
Illinois - Toxic Air Contaminants:	Not Listed
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	Not Listed

Alkanes, C10-C20 branched and linear

Louisiana Right-To-Know:	Not Listed
California Proposition 65:	Not Listed
New Jersey Right-To-Know:	Not Listed
Pennsylvania Right-To-Know:	Not Listed
Massachusetts Right-To Know:	Not Listed
Florida Substance List:	Not Listed
Rhode Island Right-To-Know:	Not Listed
Michigan Critical Materials Register List:	Not Listed
Massachusetts Extraordinarily Hazardous Substances:	Not Listed
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Not Listed
New Jersey - Special Hazardous Substances:	Not Listed
New Jersey - Environmental Hazardous Substances List:	Not Listed
Illinois - Toxic Air Contaminants:	Not Listed
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	Not Listed

Naphthalene

Louisiana Right-To-Know:	Not Listed
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California Proposition 65:	Carcinogen, initial date 4/19/02
New Jersey Right-To-Know:	SN 1322 SN 3758
Pennsylvania Right-To-Know:	Environmental hazard Present (particulate)
Massachusetts Right-To Know:	Present
Florida Substance List:	Not Listed
Rhode Island Right-To-Know:	Toxic; Flammable
Michigan Critical Materials Register List:	Not Listed
Massachusetts Extraordinarily Hazardous Substances:	Not Listed
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Not Listed
New Jersey - Special Hazardous Substances:	Carcinogen
New Jersey - Environmental Hazardous Substances List:	SN 1322 TPQ: 500 lb (Reportable at the de minimis quantity of >0.1%)
Illinois - Toxic Air Contaminants:	Present
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	100 lb RQ (air); 1 lb RQ (land/water)

Canada DSL/NDL Inventory: This product and/or its components are listed either on the Domestic Substances List (DSL) or are exempt.

Canadian Regulatory Information: This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations and the SDS contains all of the information required by those regulations.

Name	Canada - WHMIS: Classifications of Substances:	Canada - WHMIS: Ingredient Disclosure:
No. 2 Diesel Fuel	B3,D2A,D2B	0.1%
Kerosine (petroleum)	B3,D2B	1%
Alkanes, C10-C20 branched and linear	B3,D2A,D2B	0.1%
Naphthalene	B4,D2A	0.1%



Note: Not applicable.

16. OTHER INFORMATION

Prepared By Toxicology and Product Safety

Issue Date 10/31/2016

Revision Notes

Revision Date 06/01/2016

Disclaimer

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information is intended as guidance for safe handling, use, processing, storage, transportation, accidental release, clean-up and disposal and is not considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text.

7.22.25

Permit Review Branch
Division for Air Quality
Department for Environmental Protection
300 Sower Boulevard – 2nd Floor
Frankfort, Kentucky 40601

RE: Akebono Brake – Glasgow (AI# 15685) 502(b)(10) change request

Review Branch:

According to the provisions in Section 502(b)(10) for permit revisions, we request the following changes to our Title V permit (V-20-010). We request to add the following Insignificant activity to said permit:

Emission Point	Equipment	Capacity	Action
	Side Paint Re-work	500 parts per Hour	Add fugitive emission point for insignificant activity

I have added the applicable 7007 Forms and a summary of our maximum emission potentials based on these changes. Feel free to contact me at 270-590-9034 or Brandon.petz@akebono-usa.com if you have any questions or need additional information.

Sincerely,

A handwritten signature in black ink, appearing to read 'Brandon Petz', with a stylized, cursive script.

Brandon Petz
HSE Manager

Division for Air Quality

300 Sower Boulevard
Frankfort, KY 40601
(502) 564-3999

DEP7007AI

Administrative Information

- ☐ Section AI.1: Source Information
☐ Section AI.2: Applicant Information
☐ Section AI.3: Owner Information
☐ Section AI.4: Type of Application
☐ Section AI.5: Other Required Information
☐ Section AI.6: Signature Block
☐ Section AI.7: Notes, Comments, and Explanations

