Separation Technologies, Inc.

Air Construction Permit Application
Flyash Benefication Process
At the St. Johns' River Power Park

Prepared by:

BLACK & VEATCH

December 9, 1999

Department of Environmental Protection

Division of Air Resources Management

APPLICATION FOR AIR PERMIT - NON-TITLE V SOURCE

See Instructions for Form No. 62-210.900(3)

I. APPLICATION INFORMATION

Identification of Facility

1. Facility Owner/Company Name: Separation Technologies, Inc.	
2. Site Name: St. John's River Power Park	
3. Facility Identification Number: NA [ ] Unknown	
4. Facility Location: STI Processed Ash Street Address or Other Locator: 11201 New Berlin Rd. City: Jacksonville County: Duvall Zip Code: 32226	
5. Relocatable Facility? [ ] Yes [x] No	6. Existing Permitted Facility? [ ] Yes [x] No

Application Contact

1. Name and Title of Application Contact: Frank Hrach / Project Manager
2. Application Contact Mailing Address: Organization/Firm: Separation Technologies, Inc. Street Address: 10 Kearney Road City: Needham State: MA Zip Code: 02494
3. Application Contact Telephone Numbers: Telephone: (781) 455 - 8824 Fax: (781) 455 - 6518

Application Processing Information (DEP Use)

1. Date of Receipt of Application:	December 14, 1999
2. Permit Number:	050-FI-010(d)

Purpose of Application

Air Operation Permit Application

This Application for Air Permit is submitted to obtain: (Check one)

[ ] Initial non-Title V air operation permit for one or more existing, but previously unpermitted, emissions units.

[ ] Initial non-Title V air operation permit for one or more newly constructed or modified emissions units.

Current construction permit number:______________________________

[ ] Non-Title V air operation permit revision to address one or more newly constructed or modified emissions units.

Current construction permit number:______________________________

Operation permit number to be revised:______________________________

[ ] Initial non-Title V air operation permit under Rule 62-210.300(2)(b), F.A.C., for an existing facility seeking classification as a synthetic non-Title V source.

Current operation/construction permit number(s):

____

[ ] Non-Title V air operation permit revision for a synthetic non-Title V source. Give reason for revision; e.g., to address one or more newly constructed or modified emissions units.

Operation permit number to be revised:______________________________

Reason for revision:______________________________

Air Construction Permit Application

This Application for Air Permit is submitted to obtain: (Check one)

[x] Air construction permit to construct or modify one or more emissions units.

[ ] Air construction permit to make federally enforceable an assumed restriction on the potential emissions of one or more existing, permitted emissions units.

[ ] Air construction permit for one or more existing, but unpermitted, emissions units.

Owner/Authorized Representative

1. Name and Title of Owner/Authorized Representative: Joseph Teves / President and CEO
2. Owner/Authorized Representative Mailing Address: Organization/Firm: Separation Technologies, Inc. Street Address: 10 Kearney Road City: Needham State: MA Zip Code: 02494
3. Owner/Authorized Representative Telephone Numbers: Telephone: (781) 455 - 6600 Fax: (781) 455 - 6518
4. Owner/Authorized Representative Statement: *I, the undersigned, am the owner or authorized representative* of the facility addressed in this application. I hereby certify, based on information and belief formed after reasonable inquiry, that the statements made in this application are true, accurate and complete and that, to the best of my knowledge, any estimates of emissions reported in this application are based upon reasonable techniques for calculating emissions. The air pollutant emissions units and air pollution control equipment described in this application will be operated and maintained so as to comply with all applicable standards for control of air pollutant emissions found in the statutes of the State of Florida and rules of the Department of Environmental Protection and revisions thereof. I understand that a permit, if granted by the Department, cannot be transferred without authorization from the Department, and I will promptly notify the Department upon sale or legal transfer of any permitted emissions unit.* Joseph Teves 10/5/99 Signature Date

* Attach letter of authorization if not currently on file.

Professional Engineer Certification

1. Professional Engineer Name: Donald Schultz, P.E. Registration Number: 30304
2. Professional Engineer Mailing Address: Organization/Firm: Black & Veatch Corporation Street Address: 11401 Lamar Avenue City: Overland Park State: KS Zip Code: 66211
3. Professional Engineer Telephone Numbers: Telephone: (913) 458-2028 Fax: (913) 458 - 2934

4. Professional Engineer Statement:

I, the undersigned, hereby certify, except as particularly noted herein, that:*

(1) To the best of my knowledge, there is reasonable assurance that the air pollutant emissions unit(s) and the air pollution control equipment described in this Application for Air Permit, when properly operated and maintained, will comply with all applicable standards for control of air pollutant emissions found in the Florida Statutes and rules of the Department of Environmental Protection; and

(2) To the best of my knowledge, any emission estimates reported or relied on in this application are true, accurate, and complete and are either based upon reasonable techniques available for calculating emissions or, for emission estimates of hazardous air pollutants not regulated for an emissions unit addressed in this application, based solely upon the materials, information and calculations submitted with this application.

If the purpose of this application is to obtain an air construction permit for one or more proposed new or modified emissions units (check here [ ], if so), I further certify that the engineering features of each such emissions unit described in this application have been designed or examined by me or individuals under my direct supervision and found to be in conformity with sound engineering principles applicable to the control of emissions of the air pollutants characterized in this application.

If the purpose of this application is to obtain an initial air operation permit or operation permit revision for one or more newly constructed or modified emissions units (check here [ ], if so), I further certify that, with the exception of any changes detailed as part of this application, each such emissions unit has been constructed or modified in substantial accordance with the information given in the corresponding application for air construction permit and with all provisions contained in such permit.

O D Schultz
Signature

October 7, 1999
Date

(seal)

* Attach any exception to certification statement.

Scope of Application

Emissions Unit ID	Description of Emissions Unit	Permit Type	Processing Fee
001	Separator A Filter - Receiver Vent	1	
002	Separator B Filter - Receiver Vent	1	
003	Separator Dust Collector Vent	1	
004	Clean-up Vacuum Vent	1	
005	Flyash Surge Bin Vent	1	
006	Mineral Additive Storage Bin Vent	1	
007	Gas-fired Dryer Stack	1	

Application Processing Fee

Check one: [ ] Attached - Amount: $____________ [x] Not Applicable

Construction/Modification Information

1. Description of Proposed Project or Alterations: Separation Technologies, Inc. (STI) is proposing to beneficiate and market the 300,000 tons per year of fly ash produced by St. John's River Power Park that is currently landfilled onsite. The two-step process will consist of (1) removal of the residual carbon from the flyash using STI's patented electrostatic separation technology; and (2) removal of residual ammonia from the flyash using STI's new ammonia removal technology.
2. Projected or Actual Date of Commencement of Construction:
3. Projected Date of Completion of Construction:

Application Comment

II. FACILITY INFORMATION

A. GENERAL FACILITY INFORMATION

Facility Location and Type

1. Facility UTM Coordinates: Zone: 17	East (km): 446.9	North (km): 3359.15	
2. Facility Latitude/Longitude: Latitude (DD/MM/SS): 30"21'52"		Longitude (DD/MM/SS): 81°37'25"	
3. Governmental Facility Code: 0	4. Facility Status Code: A	5. Facility Major Group SIC Code: 39	6. Facility SIC(s): 39

7. Facility Comment (limit to 500 characters):

The STI facility is a separate, stand-alone facility located within the existing St. Johns' River Power Park. STI will lease a portion of the land at SJRPP where they will construct, own, and operate the proposed equipment. For the purposes of this application, it is assumed that the proposed construction by STI will be considered a minor modification to an existing major facility (SJRPP) by FDEP.

Facility Contact

1. Name and Title of Facility Contact: Frank Hrach / Project Manager

2. Facility Contact Mailing Address:
Organization/Firm: Separation Technologies, Inc.
Street Address: 10 Kearney Road
City: Needham State: MA Zip Code: 02494

3. Facility Contact Telephone Numbers:
Telephone: (781) 455 - 6600 Fax: (781) 455 - 6518

Facility Regulatory Classifications

Check all that apply:

1. [ ] Small Business Stationary Source?	[ ] Unknown
2. [ ] Synthetic Non-Title V Source?	
3. [ ] Synthetic Minor Source of Pollutants Other than HAPs?	
4. [ ] Synthetic Minor Source of HAPs?	
5. [X] One or More Emissions Units Subject to NSPS?	
6. [ ] One or More Emission Units Subject to NESHAP Recordkeeping or Reporting?	
7. Facility Regulatory Classifications Comment (limit to 200 characters):	

Rule Applicability Analysis

See Attachment A for the Rule Applicability Analysis.

B. FACILITY POLLUTANTS

List of Pollutants Emitted

1. Pollutant Emitted	2. Pollutant Classif.	3. Requested Emissions Cap lb/hour	tons/year	4. Basis for Emissions Cap	5. Pollutant Comment
PM / PM_{10}	A	NA	NA	NA	
NOx	A	NA	NA	NA	
CO	A	NA	NA	NA	
SO_2	A	NA	NA	NA	
VOC	A	NA	NA	NA	
Pb	A	NA	NA	NA	

C. FACILITY SUPPLEMENTAL INFORMATION

Supplemental Requirements

1. Area Map Showing Facility Location: [X] Attached, Document ID: B [ ] Not Applicable [ ] Waiver Requested
2. Facility Plot Plan: [X] Attached, Document ID: B [ ] Not Applicable [ ] Waiver Requested
3. Process Flow Diagram(s): [X] Attached, Document ID: C [ ] Not Applicable [ ] Waiver Requested
4. Precautions to Prevent Emissions of Unconfined Particulate Matter: [ ] Attached, Document ID: ______ [X] Not Applicable [ ] Waiver Requested
5. Supplemental Information for Construction Permit Application: [X] Attached, Document ID: A [ ] Not Applicable
6. Supplemental Requirements Comment: List of Attachments: Attachment A Supplemental Application Information Attachment B Facility Plot Plan Attachment C Process Flow Diagram Attachment D Building & Equipment Drawings Attachment E Control Equipment Specifications Attachment F O & M Plan Attachment G Particulate Emmissions Test Results Attachment H Reference Material

III. EMISSIONS UNIT INFORMATION

A separate Emissions Unit Information Section (including subsections A through G as required) must be completed for each emissions unit addressed in this Application for Air Permit. If submitting the application form in hard copy, indicate, in the space provided at the top of each page, the number of this Emissions Unit Information Section and the total number of Emissions Unit Information Sections submitted as part of this application.