Additional Documentation

☐ Additional Documentation attached

Source Name: Akebono Brake Corporation Glasgow Plant

KY EIS (AFS) #: 21- 009-00067

Permit #: V-20-010

Agency Interest (AI) ID: 15685

Date: 7.22.25

Section AI.1: Source Information

Physical Location Address:	Street:	<u>1765 Cleveland Ave</u>		
	City:	<u>Glasgow</u>	County:	<u>Barren</u>
Mailing Address:	Street or P.O. Box:	<u>1765 Cleveland Ave</u>		
	City:	<u>Glasgow</u>	State:	<u>KY</u>
		Zip Code:	<u>42141</u>	
		Zip Code:	<u>42141</u>	

Standard Coordinates for Source Physical Location

Longitude: -85 (decimal degrees) Latitude: 36 (decimal degrees)

Primary (NAICS) Category: Motor Vehicle Brake System
Manufacturing Primary NAICS #: 336340

Classification (SIC) Category:		<u>Motor Vehicle Parts and Accessories</u>		Primary SIC #:	<u>3714</u>
Briefly discuss the type of business conducted at this site:		<u>Manufacture Brake Components</u>			
Description of Area Surrounding Source:	☐ Rural Area	☐ Industrial Park	☐ Residential Area	Is any part of the source located on federal land?	☐ Yes
	☐ Urban Area	☒ Industrial Area	☐ Commercial Area		☒ No
			Number of Employees:	518	
Approximate distance to nearest residence or commercial property:		<u>1000ft</u>	Property Area:	<u>50 Acres</u>	Is this source portable? ☐ Yes ☒ No
What other environmental permits or registrations does this source currently hold or need to obtain in Kentucky?					
NPDES/KPDES:	☒ Currently Hold	☐ Need	☐ N/A		
Solid Waste:	☒ Currently Hold	☐ Need	☐ N/A		
RCRA:	☒ Currently Hold	☐ Need	☐ N/A		
UST:	☐ Currently Hold	☐ Need	☒ N/A		
Type of Regulated Waste Activity:	☐ Mixed Waste Generator	☒ Generator	☐ Recycler	☐ Other: _____	
	☐ U.S. Importer of Hazardous Waste	☐ Transporter	☐ Treatment/Storage/Disposal Facility	☐ N/A	

Section AI.2: Applicant Information**Applicant Name:** Akebono Brake Corporation**Title:** (if individual) _____**Mailing Address:** **Street or P.O. Box:** 1765 Cleveland Ave
City: Glasgow **State:** KY **Zip Code:** 42141**Email:** (if individual) _____**Phone:** 270-678-1765**Technical Contact****Name:** Brandon Petz**Title:** HSE Manager**Mailing Address:** **Street or P.O. Box:** 1765 Cleveland Ave
City: Glasgow **State:** KY **Zip Code:** 42141**Email:** brandon.petz@akebono-usa.com**Phone:** 270-590-9034**Air Permit Contact for Source****Name:** Brandon Petz**Title:** HSE Manager**Mailing Address:** **Street or P.O. Box:** 1765 Cleveland Ave
City: Glasgow **State:** KY **Zip Code:** 42141**Email:** brandon.petz@akebono-usa.com**Phone:** 270-590-9034

Section AI.3: Owner Information

☒ **Owner same as applicant**

Name: _____

Title: _____

Mailing Address: **Street or P.O. Box:** _____
City: _____ **State:** _____ **Zip Code:** _____

Email: _____

Phone: _____

List names of owners and officers of the company who have an interest in the company of 5% or more.

Name		Position	
_____		_____	
_____		_____	
_____		_____	

Section AI.4: Type of Application

Current Status:	☐ Title V	☐ Conditional Major	☐ State-Origin	☐ General Permit	☐ Registration	☐ None		
Requested Action: (check all that apply)	☐ Name Change	☐ Initial Registration	☐ Significant Revision	☐ Administrative Permit Amendment	☐ Renewal Permit	☐ Revised Registration	☐ Minor Revision	☐ Initial Source-wide Operating Permit
	☒ 502(b)(10) Change	☐ Extension Request	☐ Addition of New Facility	☐ Portable Plant Relocation Notice	☐ Revision	☒ Off Permit Change	☐ Landfill Alternate Compliance Submittal	☐ Modification of Existing Facilities
	☐ Ownership Change	☐ Closure						
Requested Status:	☐ Title V	☐ Conditional Major	☐ State-Origin	☐ PSD	☐ NSR	☐ Other: _____		

Is the source requesting a limitation of potential emissions?

☐ Yes ☒ No

Pollutant:	Requested Limit:	Pollutant:	Requested Limit:
☐ Particulate Matter	_____	☐ Single HAP	_____
☐ Volatile Organic Compounds (VOC)	_____	☐ Combined HAPs	_____
☐ Carbon Monoxide	_____	☐ Air Toxics (40 CFR 68, Subpart F)	_____
☐ Nitrogen Oxides	_____	☐ Carbon Dioxide	_____
☐ Sulfur Dioxide	_____	☐ Greenhouse Gases (GHG)	_____
☐ Lead	_____	☐ Other	_____

For New Construction:

Proposed Start Date of Construction:
(MM/YYYY)

Proposed Operation Start-Up Date: (MM/YYYY)

For Modifications:

Proposed Start Date of Modification:
(MM/YYYY)

Proposed Operation Start-Up Date: (MM/YYYY)

07/2025

08/2025

Applicant is seeking coverage under a permit shield.

☐ Yes ☒ No

Identify any non-applicable requirements for which permit shield is sought on a separate attachment to the application.

Section AI.5 Other Required Information

Indicate the documents attached as part of this application:

- | | |
|--|--|
| ☐ DEP7007A Indirect Heat Exchangers and Turbines | ☐ DEP7007CC Compliance Certification |
| ☐ DEP7007B Manufacturing or Processing Operations | ☒ DEP7007DD Insignificant Activities |
| ☐ DEP7007C Incinerators and Waste Burners | ☐ DEP7007EE Internal Combustion Engines |
| ☐ DEP7007F Episode Standby Plan | ☐ DEP7007FF Secondary Aluminum Processing |
| ☐ DEP7007J Volatile Liquid Storage | ☐ DEP7007GG Control Equipment |
| ☐ DEP7007K Surface Coating or Printing Operations | ☐ DEP7007HH Haul Roads |
| ☐ DEP7007L Mineral Processes | ☐ Confidentiality Claim |
| ☐ DEP7007M Metal Cleaning Degreasers | ☐ Ownership Change Form |
| ☐ DEP7007N Source Emissions Profile | ☐ Secretary of State Certificate |
| ☐ DEP7007P Perchloroethylene Dry Cleaning Systems | ☐ Flowcharts or diagrams depicting process |
| ☐ DEP7007R Emission Offset Credit | ☐ Digital Line Graphs (DLG) files of buildings, roads, etc. |
| ☐ DEP7007S Service Stations | ☐ Site Map |
| ☐ DEP7007T Metal Plating and Surface Treatment Operations | ☐ Map or drawing depicting location of facility |
| ☐ DEP7007V Applicable Requirements and Compliance Activities | ☐ Safety Data Sheet (SDS) |
| ☐ DEP7007Y Good Engineering Practice and Stack Height Determination | ☐ Emergency Response Plan |
| ☐ DEP7007AA Compliance Schedule for Non-complying Emission Units | ☐ Other: _____ |
| ☐ DEP7007BB Certified Progress Report | |

Section AI.6: Signature Block

I, the undersigned, hereby certify under penalty of law, that I am a responsible official*, and that I have personally examined, and am familiar with, the information submitted in this document and all its attachments. Based on my inquiry of those individuals with primary responsibility for obtaining the information, I certify that the information is on knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false or incomplete information, including the possibility of fine or imprisonment.

Authorized Signature

Date

Brad Burd

Type or Printed Name of Signatory

Title of Signatory

*Responsible official as defined by 401 KAR 52:001.

Section AI.7: Notes, Comments, and Explanations

Division for Air Quality

300 Sower Boulevard

Frankfort, KY 40601

(502) 564-3999

DEP7007DD**Insignificant Activities**

___ Section DD.1: Table of Insignificant Activities

___ Section DD.2: Signature Block

___ Section DD.3: Notes, Comments, and Explanations

Source Name: Akebono Brake - Glasgow Plant**KY EIS (AFS) #:** 21-00900067**Permit #:** V-20-010**Agency Interest:** 15685**Date:** 7.22.25**Section DD.1: Table of Insignificant Activities**

*Identify each activity with a unique Insignificant Activity number (IA #); for example: 1, 2, 3... etc.

Insignificant Activity #	Description of Activity including Rated Capacity	Serial Number or Other Unique Identifier	Applicable Regulation(s)	Calculated Emissions
10	Side Paint Re-work Process	Side Paint	401 KAR 63:010	See attachment.