A. GENERAL EMISSIONS UNIT INFORMATION

Emissions Unit Description and Status

1. Type of Emissions Unit Addressed in This Section: (Check one)

[x] This Emissions Unit Information Section addresses, as a single emissions unit, a single process or production unit, or activity, which produces one or more air pollutants and which has at least one definable emission point (stack or vent).

[ ] This Emissions Unit Information Section addresses, as a single emissions unit, a group of process or production units and activities which has at least one definable emission point (stack or vent) but may also produce fugitive emissions.

[ ] This Emissions Unit Information Section addresses, as a single emissions unit, one or more process or production units and activities which produce fugitive emissions only.

2. Description of Emissions Unit Addressed in This Section (limit to 60 characters):

Separator A Filter - Receiver Vent

3. Emissions Unit Identification Number:
ID:

[ ] No ID
[x] ID Unknown

4. Emissions Unit Status Code: C	5. Initial Startup Date:	6. Emissions Unit Major Group SIC Code: 39

7. Emissions Unit Comment: (Limit to 500 Characters)

Emissions Unit Control Equipment

1. Control Equipment/Method Description (limit to 200 characters per device or method): Pulse Jet Fabric Filter Fuller Bulk Handling Manufacturer: Camco Model # 8TR10x80 See Attachment D for Manufacturer's Data.
2. Control Device or Method Code(s): 018

Emissions Unit Details

1. Package Unit: Manufacturer:	Model Number:
2. Generator Nameplate Rating:	MW
3. Incinerator Information: Dwell Temperature: Dwell Time: Incinerator Afterburner Temperature:	 °F seconds °F

Emissions Unit Operating Capacity and Schedule

1. Maximum Heat Input Rate: NA		mmBtu/hr
2. Maximum Incineration Rate:	lb/hr	tons/day
3. Maximum Process or Throughput Rate: 150,000 tpy		
4. Maximum Production Rate: 150,000 tpy		
5. Requested Maximum Operating Schedule: 24 hours/day 52 weeks/year		 7 days/week 8,760 hours/year
6. Operating Capacity/Schedule Comment (limit to 200 characters):		

III. EMISSIONS UNIT INFORMATION

A separate Emissions Unit Information Section (including subsections A through G as required) must be completed for each emissions unit addressed in this Application for Air Permit. If submitting the application form in hard copy, indicate, in the space provided at the top of each page, the number of this Emissions Unit Information Section and the total number of Emissions Unit Information Sections submitted as part of this application.

A. GENERAL EMISSIONS UNIT INFORMATION

Emissions Unit Description and Status

1. Type of Emissions Unit Addressed in This Section: (Check one)

[x] This Emissions Unit Information Section addresses, as a single emissions unit, a single process or production unit, or activity, which produces one or more air pollutants and which has at least one definable emission point (stack or vent).

[ ] This Emissions Unit Information Section addresses, as a single emissions unit, a group of process or production units and activities which has at least one definable emission point (stack or vent) but may also produce fugitive emissions.

[ ] This Emissions Unit Information Section addresses, as a single emissions unit, one or more process or production units and activities which produce fugitive emissions only.

2. Description of Emissions Unit Addressed in This Section (limit to 60 characters):

Separator B Filter - Receiver Vent

3. Emissions Unit Identification Number:
ID:

[ ] No ID
[x] ID Unknown

4. Emissions Unit Status Code: C	5. Initial Startup Date:	6. Emissions Unit Major Group SIC Code: 39

7. Emissions Unit Comment: (Limit to 500 Characters)

Emissions Unit Control Equipment

1. Control Equipment/Method Description (limit to 200 characters per device or method): Pulse Jet Filter Fuller Bulk Handling Manufacturer: Camco Model # 8TR10X80 See Attachment D for Manufacturer's Data.
2. Control Device or Method Code(s): 018

Emissions Unit Details

1. Package Unit: Manufacturer:	Model Number:
2. Generator Nameplate Rating:	MW
3. Incinerator Information: Dwell Temperature: Dwell Time: Incinerator Afterburner Temperature:	 °F seconds °F

Emissions Unit Operating Capacity and Schedule

1. Maximum Heat Input Rate: NA		mmBtu/hr
2. Maximum Incineration Rate:	lb/hr	tons/day
3. Maximum Process or Throughput Rate:	150,000 tpy	
4. Maximum Production Rate:	150,000 tpy	
5. Requested Maximum Operating Schedule:	24 hours/day 52 weeks/year	7 days/week 8,760 hours/year
6. Operating Capacity/Schedule Comment (limit to 200 characters):		

III. EMISSIONS UNIT INFORMATION

A separate Emissions Unit Information Section (including subsections A through G as required) must be completed for each emissions unit addressed in this Application for Air Permit. If submitting the application form in hard copy, indicate, in the space provided at the top of each page, the number of this Emissions Unit Information Section and the total number of Emissions Unit Information Sections submitted as part of this application.

A. GENERAL EMISSIONS UNIT INFORMATION

Emissions Unit Description and Status

1. Type of Emissions Unit Addressed in This Section: (Check one)

[X] This Emissions Unit Information Section addresses, as a single emissions unit, a single process or production unit, or activity, which produces one or more air pollutants and which has at least one definable emission point (stack or vent).

[ ] This Emissions Unit Information Section addresses, as a single emissions unit, a group of process or production units and activities which has at least one definable emission point (stack or vent) but may also produce fugitive emissions.

[ ] This Emissions Unit Information Section addresses, as a single emissions unit, one or more process or production units and activities which produce fugitive emissions only.

2. Description of Emissions Unit Addressed in This Section (limit to 60 characters):

Separator Dust Collector Vent

3. Emissions Unit Identification Number:
ID:

[ ] No ID
[x] ID Unknown

4. Emissions Unit Status Code: C	5. Initial Startup Date:	6. Emissions Unit Major Group SIC Code: 39

7. Emissions Unit Comment: (Limit to 500 Characters)

Emissions Unit Control Equipment

1. Control Equipment/Method Description (limit to 200 characters per device or method): Pulse Jet Filter Manufacturer : Z&Z Conveying Model # 64-08(b)-20 See Attachment D for Manufacturer's Data.
2. Control Device or Method Code(s): 018

Emissions Unit Details

1. Package Unit: Manufacturer:	Model Number:
2. Generator Nameplate Rating:	MW
3. Incinerator Information: Dwell Temperature: Dwell Time: Incinerator Afterburner Temperature:	 °F seconds °F

Emissions Unit Operating Capacity and Schedule

1. Maximum Heat Input Rate:	NA	mmBtu/hr
2. Maximum Incineration Rate:	lb/hr	tons/day
3. Maximum Process or Throughput Rate:	300,000 tpy	
4. Maximum Production Rate:	300,000 tpy	
5. Requested Maximum Operating Schedule:	24 hours/day 52 weeks/year	7 days/week 8,760 hours/year
6. Operating Capacity/Schedule Comment (limit to 200 characters):		

III. EMISSIONS UNIT INFORMATION

A separate Emissions Unit Information Section (including subsections A through G as required) must be completed for each emissions unit addressed in this Application for Air Permit. If submitting the application form in hard copy, indicate, in the space provided at the top of each page, the number of this Emissions Unit Information Section and the total number of Emissions Unit Information Sections submitted as part of this application.

A. GENERAL EMISSIONS UNIT INFORMATION

Emissions Unit Description and Status

1. Type of Emissions Unit Addressed in This Section: (Check one)

[X] This Emissions Unit Information Section addresses, as a single emissions unit, a single process or production unit, or activity, which produces one or more air pollutants and which has at least one definable emission point (stack or vent).

[ ] This Emissions Unit Information Section addresses, as a single emissions unit, a group of process or production units and activities which has at least one definable emission point (stack or vent) but may also produce fugitive emissions.

[ ] This Emissions Unit Information Section addresses, as a single emissions unit, one or more process or production units and activities which produce fugitive emissions only.

2. Description of Emissions Unit Addressed in This Section (limit to 60 characters):

Clean-up Vacuum Vent

3. Emissions Unit Identification Number: ID:

[ ] No ID
[x] ID Unknown

4. Emissions Unit Status Code:	5. Initial Startup Date:	6. Emissions Unit Major Group SIC Code:
C		39

7. Emissions Unit Comment: (Limit to 500 Characters)

Emissions Unit Control Equipment

1. Control Equipment/Method Description (limit to 200 characters per device or method): Pulse Jet Filter Manufacturer: Max Vac Model # AK15E See Attachment D for Manufacturer's Data.	
2. Control Device or Method Code(s):	018

Emissions Unit Details

1. Package Unit: Manufacturer:	Model Number:
2. Generator Nameplate Rating:	MW
3. Incinerator Information: Dwell Temperature: Dwell Time: Incinerator Afterburner Temperature:	 °F seconds °F

Emissions Unit Operating Capacity and Schedule

1. Maximum Heat Input Rate: NA		mmBtu/hr
2. Maximum Incineration Rate:	lb/hr	tons/day
3. Maximum Process or Throughput Rate:	3,000 tpy	
4. Maximum Production Rate: 3,000 tpy		
5. Requested Maximum Operating Schedule:	24 hours/day	7 days/week
	52 weeks/year	8,760 hours/year
6. Operating Capacity/Schedule Comment (limit to 200 characters):		

III. EMISSIONS UNIT INFORMATION

A separate Emissions Unit Information Section (including subsections A through G as required) must be completed for each emissions unit addressed in this Application for Air Permit. If submitting the application form in hard copy, indicate, in the space provided at the top of each page, the number of this Emissions Unit Information Section and the total number of Emissions Unit Information Sections submitted as part of this application.