Section DD.2: Signature Block

I, THE UNDERSIGNED, HEREBY CERTIFY UNDER PENALTY OF LAW, THAT I AM A RESPONSIBLE OFFICIAL, AND THAT I HAVE PERSONALLY EXAMINED, AND AM FAMILIAR WITH, THE INFORMATION SUBMITTED IN THIS DOCUMENT AND ALL ITS ATTACHMENTS. BASED ON MY INQUIRY OF THOSE INDIVIDUALS WITH PRIMARY RESPONSIBILITY FOR OBTAINING THE INFORMATION, I CERTIFY THAT THE INFORMATION IS ON KNOWLEDGE AND BELIEF, TRUE, ACCURATE, AND COMPLETE. I AM AWARE THAT THERE ARE SIGNIFICANT PENALTIES FOR SUBMITTING FALSE OR INCOMPLETE INFORMATION, INCLUDING THE POSSIBILITY OF FINE OR IMPRISONMENT.

By:

Authorized Signature

Date

Brad Burd

Plant Manager

Type/Print Name of Signatory

Title of Signatory

Section DD.3: Notes, Comments, and Explanations

Calculated Emissions highlighted on attached spreadsheet

Side Paint Process - Insignificant Activity

Side Paint Process - Insignificant Activity				gal/lb										
Type	Chemical			sp. Grav.		%		weight gallon of chemical (sp.g.h2o-8.34lb)		weight in gallon(max %)	Total weight(1gal/lb)(max%)	Total VOC/gal(lb)	Total PM/gal(lb)	%
VOC	Ethanol			0.79		25% - 40%		6.5886		2.63544	11.397444	7.536024		66%
VOC	1-Methoxy-2-Propanol			0.924		20% - 30%		7.70616		2.311848				
VOC	1-Methoxy-2-propyl acetate			0.966		5% - 10%		8.05644		0.805644				
VOC	Ethyl Acetate			0.902		10% - 15%		7.52268		1.128402				
VOC	Isopropanol			0.785		5% - 10%		6.5469		0.65469				
PM	Nitrocellulose			1.66		5% - 10%		13.8444		1.38444			3.86142	33.80%
PM	Modified Polymers/Binders(acrylic)			1.02		5% - 10%		8.5068		0.85068				
PM	Carbon Black			1.95		5% - 10%		16.263		1.6263				

Trial									
overspray and painted				VOC:	100%	fugitive			
0.16 g fugitive		0.22 g painted		PM:	58%	applied	42% fugitive		
Total/part:	0.38 g/part		500	parts/hr	10	hrs/shift	250	shifts/year	16 hr/weekend
Total g/year:	627000 g		Max Parts Shift:		5000		50	weeks	800 hrs overtime
Total lb/year:	1382.297 lb		Max weight/shift:		1900 g		Total Hours/Year:	3300	
Total tons:	0.691148 t				4.188778 lb				
Total Gal/yr:	121.2813								

VOC				
Actual Emissions				
121.2812925 gal/yr		11.39 lb/gal		66% VOC
911.7199886 lb/VOC	X	1 ton/		2000 lb
		Actual Emissions:	0.455859994 t/VOC	
Potential Emissions				
0.455859994 t/voc	X	8760 potential hours		3300 actual hours
		Potential Emissions:	1.210101076 t/VOC	

PM					42% fugitive		58% applied	
Actual Emissions								42% fugitive
121.2812925 gal/yr		11.39 lb/gal		33.8 % PM				
455.8599943 lb/PM		X		42%		1 ton/		
				Actual Emissions:		0.095730599 t/PM		
Potential Emissions								
0.095730599 t/voc		X		8760 potential hours		3300 actual hours		
				Potential Emissions:		0.254121226 t/PM		

9.5.25

Permit Review Branch
Division for Air Quality
Department for Environmental Protection
300 Sower Boulevard – 2nd Floor
Frankfort, Kentucky 40601

RE: Akebono Brake – Glasgow (AI# 15685) 502(b)(10) change request

Review Branch:

According to the provisions in Section 502(b)(10) for permit revisions, we request the following changes to our Title V permit (V-20-010):

Emission Point	Equipment	Capacity	Action
21	Boiler 1	5.5 MMBTU/hr	Boiler 1 to be replaced with new boiler with slightly higher capacity

I have added the applicable 7007 Forms. Feel free to contact me at 270-590-9034 or Brandon.petz@akebono-usa.com if you have any questions or need additional information.