A. GENERAL EMISSIONS UNIT INFORMATION

Emissions Unit Description and Status

1. Type of Emissions Unit Addressed in This Section: (Check one)

[X] This Emissions Unit Information Section addresses, as a single emissions unit, a single process or production unit, or activity, which produces one or more air pollutants and which has at least one definable emission point (stack or vent).

[ ] This Emissions Unit Information Section addresses, as a single emissions unit, a group of process or production units and activities which has at least one definable emission point (stack or vent) but may also produce fugitive emissions.

[ ] This Emissions Unit Information Section addresses, as a single emissions unit, one or more process or production units and activities which produce fugitive emissions only.

2. Description of Emissions Unit Addressed in This Section (limit to 60 characters):

Flyash Surge Bin Vent

3. Emissions Unit Identification Number: ID:
[ ] No ID
[x] ID Unknown

4. Emissions Unit Status Code:	5. Initial Startup Date:	6. Emissions Unit Major Group SIC Code:
C		39

7. Emissions Unit Comment: (Limit to 500 Characters)

Emissions Unit Control Equipment

1. Control Equipment/Method Description (limit to 200 characters per device or method): Pulse Jet Filter Fuller Bulk Handling Manufacturer: Camco Model # 64DS8 See Attachment D for Manufacturer's Data.
2. Control Device or Method Code(s): 018

Emissions Unit Details

1. Package Unit: Manufacturer:	Model Number:
2. Generator Nameplate Rating:	MW
3. Incinerator Information: Dwell Temperature: Dwell Time: Incinerator Afterburner Temperature:	 °F seconds °F

Emissions Unit Operating Capacity and Schedule

1. Maximum Heat Input Rate: NA		mmBtu/hr
2. Maximum Incineration Rate:	lb/hr	tons/day
3. Maximum Process or Throughput Rate:	255,000 tpy	
4. Maximum Production Rate: 255,000 tpy		
5. Requested Maximum Operating Schedule: 24 hours/day 52 weeks/year		 7 days/week 8,760 hours/year
6. Operating Capacity/Schedule Comment (limit to 200 characters):		

III. EMISSIONS UNIT INFORMATION

A separate Emissions Unit Information Section (including subsections A through G as required) must be completed for each emissions unit addressed in this Application for Air Permit. If submitting the application form in hard copy, indicate, in the space provided at the top of each page, the number of this Emissions Unit Information Section and the total number of Emissions Unit Information Sections submitted as part of this application.

A. GENERAL EMISSIONS UNIT INFORMATION

Emissions Unit Description and Status

1. Type of Emissions Unit Addressed in This Section: (Check one)

[x] This Emissions Unit Information Section addresses, as a single emissions unit, a single process or production unit, or activity, which produces one or more air pollutants and which has at least one definable emission point (stack or vent).

[ ] This Emissions Unit Information Section addresses, as a single emissions unit, a group of process or production units and activities which has at least one definable emission point (stack or vent) but may also produce fugitive emissions.

[ ] This Emissions Unit Information Section addresses, as a single emissions unit, one or more process or production units and activities which produce fugitive emissions only.

2. Description of Emissions Unit Addressed in This Section (limit to 60 characters):

Mineral Additive Storage Bin Vent

3. Emissions Unit Identification Number:
ID:

[ ] No ID
[x] ID Unknown

4. Emissions Unit Status Code:	5. Initial Startup Date:	6. Emissions Unit Major Group SIC Code:
C		39

7. Emissions Unit Comment: (Limit to 500 Characters)

Emissions Unit Control Equipment

1. Control Equipment/Method Description (limit to 200 characters per device or method): Pulse Jet Filter Manufacturer: DCE Model # VS20 KS5 See Attachment D for Manufacturer's Data.	
2. Control Device or Method Code(s):	018

Emissions Unit Details

1. Package Unit: Manufacturer:	Model Number:
2. Generator Nameplate Rating:	MW
3. Incinerator Information: Dwell Temperature: Dwell Time: Incinerator Afterburner Temperature:	 °F seconds °F

Emissions Unit Operating Capacity and Schedule

1. Maximum Heat Input Rate: NA		mmBtu/hr
2. Maximum Incineration Rate:	lb/hr	tons/day
3. Maximum Process or Throughput Rate:	2,550 tpy	
4. Maximum Production Rate: 2,550 tpy		
5. Requested Maximum Operating Schedule:	24 hours/day 52 weeks/year	7 days/week 8,760 hours/year
6. Operating Capacity/Schedule Comment (limit to 200 characters):		

III. EMISSIONS UNIT INFORMATION

A separate Emissions Unit Information Section (including subsections A through G as required) must be completed for each emissions unit addressed in this Application for Air Permit. If submitting the application form in hard copy, indicate, in the space provided at the top of each page, the number of this Emissions Unit Information Section and the total number of Emissions Unit Information Sections submitted as part of this application.

A. GENERAL EMISSIONS UNIT INFORMATION

Emissions Unit Description and Status

1. Type of Emissions Unit Addressed in This Section: (Check one)

[x] This Emissions Unit Information Section addresses, as a single emissions unit, a single process or production unit, or activity, which produces one or more air pollutants and which has at least one definable emission point (stack or vent).

[ ] This Emissions Unit Information Section addresses, as a single emissions unit, a group of process or production units and activities which has at least one definable emission point (stack or vent) but may also produce fugitive emissions.

[ ] This Emissions Unit Information Section addresses, as a single emissions unit, one or more process or production units and activities which produce fugitive emissions only.

2. Description of Emissions Unit Addressed in This Section (limit to 60 characters):

Gas-fired Dryer Stack

3. Emissions Unit Identification Number:
ID:

[ ] No ID
[x] ID Unknown

4. Emissions Unit Status Code:	5. Initial Startup Date:	6. Emissions Unit Major Group SIC Code:
C		39

7. Emissions Unit Comment: (Limit to 500 Characters)

Emissions Unit Control Equipment

1. Control Equipment/Method Description (limit to 200 characters per device or method): Particulate Control: Pulse Jet Filter Manufacturer: MAC Equipment Model # 144MCF756-450 NOx Control: Low NOx Burner Manufacturer: Scott Equipment Company Model # Eclipse AH-MA See Attachment D for Manufacturers' Data.
2. Control Device or Method Code(s): 017, 025

Emissions Unit Details

1. Package Unit: Manufacturer:	Model Number:
2. Generator Nameplate Rating:	MW
3. Incinerator Information: Dwell Temperature: Dwell Time: Incinerator Afterburner Temperature:	 °F seconds °F

Emissions Unit Operating Capacity and Schedule

1. Maximum Heat Input Rate: 12.0		mmBtu/hr
2. Maximum Incineration Rate:	lb/hr	tons/day
3. Maximum Process or Throughput Rate: 257,550 tpy		
4. Maximum Production Rate: 257,550 tpy		
5. Requested Maximum Operating Schedule:	24 hours/day 52 weeks/year	7 days/week 8,760 hours/year
6. Operating Capacity/Schedule Comment (limit to 200 characters):		

B. EMISSION POINT (STACK/VENT) INFORMATION

Emission Point Description and Type

1. Identification of Point on Plot Plan or Flow Diagram? 1	2. Emission Point Type Code: 1	
3. Descriptions of Emission Points Comprising this Emissions Unit for VE Tracking (limit to 100 characters per point): N/A		
4. ID Numbers or Descriptions of Emission Units with this Emission Point in Common: N/A		
5. Discharge Type Code: H	6. Stack Height: 47' 10"	7. Exit Diameter: 14"
8. Exit Temperature: 100 °F	9. Actual Volumetric Flow Rate: 1,796 acfm	10. Water Vapor: %
11. Maximum Dry Standard Flow Rate: 1,700 dscfm	12. Nonstack Emission Point Height: feet	
13. Emission Point UTM Coordinates: Zone: 17 East (km): 447.4 North (km): 3366.8		
14. Emission Point Comment (limit to 200 characters):		

B. EMISSION POINT (STACK/VENT) INFORMATION

Emission Point Description and Type

1. Identification of Point on Plot Plan or Flow Diagram? 2	2. Emission Point Type Code: 1
3. Descriptions of Emission Points Comprising this Emissions Unit for VE Tracking (limit to 100 characters per point): N/A	
4. ID Numbers or Descriptions of Emission Units with this Emission Point in Common: N/A	

5. Discharge Type Code: H	6. Stack Height: 47' 10"	7. Exit Diameter: 14"
8. Exit Temperature: 100 °F	9. Actual Volumetric Flow Rate: 1,480 acfm	10. Water Vapor: %

11. Maximum Dry Standard Flow Rate: 1,400 dscfm	12. Nonstack Emission Point Height: feet
13. Emission Point UTM Coordinates: Zone: 17 East (km): 447.4 North (km): 3366.8	
14. Emission Point Comment (limit to 200 characters):	

B. EMISSION POINT (STACK/VENT) INFORMATION

Emission Point Description and Type

1. Identification of Point on Plot Plan or Flow Diagram? 3	2. Emission Point Type Code: 1	
3. Descriptions of Emission Points Comprising this Emissions Unit for VE Tracking (limit to 100 characters per point): N/A		
4. ID Numbers or Descriptions of Emission Units with this Emission Point in Common: N/A		
5. Discharge Type Code: H	6. Stack Height: 31' 1"	7. Exit Diameter: 12" x 10"
8. Exit Temperature: 100 °F	9. Actual Volumetric Flow Rate: 4,226 acfm	10. Water Vapor: %
11. Maximum Dry Standard Flow Rate: 4,000 dscfm	12. Nonstack Emission Point Height: feet	
13. Emission Point UTM Coordinates: Zone: 17 East (km): 447.4 North (km): 3366.8		
14. Emission Point Comment (limit to 200 characters):		

B. EMISSION POINT (STACK/VENT) INFORMATION

Emission Point Description and Type

1. Identification of Point on Plot Plan or Flow Diagram? 4	2. Emission Point Type Code: 1	
3. Descriptions of Emission Points Comprising this Emissions Unit for VE Tracking (limit to 100 characters per point): N/A		
4. ID Numbers or Descriptions of Emission Units with this Emission Point in Common: N/A		
5. Discharge Type Code: H	6. Stack Height: 5'	7. Exit Diameter: 4"
8. Exit Temperature: 100 °F	9. Actual Volumetric Flow Rate: 423 acfm	10. Water Vapor: %
11. Maximum Dry Standard Flow Rate: 400 dscfm	12. Nonstack Emission Point Height: feet	
13. Emission Point UTM Coordinates: Zone: 17 East (km): 447.4 North (km): 3366.8		
14. Emission Point Comment (limit to 200 characters):		

B. EMISSION POINT (STACK/VENT) INFORMATION

Emission Point Description and Type

1. Identification of Point on Plot Plan or Flow Diagram? 5		2. Emission Point Type Code: 1
3. Descriptions of Emission Points Comprising this Emissions Unit for VE Tracking (limit to 100 characters per point): N/A		
4. ID Numbers or Descriptions of Emission Units with this Emission Point in Common: N/A		
5. Discharge Type Code: H	6. Stack Height: 75' 3"	7. Exit Diameter: 8"x28"
8. Exit Temperature: 100 °F	9. Actual Volumetric Flow Rate: 4,121 acfm	10. Water Vapor: %
11. Maximum Dry Standard Flow Rate: 3,900 dscfm		12. Nonstack Emission Point Height: feet
13. Emission Point UTM Coordinates: Zone: 17 East (km): 447.4 North (km): 3366.8		
14. Emission Point Comment (limit to 200 characters):		

B. EMISSION POINT (STACK/VENT) INFORMATION

Emission Point Description and Type

1. Identification of Point on Plot Plan or Flow Diagram? 6	2. Emission Point Type Code: 1	
3. Descriptions of Emission Points Comprising this Emissions Unit for VE Tracking (limit to 100 characters per point): N/A		
4. ID Numbers or Descriptions of Emission Units with this Emission Point in Common: N/A		
5. Discharge Type Code: H	6. Stack Height: 74' 8 "	7. Exit Diameter: 32"
8. Exit Temperature: 100 °F	9. Actual Volumetric Flow Rate: 423 acfm	10. Water Vapor: %
11. Maximum Dry Standard Flow Rate: 400 dscfm	12. Nonstack Emission Point Height: feet	
13. Emission Point UTM Coordinates: Zone: 17 East (km): 447.4 North (km): 3366.8		
14. Emission Point Comment (limit to 200 characters):		

B. EMISSION POINT (STACK/VENT) INFORMATION

Emission Point Description and Type

1. Identification of Point on Plot Plan or Flow Diagram? 7	2. Emission Point Type Code: 1

3. Descriptions of Emission Points Comprising this Emissions Unit for VE Tracking (limit to 100 characters per point):

N/A

4. ID Numbers or Descriptions of Emission Units with this Emission Point in Common:

N/A

5. Discharge Type Code: V	6. Stack Height: 88' 6"	7. Exit Diameter: 32"
8. Exit Temperature: 220 °F	9. Actual Volumetric Flow Rate: 28,240 acfm	10. Water Vapor: %

11. Maximum Dry Standard Flow Rate: 22,000 dscfm	12. Nonstack Emission Point Height: feet

13. Emission Point UTM Coordinates:

Zone: 17 East (km): 447.4 North (km): 3366.8

14. Emission Point Comment (limit to 200 characters):

C. SEGMENT (PROCESS/FUEL) INFORMATION

Segment Description and Rate: Segment 1 of 1

1. Segment Description (Process/Fuel Type) (limit to 500 characters): Flyash from St. Johns' River Power Park will be pneumatically conveyed from the existing storage silos to one of two Flyash Receiving Bins at STI. The two bins operate in parallel and are each equipped with a Pulse Jet Fabric Filter to control particulate emissions.		
2. Source Classification Code (SCC): 3-05-025-03	3. SCC Units: tons of product	
4. Maximum Hourly Rate:	5. Maximum Annual Rate: 150,000 tons/yr	6. Estimated Annual Activity Factor: 1.0
7. Maximum % Sulfur:	8. Maximum % Ash:	9. Million Btu per SCC Unit:
10. Segment Comment (limit to 200 characters):		

Segment Description and Rate: Segment ____ of ____

1. Segment Description (Process/Fuel Type) (limit to 500 characters):		
2. Source Classification Code (SCC):	3. SCC Units:	
4. Maximum Hourly Rate:	5. Maximum Annual Rate:	6. Estimated Annual Activity Factor:
7. Maximum % Sulfur:	8. Maximum % Ash:	9. Million Btu per SCC Unit:
10. Segment Comment (limit to 200 characters):		

C. SEGMENT (PROCESS/FUEL) INFORMATION

Segment Description and Rate: Segment 1 of 1

1. Segment Description (Process/Fuel Type) (limit to 500 characters): Flyash from St. Johns' River Power Park will be pneumatically conveyed from the existing storage silos to one of two Flyash Receiving Bins at STI. The two bins operate in parallel and are each equipped with a Pulse Jet Fabric Filter to control particulate emissions.		
2. Source Classification Code (SCC): 3-05-025-03	3. SCC Units: tons of product	
4. Maximum Hourly Rate:	5. Maximum Annual Rate: 150,000 tons/yr	6. Estimated Annual Activity Factor: 1.0
7. Maximum % Sulfur:	8. Maximum % Ash:	9. Million Btu per SCC Unit:
10. Segment Comment (limit to 200 characters):		

Segment Description and Rate: Segment ____ of ____

1. Segment Description (Process/Fuel Type) (limit to 500 characters):		
2. Source Classification Code (SCC):	3. SCC Units:	
4. Maximum Hourly Rate:	5. Maximum Annual Rate:	6. Estimated Annual Activity Factor:
7. Maximum % Sulfur:	8. Maximum % Ash:	9. Million Btu per SCC Unit:
10. Segment Comment (limit to 200 characters):		

C. SEGMENT (PROCESS/FUEL) INFORMATION

Segment Description and Rate: Segment 1 of 1

1. Segment Description (Process/Fuel Type) (limit to 500 characters): The Carbon Separation Unit involves STI's electrostatic separation technology. The separation is accomplished by passing the flyash through a high-voltage direct current electrical field. The charged mineral-rich flyash particles are then separated from the carbon-rich flyash particles. Particulate emissions are controlled with a pulse jet fabric filter.		
2. Source Classification Code (SCC): 3-05-025-03	3. SCC Units: tons of product	
4. Maximum Hourly Rate:	5. Maximum Annual Rate: 300,000 tons/yr	6. Estimated Annual Activity Factor: 1.0
7. Maximum % Sulfur:	8. Maximum % Ash:	9. Million Btu per SCC Unit:
10. Segment Comment (limit to 200 characters):		

Segment Description and Rate: Segment _____ of _____

1. Segment Description (Process/Fuel Type) (limit to 500 characters):		
2. Source Classification Code (SCC):	3. SCC Units:	
4. Maximum Hourly Rate:	5. Maximum Annual Rate:	6. Estimated Annual Activity Factor:
7. Maximum % Sulfur:	8. Maximum % Ash:	9. Million Btu per SCC Unit:
10. Segment Comment (limit to 200 characters):		

C. SEGMENT (PROCESS/FUEL) INFORMATION

Segment Description and Rate: Segment 1 of 1

1. Segment Description (Process/Fuel Type) (limit to 500 characters): Any spills or fugitive dust that settles in the Separator Building will be cleaned with the Clean-up Vacuum. The Clean-up Vacuum comes equipped with a pulse jet fabric filter to control particulate emissions.		
2. Source Classification Code (SCC): 3-05-025-03	3. SCC Units: tons of product	
4. Maximum Hourly Rate: 12 tons/hr *	5. Maximum Annual Rate: 3,000 tons/yr	6. Estimated Annual Activity Factor: 1.0
7. Maximum % Sulfur:	8. Maximum % Ash:	9. Million Btu per SCC Unit:
10. Segment Comment (limit to 200 characters): *The vacuum is cabable of handling up to 12 tons/hr of wet or dry material. However, since the flyash processing system is enclosed it is conservatively assumed that less than 1% of the flyash processed will be spilled or lost and subsequently vacuumed.		