Sincerely,

A handwritten signature in black ink, appearing to read 'Brandon Petz', with a stylized, cursive script.

Brandon Petz
HSE Manager

Division for Air Quality

300 Sower Boulevard
Frankfort, KY 40601
(502) 564-3999

DEP7007AI

Administrative Information

- ☐ Section AI.1: Source Information
- ☐ Section AI.2: Applicant Information
- ☐ Section AI.3: Owner Information
- ☐ Section AI.4: Type of Application
- ☐ Section AI.5: Other Required Information
- ☐ Section AI.6: Signature Block
- ☐ Section AI.7: Notes, Comments, and Explanations

Additional Documentation

☐ Additional Documentation attached

Source Name:

Akebono Brake Corporation Glasgow Plant

KY EIS (AFS) #:

21- 009-00067

Permit #:

V-20-010

Agency Interest (AI) ID:

15685

Date:

9.5.25

Section AI.1: Source Information

Physical Location Address:	Street:	1765 Cleveland Ave	City:	Glasgow	County:	Barren	Zip Code:	42141
Mailing Address:	Street or P.O. Box:	1765 Cleveland Ave	City:	Glasgow	State:	KY	Zip Code:	42141

Standard Coordinates for Source Physical Location

Longitude: 36.996261 (decimal degrees) Latitude: -85.959136 (decimal degrees)

Primary (NAICS) Category:

Motor Vehicle Brake System
Manufacturing

Primary NAICS #:

336340

Classification (SIC) Category:		Motor Vehicle Parts and Accessories		Primary SIC #: 3714	
Briefly discuss the type of business conducted at this site:					
Manufacture Brake Components					
Description of Area Surrounding Source:		☒ Rural Area ☐ Urban Area		☐ Industrial Park ☐ Industrial Area	
Approximate distance to nearest residence or commercial property: 1000ft		Property Area: 50 Acres		Is this source portable? ☐ Yes ☒ No	
Number of Employees: 520					
What other environmental permits or registrations does this source currently hold or need to obtain in Kentucky?					
NPDES/KPDES: ☒ Currently Hold ☐ Need ☐ N/A					
Solid Waste: ☐ Currently Hold ☐ Need ☒ N/A					
RCRA: ☒ Currently Hold ☐ Need ☐ N/A					
UST: ☐ Currently Hold ☐ Need ☒ N/A					
Type of Regulated Waste Activity:					
☐ Mixed Waste Generator ☒ Generator ☐ Recycler ☐ Other:					
☐ U.S. Importer of Hazardous Waste ☐ Transporter ☐ Treatment/Storage/Disposal Facility ☐ N/A					

Section A1.2: Applicant Information**Applicant Name:** Akebono Brake Corporation**Title:** (if individual)**Mailing Address:**

Street or P.O. Box: 1765 Cleveland Ave

City: Glasgow State: KY Zip Code: 42141

Email: (if individual)**Phone:** 270-678-1765**Technical Contact****Name:** Brandon Petz**Title:** HSE Manager**Mailing Address:**

Street or P.O. Box: 1765 Cleveland Ave

City: Glasgow State: KY Zip Code: 42141

Email: brandon.petz@akebono-usa.com**Phone:** 270-590-9034**Air Permit Contact for Source****Name:** Brandon Petz**Title:** HSE Manager**Mailing Address:**

Street or P.O. Box: 1765 Cleveland Ave

City: Glasgow State: KY Zip Code: 42141

Email: brandon.petz@akebono-usa.com**Phone:** 270-590-9034

Section AI.3: Owner Information

☒ **Owner same as applicant**

Name:

Title:

Street or P.O. Box:

Mailing Address:

City:

State:

Zip Code:

Email:

Phone:

List names of owners and officers of the company who have an interest in the company of 5% or more.

Name

Position

Section A1.4: Type of Application

Current Status: ☒ Title V ☐ Conditional Major ☐ State-Origin ☐ General Permit ☐ Registration ☐ None

☐ Name Change ☐ Initial Registration ☐ Significant Revision ☐ Administrative Permit Amendment
☐ Renewal Permit ☐ Revised Registration ☐ Minor Revision ☐ Initial Source-wide Operating Permit
☒ 502(b)(10) Change ☐ Extension Request ☐ Addition of New Facility ☐ Portable Plant Relocation Notice
☐ Revision ☐ Off Permit Change ☐ Landfill Alternate Compliance Submittal ☐ Modification of Existing Facilities
☐ Ownership Change ☐ Closure

Requested Status: ☒ Title V ☐ Conditional Major ☐ State-Origin ☐ PSD ☐ NSR ☐ Other: _____

Is the source requesting a limitation of potential emissions?