Segment Description and Rate: Segment ____ of ____

1. Segment Description (Process/Fuel Type) (limit to 500 characters):		
2. Source Classification Code (SCC):	3. SCC Units:	
4. Maximum Hourly Rate:	5. Maximum Annual Rate:	6. Estimated Annual Activity Factor:
7. Maximum % Sulfur:	8. Maximum % Ash:	9. Million Btu per SCC Unit:
10. Segment Comment (limit to 200 characters):		

C. SEGMENT (PROCESS/FUEL) INFORMATION

Segment Description and Rate: Segment 1 of 1

1. Segment Description (Process/Fuel Type) (limit to 500 characters): The mineral-rich portion of the flyash is sent to the Flyash Surge Bin before entering the ammonia removal system. The carbon-rich flyash is returned to SJRPP after leaving the Carbon Separation Unit.		
2. Source Classification Code (SCC): 3-05-025-03	3. SCC Units: tons of product	
4. Maximum Hourly Rate:	5. Maximum Annual Rate: 255,000 tons/yr	6. Estimated Annual Activity Factor: 1.0
7. Maximum % Sulfur:	8. Maximum % Ash:	9. Million Btu per SCC Unit:
10. Segment Comment (limit to 200 characters):		

Segment Description and Rate: Segment ____ of ____

1. Segment Description (Process/Fuel Type) (limit to 500 characters):		
2. Source Classification Code (SCC):	3. SCC Units:	
4. Maximum Hourly Rate:	5. Maximum Annual Rate:	6. Estimated Annual Activity Factor:
7. Maximum % Sulfur:	8. Maximum % Ash:	9. Million Btu per SCC Unit:
10. Segment Comment (limit to 200 characters):		

C. SEGMENT (PROCESS/FUEL) INFORMATION

Segment Description and Rate: Segment 1 of 1

1. Segment Description (Process/Fuel Type) (limit to 500 characters): The ammonia removal process involves mixing the mineral-rich flyash with water and a mineral additive. The mineral additive liberates the ammonia from the flyash. The ammonia is then collected and recycled back to SJRPP. Emission unit 6 is the Mineral Additive Storage Bin and is equipped with a pulse jet fabric filter to control particulat emissions from bin loading.		
2. Source Classification Code (SCC): 3-05-025-03	3. SCC Units: tons of product	
4. Maximum Hourly Rate:	5. Maximum Annual Rate: 2,550 tons/yr	6. Estimated Annual Activity Factor: 1.0
7. Maximum % Sulfur:	8. Maximum % Ash:	9. Million Btu per SCC Unit:
10. Segment Comment (limit to 200 characters): The material throughput to the Mineral Additive Storage Bin is based on the design of the ammonia removal process which requires the mineral additive to be approximately 1% of the total weight of the mineral-rich flyash being processed.		

Segment Description and Rate: Segment _____ of _____

1. Segment Description (Process/Fuel Type) (limit to 500 characters):		
2. Source Classification Code (SCC):	3. SCC Units:	
4. Maximum Hourly Rate:	5. Maximum Annual Rate:	6. Estimated Annual Activity Factor:
7. Maximum % Sulfur:	8. Maximum % Ash:	9. Million Btu per SCC Unit:
10. Segment Comment (limit to 200 characters):		

C. SEGMENT (PROCESS/FUEL) INFORMATION

Segment Description and Rate: Segment 1 of 1

1. Segment Description (Process/Fuel Type) (limit to 500 characters): The final stage in the flyash benefication process is drying of the wetted ammonia-free mineral-rich flyash product. A natural gas fired Low-NOx burner heats the wetted flyash driving off any excess moisture. Particulate emissions from the dryer are controlled with a pulse jet fabric filter.		
2. Source Classification Code (SCC): 3-05-025-08	3. SCC Units: tons of product	
4. Maximum Hourly Rate:	5. Maximum Annual Rate: 257,550 tons/yr	6. Estimated Annual Activity Factor: 1.0
7. Maximum % Sulfur:	8. Maximum % Ash:	9. Million Btu per SCC Unit:
10. Segment Comment (limit to 200 characters): The heat input to the natural gas fired dryer is 12 MMBtu/hr.		

Segment Description and Rate: Segment _____ of _____

1. Segment Description (Process/Fuel Type) (limit to 500 characters):		
2. Source Classification Code (SCC):	3. SCC Units:	
4. Maximum Hourly Rate:	5. Maximum Annual Rate:	6. Estimated Annual Activity Factor:
7. Maximum % Sulfur:	8. Maximum % Ash:	9. Million Btu per SCC Unit:
10. Segment Comment (limit to 200 characters):		

D. EMISSIONS UNIT POLLUTANT DETAIL INFORMATION

Potential Emissions

1. Pollutant Emitted: PM/PM_{10}	2. Pollutant Regulatory Code: EL	
3. Primary Control Device Code: 018	4. Secondary Control Device Code:	5. Total Percent Efficiency of Control: 99%+
6. Potential Emissions: 0.2 lb/hour 1.0 tons/year		7. Synthetically Limited? [ ]
8. Emission Factor: 0.015 gr/scf Reference: manufacturer's guarantee		9. Emissions Method Code: 1

10. Calculation of Emissions (limit to 600 characters):

E = (0.015 gr/scf x 1700 scfm x 60 min/hr)/7000 gr/lb
E = 0.2 lb/hr

11. Pollutant Potential Emissions Comment (limit to 200 characters):

Potential emissions are based on the manufacturer's guaranteed outlet grain loading.

Allowable Emissions Allowable Emissions 1 of 1

1. Basis for Allowable Emissions Code: ESCPSD	2. Future Effective Date of Allowable Emissions:
3. Requested Allowable Emissions and Units: 0.015 gr/scf	4. Equivalent Allowable Emissions: 0.2 lb/hour 1.0 tons/year

5. Method of Compliance (limit to 60 characters):

Manufacturers' performance guarantee for control equipment.
O&M plan to ensure performance guarantee.

6. Allowable Emissions Comment (Desc. of Operating Method) (limit to 200 characters):

D. EMISSIONS UNIT POLLUTANT DETAIL INFORMATION

Potential Emissions

1. Pollutant Emitted: PM/PM_{10}		2. Pollutant Regulatory Code: EL
3. Primary Control Device Code: 018	4. Secondary Control Device Code:	5. Total Percent Efficiency of Control: 99%+
6. Potential Emissions: 0.2 lb/hour 0.8 tons/year		7. Synthetically Limited? [ ]
8. Emission Factor: 0.015 gr/scf Reference: manufacturer's guarantee		9. Emissions Method Code: 1
10. Calculation of Emissions (limit to 600 characters): E = (0.015 gr/scf x 1400 scfm x 60 min/hr)/7000 gr/lb E = 0.20 lb/hr		
11. Pollutant Potential Emissions Comment (limit to 200 characters): Potential emissions are based on the manufacture's guaranteed outlet grain loading.		

Allowable Emissions Allowable Emissions 1 of 1

1. Basis for Allowable Emissions Code: ESCPSD	2. Future Effective Date of Allowable Emissions:
3. Requested Allowable Emissions and Units: 0.015 gr/scf	4. Equivalent Allowable Emissions: 0.2 lb/hour 0.8 tons/year
5. Method of Compliance (limit to 60 characters): Manufacturers' performance guarantee for control equipment. O&M plan to ensure performance guarantee.	
6. Allowable Emissions Comment (Desc. of Operating Method) (limit to 200 characters):	

D. EMISSIONS UNIT POLLUTANT DETAIL INFORMATION

Potential Emissions

1. Pollutant Emitted: PM/PM_{10}	2. Pollutant Regulatory Code: EL	
3. Primary Control Device Code: 018	4. Secondary Control Device Code:	5. Total Percent Efficiency of Control: 99%+
6. Potential Emissions: 0.5 lb/hour 2.3 tons/year		7. Synthetically Limited? [ ]
8. Emission Factor: 0.015 gr/scf Reference: manufacturer's guarantee		9. Emissions Method Code: 1
10. Calculation of Emissions (limit to 600 characters): E = (0.015 gr/scf x 4000 scfm x 60 min/hr)/7000 gr/lb E = 0.5 lb/hr		
11. Pollutant Potential Emissions Comment (limit to 200 characters): Potential emissions are based on the manufacturer's guaranteed outlet grain loading.		

Allowable Emissions Allowable Emissions 1 of 1

1. Basis for Allowable Emissions Code: ESCPSD	2. Future Effective Date of Allowable Emissions:
3. Requested Allowable Emissions and Units: 0.015 gr/scf	4. Equivalent Allowable Emissions: 0.50 lb/hour 2.3 tons/year
5. Method of Compliance (limit to 60 characters): Manufacturers' performance guarantee for control equipment. O&M plan to ensure performance guarantee.	
6. Allowable Emissions Comment (Desc. of Operating Method) (limit to 200 characters):	

D. EMISSIONS UNIT POLLUTANT DETAIL INFORMATION

Potential Emissions

1. Pollutant Emitted: PM/PM_{10}		2. Pollutant Regulatory Code: EL
3. Primary Control Device Code: 018	4. Secondary Control Device Code:	5. Total Percent Efficiency of Control: 99%+
6. Potential Emissions: 0.1 lb/hour 0.2 tons/year		7. Synthetically Limited? [ ]
8. Emission Factor: 0.015 gr/scf Reference: manufacturer's guarantee		9. Emissions Method Code: 1

10. Calculation of Emissions (limit to 600 characters):

E = (0.015 gr/scf x 400 scfm x 60 min/hr)/7000 gr/lb
E = 0.1 lb/hr

11. Pollutant Potential Emissions Comment (limit to 200 characters):

Potential emissions are based on the manufacturer's guaranteed outlet grain loading.