☐ Yes ☒ No

Pollutant:

Requested Limit:

Requested Limit:

☐ Particulate Matter

☐ Single HAP

☐ Volatile Organic Compounds (VOC)

☐ Combined HAPs

☐ Carbon Monoxide

☐ Air Toxics (40 CFR 68, Subpart F)

☐ Nitrogen Oxides

☐ Carbon Dioxide

☐ Sulfur Dioxide

☐ Greenhouse Gases (GHG)

☐ Lead

☐ Other

For New Construction:

Proposed Start Date of Construction:
(MM/YYYY)

Proposed Operation Start-Up Date: (MM/YYYY)

For Modifications:

Proposed Start Date of Modification:
(MM/YYYY)

Proposed Operation Start-Up Date: (MM/YYYY)

09/2025

09/2025

Applicant is seeking coverage under a permit shield. ☐ Yes ☒ No

Identify any non-applicable requirements for which permit shield is sought on a separate attachment to the application.

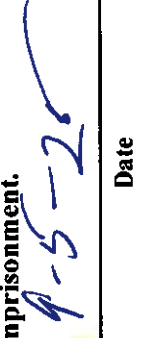
Section AI.5 Other Required Information

Indicate the documents attached as part of this application:

- | | |
|--|--|
| ☒ DEP7007A Indirect Heat Exchangers and Turbines | ☐ DEP7007CC Compliance Certification |
| ☐ DEP7007B Manufacturing or Processing Operations | ☐ DEP7007DD Insignificant Activities |
| ☐ DEP7007C Incinerators and Waste Burners | ☐ DEP7007EE Internal Combustion Engines |
| ☐ DEP7007F Episode Standby Plan | ☐ DEP7007FF Secondary Aluminum Processing |
| ☐ DEP7007J Volatile Liquid Storage | ☐ DEP7007GG Control Equipment |
| ☐ DEP7007K Surface Coating or Printing Operations | ☐ DEP7007HH Haul Roads |
| ☐ DEP7007L Mineral Processes | ☐ Confidentiality Claim |
| ☐ DEP7007M Metal Cleaning Degreasers | ☐ Ownership Change Form |
| ☒ DEP7007N Source Emissions Profile | ☐ Secretary of State Certificate |
| ☐ DEP7007P Perchloroethylene Dry Cleaning Systems | ☐ Flowcharts or diagrams depicting process |
| ☐ DEP7007R Emission Offset Credit | ☐ Digital Line Graphs (DLG) files of buildings, roads, etc. |
| ☐ DEP7007S Service Stations | ☐ Site Map |
| ☐ DEP7007T Metal Plating and Surface Treatment Operations | ☐ Map or drawing depicting location of facility |
| ☒ DEP7007V Applicable Requirements and Compliance Activities | ☐ Safety Data Sheet (SDS) |
| ☐ DEP7007Y Good Engineering Practice and Stack Height Determination | ☐ Emergency Response Plan |
| ☐ DEP7007AA Compliance Schedule for Non-complying Emission Units | ☐ Other: _____ |
| ☐ DEP7007BB Certified Progress Report | |

Section AI.6: Signature Block

I, the undersigned, hereby certify under penalty of law, that I am a responsible official*, and that I have personally examined, and am familiar with, the information submitted in this document and all its attachments. Based on my inquiry of those individuals with primary responsibility for obtaining the information, I certify that the information is on knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false or incomplete information, including the possibility of fine or imprisonment.

Authorized Signature

Date

Brad Burd

Plant Manager

Type or Printed Name of Signatory

Title of Signatory

*Responsible official as defined by 401 KAR 52:001.