Allowable Emissions Allowable Emissions 1 of 1

1. Basis for Allowable Emissions Code: ESCPSD	2. Future Effective Date of Allowable Emissions:
3. Requested Allowable Emissions and Units: 0.015 gr/scf	4. Equivalent Allowable Emissions: 0.1 lb/hour 0.2 tons/year

5. Method of Compliance (limit to 60 characters):

Manufacturers' performance guarantee for control equipment.
O&M plan to ensure performance guarantee.

6. Allowable Emissions Comment (Desc. of Operating Method) (limit to 200 characters):

D. EMISSIONS UNIT POLLUTANT DETAIL INFORMATION

Potential Emissions

1. Pollutant Emitted: PM/PM_{10}	2. Pollutant Regulatory Code: EL	
3. Primary Control Device Code: 018	4. Secondary Control Device Code:	5. Total Percent Efficiency of Control: 99%+
6. Potential Emissions: 0.5 lb/hour 2.2 tons/year		7. Synthetically Limited? [ ]
8. Emission Factor: 0.015 gr/scf Reference: manufacturer's guarantee		9. Emissions Method Code: 1

10. Calculation of Emissions (limit to 600 characters):

E = (0.015 gr/scf x 3900 scfm x 60 min/hr)/7000 gr/lb
E = 0.5 lb/hr

11. Pollutant Potential Emissions Comment (limit to 200 characters):

Potential emissions are based on the manufacturer's guaranteed outlet grain loading.

Allowable Emissions Allowable Emissions 1 of 1

1. Basis for Allowable Emissions Code: ESCPSD	2. Future Effective Date of Allowable Emissions:
3. Requested Allowable Emissions and Units: 0.015 gr/scf	4. Equivalent Allowable Emissions: 0.5 lb/hour 2.2 tons/year

5. Method of Compliance (limit to 60 characters):

Manufacturers' performance guarantee for control equipment.
O&M plan to ensure performance guarantee.

6. Allowable Emissions Comment (Desc. of Operating Method) (limit to 200 characters):

D. EMISSIONS UNIT POLLUTANT DETAIL INFORMATION

Potential Emissions

1. Pollutant Emitted: PM/PM_{10}		2. Pollutant Regulatory Code: EL
3. Primary Control Device Code: 018	4. Secondary Control Device Code:	5. Total Percent Efficiency of Control: 99%+
6. Potential Emissions: 0.1 lb/hour 0.2 tons/year		7. Synthetically Limited? [ ]
8. Emission Factor: 0.015 gr/scf Reference: manufacturer's guarantee		9. Emissions Method Code: 1
10. Calculation of Emissions (limit to 600 characters): E = (0.015 gr/scf x 400 scfm x 60 min/hr)/7000 gr/lb E = 0.1 lb/hr		
11. Pollutant Potential Emissions Comment (limit to 200 characters): Potential emissions are based on the manufacutrer's guaranteed outlet grain loading.		

Allowable Emissions Allowable Emissions 1 of 1

1. Basis for Allowable Emissions Code: ESCPSD	2. Future Effective Date of Allowable Emissions:
3. Requested Allowable Emissions and Units: 0.015 gr/scf	4. Equivalent Allowable Emissions: 0.1 lb/hour 0.2 tons/year
5. Method of Compliance (limit to 60 characters): Manufacturers' performance guarantee for control equipment. O&M plan to ensure performance guarantee.	
6. Allowable Emissions Comment (Desc. of Operating Method) (limit to 200 characters):	

D. EMISSIONS UNIT POLLUTANT DETAIL INFORMATION

Potential Emissions

1. Pollutant Emitted: PM/PM_{10}	2. Pollutant Regulatory Code: EL	
3. Primary Control Device Code: 018	4. Secondary Control Device Code:	5. Total Percent Efficiency of Control: 99%+
6. Potential Emissions: 1.6 lb/hour 7.0 tons/year		7. Synthetically Limited? [ ]
8. Emission Factor: 0.0083 gr/scf Reference: manufacturer's guarantee		9. Emissions Method Code: 1

10. Calculation of Emissions (limit to 600 characters):

E = (0.0083 gr/scf x 22,446 scfm x 60 min/hr)/7000 gr/lb
E = 1.6 lb/hr

11. Pollutant Potential Emissions Comment (limit to 200 characters):

Potential emissions are based on the manufacturer's guarantee.

Allowable Emissions Allowable Emissions 1 of 1

1. Basis for Allowable Emissions Code: ESCPSD	2. Future Effective Date of Allowable Emissions:
3. Requested Allowable Emissions and Units: 7.0 tons/year	4. Equivalent Allowable Emissions: 1.6 lb/hour 7.0 tons/year

5. Method of Compliance (limit to 60 characters):
Manufacturers' performance guarantee for control equipment.
O&M plan to ensure performance guarantee.

6. Allowable Emissions Comment (Desc. of Operating Method) (limit to 200 characters):

D. EMISSIONS UNIT POLLUTANT DETAIL INFORMATION

Potential Emissions

1. Pollutant Emitted: NOx	2. Pollutant Regulatory Code: NS	
3. Primary Control Device Code: 025	4. Secondary Control Device Code:	5. Total Percent Efficiency of Control:
6. Potential Emissions: 0.10 lb/hour 0.53 tons/year		7. Synthetically Limited? [ ]
8. Emission Factor: 0.01 lb/MMBtu Reference: Manufacturers' Guarantee See Attachment E.		9. Emissions Method Code: 1

10. Calculation of Emissions (limit to 600 characters):

PTE = 0.01 lb/MMBtu x 12 MMBtu/hr x 8,760 hr/yr / 2,000 lb/ton
PTE = 0.53 tons/yr

11. Pollutant Potential Emissions Comment (limit to 200 characters):

Allowable Emissions Allowable Emissions 1 of 1

1. Basis for Allowable Emissions Code:	2. Future Effective Date of Allowable Emissions:
3. Requested Allowable Emissions and Units: No limit is requested.	4. Equivalent Allowable Emissions: lb/hour tons/year

5. Method of Compliance (limit to 60 characters):

6. Allowable Emissions Comment (Desc. of Operating Method) (limit to 200 characters):

D. EMISSIONS UNIT POLLUTANT DETAIL INFORMATION

Potential Emissions

1. Pollutant Emitted: CO	2. Pollutant Regulatory Code: NS	
3. Primary Control Device Code:	4. Secondary Control Device Code:	5. Total Percent Efficiency of Control:
6. Potential Emissions: 1.70 lb/hour 7.60 tons/year		7. Synthetically Limited? [ ]
8. Emission Factor: 0.144 lb/MMBtu Reference: Manufacturers' Guarantee See Attachment E.		9. Emissions Method Code: 1
10. Calculation of Emissions (limit to 600 characters): PTE = 0.144 lb/MMBtu x 12 MMBtu/hr x 8,760 hr/yr / 2,000 lb/ton PTE = 7.60 tons/yr		
11. Pollutant Potential Emissions Comment (limit to 200 characters):		

Allowable Emissions Allowable Emissions 1 of 1

1. Basis for Allowable Emissions Code:	2. Future Effective Date of Allowable Emissions:
3. Requested Allowable Emissions and Units: No limit is requested.	4. Equivalent Allowable Emissions: lb/hour tons/year
5. Method of Compliance (limit to 60 characters):	
6. Allowable Emissions Comment (Desc. of Operating Method) (limit to 200 characters):	

E. VISIBLE EMISSIONS INFORMATION
(Only Emissions Units Subject to a VE Limitation)

Visible Emissions Limitation: Visible Emissions Limitation 1 of 1

1. Visible Emissions Subtype: VE05	2. Basis for Allowable Opacity: [XX] Rule [ ] Other
3. Requested Allowable Opacity: Normal Conditions: 5 % Exceptional Conditions: % Maximum Period of Excess Opacity Allowed: min/hour	
4. Method of Compliance: O & M Plan (See Attachment F) to ensure proper opertion and particulate control efficiency of fabric filter.	
5. Visible Emissions Comment (limit to 200 characters):	

F. CONTINUOUS MONITOR INFORMATION
(Only Emissions Units Subject to Continuous Monitoring)

Continuous Monitoring System: Continuous Monitor 0 of 0

1. Parameter Code:	2. Pollutant(s):
3. CMS Requirement: [ ] Rule [ ] Other	
4. Monitor Information: Manufacturer: Model Number: Serial Number:	
5. Installation Date:	6. Performance Specification Test Date:
7. Continuous Monitor Comment (limit to 200 characters):	

E. VISIBLE EMISSIONS INFORMATION
(Only Emissions Units Subject to a VE Limitation)

Visible Emissions Limitation: Visible Emissions Limitation 1 of 1

1. Visible Emissions Subtype: VE05	2. Basis for Allowable Opacity: [XX] Rule [ ] Other
3. Requested Allowable Opacity: Normal Conditions: 5 % Exceptional Conditions: % Maximum Period of Excess Opacity Allowed: min/hour	
4. Method of Compliance: O & M Plan (See Attachment F) to ensure proper opertion and particulate control efficiency of fabric filter.	
5. Visible Emissions Comment (limit to 200 characters):	

F. CONTINUOUS MONITOR INFORMATION
(Only Emissions Units Subject to Continuous Monitoring)

Continuous Monitoring System: Continuous Monitor 0 of 0

1. Parameter Code:	2. Pollutant(s):
3. CMS Requirement:	[ ] Rule [ ] Other
4. Monitor Information: Manufacturer: Model Number:	Serial Number:
5. Installation Date:	6. Performance Specification Test Date:
7. Continuous Monitor Comment (limit to 200 characters):	

E. VISIBLE EMISSIONS INFORMATION
(Only Emissions Units Subject to a VE Limitation)

Visible Emissions Limitation: Visible Emissions Limitation 1 of 1

1. Visible Emissions Subtype: VE05	2. Basis for Allowable Opacity: [XX] Rule [ ] Other

3. Requested Allowable Opacity:
Normal Conditions: 5 % Exceptional Conditions: %
Maximum Period of Excess Opacity Allowed: min/hour

4. Method of Compliance:
O & M Plan (See Attachment F) to ensure proper opertion and particulate control efficiency of fabric filter.