Division for Air Quality

300 Sower Boulevard

Frankfort, KY 40601

(502) 564-3999

DEP7007A

Indirect Heat Exchangers and Turbines

___ Section A.1: General Information

___ Section A.2: Operating and Fuel Information

___ Section A.3: Notes, Comments, and Explanations

Additional Documentation

___ Complete DEP7007AI, DEP7007N, DEP7007V, and DEP7007GG.

___ Manufacturer's specifications

Source Name:	Akebono Brake - Glasgow Plant
KY EIS (AFS) #:	21-00900067
Permit #:	V-20-010
Agency Interest (AI) ID:	15685
Date:	9/5/2025

Section A.1: General Information

Emission Unit #	Emission Unit Name	Process ID	Process Name	Identify General Type: Indirect Heat Exchanger, Gas Turbine, or Combustion Turbine	Indirect Heat Exchanger Configuration	Manufacturer	Model No./ Serial No.	Proposed/Actual Date of Construction Commencement (MM/YYYY)	SCC Code	SCC Units	Control Device ID	Stack ID
21	Boiler 1		steam	IHE	flex tube	Cleaver-Brooks	FLX-JT-700-550-150ST	9/1/2025				

Section A.2: Operating and Fuel Information

[illegible]

Section A.3: Notes, Comments, and Explanations

placement of older Boiler #1 with slightly higher output FLX550 model. Increase in MMBTU/hr from 4.5 on the old boiler to 5.5 on the new boiler.

Division for Air Quality 300 Sower Boulevard Frankfort, KY 40601 (502) 564-3999	DEP7007N Source Emissions Profile __ Section N.1: Emission Summary __ Section N.2: Stack Information __ Section N.3: Fugitive Information __ Section N.4: Notes, Comments, and Explanations	Additional Documentation __ Complete DEP7007AI
---	--	--

Source Name:	Akebono Brake - Glasgow Plant
KY EIS (AFS) #:	21- 00900067
Permit #:	V-20-010
Agency Interest (AI) ID:	15685
Date:	9.5.2025

N.1: Emission Summary

Emission Unit #	Emission Unit Name	Process ID	Process Name	Control Device Name	Control Device ID	Stack ID	Maximum Design Capacity (SCC Units/hour)	Pollutant	Uncontrolled Emission Factor (lb/SCC Units)	Emission Factor Source (e.g. AP-42, Stack Test, Mass Balance)	Capture Efficiency (%)	Control Efficiency (%)	Hourly Emissions		Annual Emissions	
													Uncontrolled Potential (lb/hr)	Controlled Potential (lb/hr)	Uncontrolled Potential (tons/yr)	Controlled Potential (tons/yr)
21	Boiler						5.5 mmBTU/hr									

Division for Air Quality 300 Sower Boulevard Frankfort, KY 40601 (502) 564-3999	DEP7007N Source Emissions Profile __ Section N.1: Emission Summary __ Section N.2: Stack Information __ Section N.3: Fugitive Information __ Section N.4: Notes, Comments, and Explanations	Additional Documentation __ Complete DEP7007AI
---	--	--

Source Name:	Akebono Brake - Glasgow Plant
KY EIS (AFS) #:	21- 00900067
Permit #:	V-14-023 R1
Agency Interest (AI) ID:	15685
Date:	9.5.2025

N.1: Emission Summary

Emission Unit #	Emission Unit Name	Process ID	Process Name	Control Device Name	Control Device ID	Stack ID	Maximum Design Capacity (SCC Units/hour)	Pollutant	Uncontrolled Emission Factor (lb/SCC Units)	Emission Factor Source (e.g. AP-42, Stack Test, Mass Balance)	Capture Efficiency (%)	Control Efficiency (%)	Hourly Emissions		Annual Emissions	
													Uncontrolled Potential (lb/hr)	Controlled Potential (lb/hr)	Uncontrolled Potential (tons/yr)	Controlled Potential (tons/yr)

Section N.2: Stack Information

UTM Zone:

Stack ID	Identify all Emission Units (with Process ID) and Control Devices that Feed to Stack	Stack Physical Data			Stack UTM Coordinates		Stack Gas Stream Data		
		Equivalent Diameter <i>(ft)</i>	Height <i>(ft)</i>	Base Elevation <i>(ft)</i>	Northing <i>(m)</i>	Easting <i>(m)</i>	Flowrate <i>(acfm)</i>	Temperature <i>(° F)</i>	Exit Velocity <i>(ft/sec)</i>
	21 - Boiler	1.33	39				1809	209	21.69

Section N.2: Stack Information

UTM Zone:

Stack ID	Identify all Emission Units (with Process ID) and Control Devices that Feed to Stack	Stack Physical Data			Stack UTM Coordinates		Stack Gas Stream Data		
		Equivalent Diameter <i>(ft)</i>	Height <i>(ft)</i>	Base Elevation <i>(ft)</i>	Northing <i>(m)</i>	Easting <i>(m)</i>	Flowrate <i>(acfm)</i>	Temperature <i>(° F)</i>	Exit Velocity <i>(ft/sec)</i>

Section N.3: Fugitive Information

UTM Zone:

Emission Unit #	Emission Unit Name	Process ID	Area Physical Data		Area UTM Coordinates		Area Release Data	
			Length of the X Side <i>(ft)</i>	Length of the Y Side <i>(ft)</i>	Northing <i>(m)</i>	Easting <i>(m)</i>	Release Temperature <i>(°F)</i>	Release Height <i>(ft)</i>

Section N.4: Notes, Comments, and Explanations

Division for Air Quality 300 Sower Boulevard Frankfort, KY 40601 (502) 564-3999	DEP7007V Applicable Requirements and Compliance Activities ___ Section V.1: Emission and Operating Limitation(s) ___ Section V.2: Monitoring Requirements ___ Section V.3: Recordkeeping Requirements ___ Section V.4: Reporting Requirements ___ Section V.5: Testing Requirements ___ Section V.6: Notes, Comments, and Explanations	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="text-align: center;">Additional Documentation</td> </tr> <tr> <td style="padding: 5px;">___ Complete DEP7007AI</td> </tr> </table>	Additional Documentation	___ Complete DEP7007AI			
Additional Documentation							
___ Complete DEP7007AI							
Source Name: <u>Akebono Brake - Glasgow Plant</u> KY EIS (AFS) #: <u>21- 00900067</u> Permit #: <u>V-20-010</u> Agency Interest (AI) ID: <u>15685</u> Date: <u>9.5.2025</u>							
Section V.1: Emission and Operating Limitation(s)							
Emission Unit #	Emission Unit Description	Applicable Regulation or Requirement	Pollutant	Emission Limit (if applicable)	Voluntary Emission Limit or Exemption (if applicable)	Operating Requirement or Limitation (if applicable)	Method of Determining Compliance with the Emission and Operating Requirement(s)
21	Boilers	401 KAR 59:015 401 KAR 63:020	PM, sulfur dioxide	0.522 lb/mmBTU, 20% opacity,		natural gas only	

DEP7007V**Applicable Requirements and Compliance Activities****Additional Documentation**

Division for Air Quality

300 Sower Boulevard

Frankfort, KY 40601

(502) 564-3999

☐ Section V.1: Emission and Operating Limitation(s)☐ Section V.2: Monitoring Requirements☐ Section V.3: Recordkeeping Requirements☐ Section V.4: Reporting Requirements☐ Section V.5: Testing Requirements☐ Section V.6: Notes, Comments, and Explanations☐ Complete DEP7007AI**Source Name:** Akebono Brake - Glasgow Plant**KY EIS (AFS) #:** 21- 00900067**Permit #:** V-20-010**Agency Interest (AI) ID:** 15685**Date:** 2.12.2025**Section V.1: Emission and Operating Limitation(s)**

Emission Unit #	Emission Unit Description	Applicable Regulation or Requirement	Pollutant	Emission Limit (if applicable)	Voluntary Emission Limit or Exemption (if applicable)	Operating Requirement or Limitation (if applicable)	Method of Determining Compliance with the Emission and Operating Requirement(s)

Section V.2: Monitoring Requirements

[illegible]

Section V.3: Recordkeeping Requirements

Emission Unit #	Emission Unit Description	Pollutant	Applicable Regulation or Requirement	Parameter Recorded	Description of Recordkeeping
21	Boilers	PM, Sulfur Dioxide			monthly natural gas usage

Section V.4: Reporting Requirements

Emission Unit #	Emission Unit Description	Pollutant	Applicable Regulation or Requirement	Parameter Reported	Description of Reporting
21	Boilers	PM, Sulfur Dioxide			general reporting requirements

Section V.5: Testing Requirements

Emission Unit #	Emission Unit Description	Pollutant	Applicable Regulation or Requirement	Parameter Tested	Description of Testing
21	Boilers	PM, Sulfur Dioxide	401 KAR 50:215 401 KAR 50:015		

Section V.6: Notes, Comments, and Explanations