5. Visible Emissions Comment (limit to 200 characters):

F. CONTINUOUS MONITOR INFORMATION
(Only Emissions Units Subject to Continuous Monitoring)

Continuous Monitoring System: Continuous Monitor 0 of 0

1. Parameter Code:	2. Pollutant(s):
3. CMS Requirement:	[ ] Rule [ ] Other

4. Monitor Information:
Manufacturer:
Model Number: Serial Number:

5. Installation Date:	6. Performance Specification Test Date:

7. Continuous Monitor Comment (limit to 200 characters):

E. VISIBLE EMISSIONS INFORMATION
(Only Emissions Units Subject to a VE Limitation)

Visible Emissions Limitation: Visible Emissions Limitation __1__ of __1__

1. Visible Emissions Subtype: VE05	2. Basis for Allowable Opacity: [XX] Rule [ ] Other
3. Requested Allowable Opacity: Normal Conditions: 5 % Exceptional Conditions: % Maximum Period of Excess Opacity Allowed: min/hour	
4. Method of Compliance: O & M Plan (See Attachment F) to ensure proper opertion and particulate control efficiency of fabric filter.	
5. Visible Emissions Comment (limit to 200 characters):	

F. CONTINUOUS MONITOR INFORMATION
(Only Emissions Units Subject to Continuous Monitoring)

Continuous Monitoring System: Continuous Monitor __0__ of __0__

1. Parameter Code:	2. Pollutant(s):
3. CMS Requirement:	[ ] Rule [ ] Other
4. Monitor Information: Manufacturer: Model Number:	Serial Number:
5. Installation Date:	6. Performance Specification Test Date:
7. Continuous Monitor Comment (limit to 200 characters):	

E. VISIBLE EMISSIONS INFORMATION
(Only Emissions Units Subject to a VE Limitation)

Visible Emissions Limitation: Visible Emissions Limitation 1 of 1

1. Visible Emissions Subtype: VE05	2. Basis for Allowable Opacity: [XX] Rule [ ] Other
3. Requested Allowable Opacity: Normal Conditions: 5 % Exceptional Conditions: % Maximum Period of Excess Opacity Allowed: min/hour	
4. Method of Compliance: O & M Plan (See Attachment F) to ensure proper opertion and particulate control efficiency of fabric filter.	
5. Visible Emissions Comment (limit to 200 characters):	

F. CONTINUOUS MONITOR INFORMATION
(Only Emissions Units Subject to Continuous Monitoring)

Continuous Monitoring System: Continuous Monitor 0 of 0

1. Parameter Code:	2. Pollutant(s):
3. CMS Requirement:	[ ] Rule [ ] Other
4. Monitor Information: Manufacturer: Model Number: Serial Number:	
5. Installation Date:	6. Performance Specification Test Date:
7. Continuous Monitor Comment (limit to 200 characters):	

E. VISIBLE EMISSIONS INFORMATION
(Only Emissions Units Subject to a VE Limitation)

Visible Emissions Limitation: Visible Emissions Limitation 1 of 1

1. Visible Emissions Subtype: VE05	2. Basis for Allowable Opacity: [XX] Rule [ ] Other
3. Requested Allowable Opacity: Normal Conditions: 5 % Exceptional Conditions: % Maximum Period of Excess Opacity Allowed: min/hour	
4. Method of Compliance: O & M Plan (See Attachment F) to ensure proper opertion and particulate control efficiency of fabric filter.	
5. Visible Emissions Comment (limit to 200 characters):	

F. CONTINUOUS MONITOR INFORMATION
(Only Emissions Units Subject to Continuous Monitoring)

Continuous Monitoring System: Continuous Monitor 0 of 0

1. Parameter Code:	2. Pollutant(s):
3. CMS Requirement:	[ ] Rule [ ] Other
4. Monitor Information: Manufacturer: Model Number:	Serial Number:
5. Installation Date:	6. Performance Specification Test Date:
7. Continuous Monitor Comment (limit to 200 characters):	

E. VISIBLE EMISSIONS INFORMATION
(Only Emissions Units Subject to a VE Limitation)

Visible Emissions Limitation: Visible Emissions Limitation 1 of 1

1. Visible Emissions Subtype: VE05	2. Basis for Allowable Opacity: [XX] Rule [ ] Other
3. Requested Allowable Opacity: Normal Conditions: 5 % Exceptional Conditions: % Maximum Period of Excess Opacity Allowed: min/hour	
4. Method of Compliance: O & M Plan (See Attachment F) to ensure proper opertion and particulate control efficiency of fabric filter.	
5. Visible Emissions Comment (limit to 200 characters):	

F. CONTINUOUS MONITOR INFORMATION
(Only Emissions Units Subject to Continuous Monitoring)

Continuous Monitoring System: Continuous Monitor 0 of 0

1. Parameter Code:	2. Pollutant(s):
3. CMS Requirement:	[ ] Rule [ ] Other
4. Monitor Information: Manufacturer: Model Number: Serial Number:	
5. Installation Date:	6. Performance Specification Test Date:
7. Continuous Monitor Comment (limit to 200 characters):	

G. EMISSIONS UNIT SUPPLEMENTAL INFORMATION

Supplemental Requirements

1. Process Flow Diagram [X] Attached, Document ID: C [ ] Not Applicable [ ] Waiver Requested
2. Fuel Analysis or Specification [ ] Attached, Document ID:______ [X] Not Applicable [ ] Waiver Requested
3. Detailed Description of Control Equipment [X] Attached, Document ID: E [ ] Not Applicable [ ] Waiver Requested
4. Description of Stack Sampling Facilities [ ] Attached, Document ID:______ [x] Not Applicable [ ] Waiver Requested
5. Compliance Test Report [ ] Attached, Document ID:______ [ ] Previously submitted, Date:________ [x] Not Applicable
6. Procedures for Startup and Shutdown [ ] Attached, Document ID:______ [X] Not Applicable [ ] Waiver Requested
7. Operation and Maintenance Plan [x] Attached, Document ID: F [ ] Not Applicable [ ] Waiver Requested
8. Supplemental Information for Construction Permit Application [X] Attached, Document ID: A [ ] Not Applicable
9. Other Information Required by Rule or Statute [ ] Attached, Document ID:______ [X] Not Applicable
10. Supplemental Requirements Comment:

G. EMISSIONS UNIT SUPPLEMENTAL INFORMATION

Supplemental Requirements

1. Process Flow Diagram [X] Attached, Document ID: C [ ] Not Applicable [ ] Waiver Requested
2. Fuel Analysis or Specification [ ] Attached, Document ID:____ [X] Not Applicable [ ] Waiver Requested
3. Detailed Description of Control Equipment [X] Attached, Document ID: E [ ] Not Applicable [ ] Waiver Requested
4. Description of Stack Sampling Facilities [ ] Attached, Document ID:____ [x] Not Applicable [ ] Waiver Requested
5. Compliance Test Report [ ] Attached, Document ID:____ [ ] Previously submitted, Date:____ [x] Not Applicable
6. Procedures for Startup and Shutdown [ ] Attached, Document ID:____ [X] Not Applicable [ ] Waiver Requested
7. Operation and Maintenance Plan [x] Attached, Document ID: F [ ] Not Applicable [ ] Waiver Requested
8. Supplemental Information for Construction Permit Application [X] Attached, Document ID: A [ ] Not Applicable
9. Other Information Required by Rule or Statute [ ] Attached, Document ID:____ [X] Not Applicable
10. Supplemental Requirements Comment:

G. EMISSIONS UNIT SUPPLEMENTAL INFORMATION

Supplemental Requirements

1. Process Flow Diagram [X] Attached, Document ID: C [ ] Not Applicable [ ] Waiver Requested
2. Fuel Analysis or Specification [ ] Attached, Document ID:____ [X] Not Applicable [ ] Waiver Requested
3. Detailed Description of Control Equipment [X] Attached, Document ID: E [ ] Not Applicable [ ] Waiver Requested
4. Description of Stack Sampling Facilities [ ] Attached, Document ID:____ [X] Not Applicable [ ] Waiver Requested
5. Compliance Test Report [ ] Attached, Document ID:____ [ ] Previously submitted, Date:____ [X] Not Applicable
6. Procedures for Startup and Shutdown [ ] Attached, Document ID:____ [X] Not Applicable [ ] Waiver Requested
7. Operation and Maintenance Plan [X] Attached, Document ID: F [ ] Not Applicable [ ] Waiver Requested
8. Supplemental Information for Construction Permit Application [X] Attached, Document ID: A [ ] Not Applicable
9. Other Information Required by Rule or Statute [ ] Attached, Document ID:____ [X] Not Applicable
10. Supplemental Requirements Comment:

G. EMISSIONS UNIT SUPPLEMENTAL INFORMATION

Supplemental Requirements

1. Process Flow Diagram [X] Attached, Document ID: C [ ] Not Applicable [ ] Waiver Requested
2. Fuel Analysis or Specification [ ] Attached, Document ID:______ [X] Not Applicable [ ] Waiver Requested
3. Detailed Description of Control Equipment [X] Attached, Document ID: E [ ] Not Applicable [ ] Waiver Requested
4. Description of Stack Sampling Facilities [ ] Attached, Document ID:______ [x] Not Applicable [ ] Waiver Requested
5. Compliance Test Report [ ] Attached, Document ID:______ [ ] Previously submitted, Date:__________ [x] Not Applicable
6. Procedures for Startup and Shutdown [ ] Attached, Document ID:______ [X] Not Applicable [ ] Waiver Requested
7. Operation and Maintenance Plan [x] Attached, Document ID: F [ ] Not Applicable [ ] Waiver Requested
8. Supplemental Information for Construction Permit Application [X] Attached, Document ID: A [ ] Not Applicable
9. Other Information Required by Rule or Statute [ ] Attached, Document ID:______ [X] Not Applicable
10. Supplemental Requirements Comment:

G. EMISSIONS UNIT SUPPLEMENTAL INFORMATION

Supplemental Requirements

1. Process Flow Diagram [X] Attached, Document ID: C [ ] Not Applicable [ ] Waiver Requested
2. Fuel Analysis or Specification [ ] Attached, Document ID:____ [X] Not Applicable [ ] Waiver Requested
3. Detailed Description of Control Equipment [X] Attached, Document ID: E [ ] Not Applicable [ ] Waiver Requested
4. Description of Stack Sampling Facilities [ ] Attached, Document ID:____ [x] Not Applicable [ ] Waiver Requested
5. Compliance Test Report [ ] Attached, Document ID:____ [ ] Previously submitted, Date:____ [x] Not Applicable
6. Procedures for Startup and Shutdown [ ] Attached, Document ID:____ [X] Not Applicable [ ] Waiver Requested
7. Operation and Maintenance Plan [x] Attached, Document ID: F [ ] Not Applicable [ ] Waiver Requested
8. Supplemental Information for Construction Permit Application [X] Attached, Document ID: A [ ] Not Applicable
9. Other Information Required by Rule or Statute [ ] Attached, Document ID:____ [X] Not Applicable
10. Supplemental Requirements Comment:

G. EMISSIONS UNIT SUPPLEMENTAL INFORMATION

Supplemental Requirements

1. Process Flow Diagram [X] Attached, Document ID: C [ ] Not Applicable [ ] Waiver Requested
2. Fuel Analysis or Specification [ ] Attached, Document ID:_____ [X] Not Applicable [ ] Waiver Requested
3. Detailed Description of Control Equipment [X] Attached, Document ID: E [ ] Not Applicable [ ] Waiver Requested
4. Description of Stack Sampling Facilities [ ] Attached, Document ID:_____ [X] Not Applicable [ ] Waiver Requested
5. Compliance Test Report [X] Attached, Document ID: G [ ] Previously submitted, Date:_____ [ ] Not Applicable
6. Procedures for Startup and Shutdown [ ] Attached, Document ID:_____ [X] Not Applicable [ ] Waiver Requested
7. Operation and Maintenance Plan [X] Attached, Document ID: F [ ] Not Applicable [ ] Waiver Requested
8. Supplemental Information for Construction Permit Application [X] Attached, Document ID: A [ ] Not Applicable
9. Other Information Required by Rule or Statute [ ] Attached, Document ID:_____ [X] Not Applicable
10. Supplemental Requirements Comment:

ATTACHMENT A

Table of Contents

1.0 Project Description 1-1
- 1.1 Flyash Receiving Bins 1-2
- 1.2 Carbon Separation Unit 1-2
- 1.3 Clean-Up Vacuum 1-2
- 1.4 Flyash Surge Bin 1-2
- 1.5 Mineral Additive Storage Bin 1-3
- 1.6 Gas-Fired Dryer 1-3

2.0 Emissions Calculations 2-1
- 2.1 Potential Emissions 2-1
  - 2.1.1 Particulate Emissions 2-1
  - 2.1.2 Natural Gas Combustion 2-3
- 2.2 Allowable Emissions 2-4

3.0 Applicability of State and Federal Regulations 3-1
- 3.1 New Source Performance Standards 3-1
  - 3.1.1 Subpart LL 3-1
  - 3.1.2 Subpart OOO 3-1
  - 3.1.3 Subpart UUU 3-2
- 3.2 State Regulations 3-2
  - 3.2.1 Construction Permits Required 3-2
  - 3.2.2 Operating Permits Required 3-3
  - 3.2.3 Plant Operational Problems 3-3
  - 3.2.4 Odor 3-3
  - 3.2.5 Particulate Matter Emissions Standards 3-3
  - 3.2.6 Compliance Demonstration Requirements 3-4

List of Tables

Table 1 Potential Emissions Calculations 2-3

Table 2 Allowable Emissions Calculations Based on RACT 2-6

1.0 Project Description

Separation Technologies, Inc. (hereinafter referred to as "STI"), proposes to construct a new flyash handling system on a portion of leased property at the St. Johns River Power Park (hereinafter referred to as SJRPP) in Duvall County, Florida. The purpose of the proposed equipment is to remove the residual carbon and ammonia from the flyash leaving a saleable product. As a result of the proposed construction, environmental benefits will include a 255,000 ton reduction in the flyash currently sent to landfill by SJRPP each year and an overall reduction in the ammonia releases with the recovery and subsequent recycle of ammonia removed from the flyash.

The new flyash processing system will include the addition of two Flyash Receiving Bins, a Carbon Separation Unit, a Clean-up Vacuum, a Flyash Surge Bin, a Mineral Additive Storage bin, and a Gas-fired Dryer. The particulate emissions generated from handling of the flyash will be collected from each source using pulse jet fabric filters.

The flyash processing system will be exclusively owned and operated by STI. STI has reached an agreement with the Jacksonville Electric Authority (JEA) St. Johns' River Power Park to beneficiate and market 255,000 tons of flyash that is currently produced and landfilled at the site. The equipment design of the proposed flyash processing system is based on a maximum flyash delivery rate from SJRPP of 300,000 tons per year.

The two-step beneficiation process will consist of (1) removal of the residual carbon from the flyash using STI's patented electrostatic separation technology, and (2) removal of residual ammonia from the flyash using STI's new ammonia removal technology (patent pending).

STI's triboelectric carbon separation technology partitions flyash into a mineral-rich and carbon-rich fraction. The mineral-rich flyash can then be sold as a usable product. The carbon-rich flyash will be returned to SJRPP flyash storage silos for eventual disposal at the onsite landfill.

In addition to residual carbon, the flyash at SJRPP also contains trace amounts of ammonia that makes it unsuitable as a cement replacement. To solve this problem, STI is planning to also install their ammonia removal process. The recovered ammonia will subsequently be returned to SJRPP for recycle.

The following section describes each emission unit proposed for construction. A process flow diagram of the flyash benefication process is shown in Attachment C.

1.1 Flyash Receiving Bins

The flyash from SJRPP will be pneumatically conveyed from existing silos to one of two new receiving bins (Emission Units 1 and 2). The two bins will be operated in parallel resulting in a maximum throughput of 150,000 tons per year of flyash to each. Each silo is equipped with a pulse jet fabric filter to control particulate emissions. Refer to Attachment E for the manufacturers' data on the dust collection devices for these units.

1.2 Carbon Separation Unit

The first step in the flyash benefication process is the removal of the carbon-rich flyash from the mineral-rich flyash product. This process involves STI's electrostatic separation technology which is similar in nature to the technology of an electrostatic precipitator in removing particulate from an air stream. Where electrostatic precipitator technology involves removal of particles from an air stream, STI's electrostatic separation technology removes particulate from a stream of solids. The separation is accomplished by passing the flyash through a high-voltage direct current electrical field. Migration of the mineral-rich flyash particles from the remaining carbon-rich flyash occurs as a result of a negative charge acquired while passage through the electrical field. The particulate emissions from this unit is control with a pulse jet dry dust collector. Refer to Attachment E for the manufacturers' data on this dust collection device.

1.3 Clean-up Vacuum

The building that will house the flyash processing equipment will be equipped with an electric powered industrial vacuum system specifically designed for handling hazardous or abrasive materials including flyash. The vacuum is capable of handling up to 12 tons per hour of wet or dry material. However, since the flyash handling and processing system is enclosed, it is conservatively estimated that only 1% of the total flyash processed, or 3,000 tons per year, will be spilled and subsequently vacuumed. The Clean-up Vacuum is equipped with a pulse jet fabric filter to control particulate emissions. Refer to Attachment E for the manufacturers' data on this equipment and dust collection system.

1.4 Flyash Surge Bin

The ammonia removal stage occurs as a batch process. Therefore, mineral-rich flyash leaving the Carbon Separation unit must be sent to a surge bin before entering the ammonia removal system. The carbon-rich flyash leaving the Carbon Separation unit is returned to the existing storage silos at SJRPP. The flyash from SJRPP is comprised of nearly 80% mineral-rich flyash. Therefore, the design of the flyash surge bin and the ammonia removal system is based on an annual throughput of 255,000 tons per year of mineral-rich flyash. Particulate emissions generated from dropping flyash into the surge bin will be collected with a Jet-Pulse Dust Collector. Refer to Attachment E for the manufacturers' data on this dust collection equipment.

1.5 Mineral Additive Storage Bin

The ammonia removal process involves mixing the mineral-rich flyash with water and a mineral additive. The mineral additive liberates the ammonia from the flyash particles. The ammonia is then captured and sent back to SJRPP for recycle. The mineral additive is designed to account for approximately 1% of the total flyash processed. Therefore, the Mineral Additive Storage Bin has been designed to accommodate a throughput of 1% of the total mineral-rich flyash produced or 2,550 tons of material per year. The particulate emissions generated from loading of the Mineral Additive Storage Bin are controlled with a DCE Silo Air Dust Collector. Refer to Attachment E for the manufacturers' data on this control device.

1.6 Gas-fired Dryer

The final stage in the flyash benefication process is drying of the wetted ammonia-free mineral-rich flyash product. The dewatering process involves direct heating of the flyash in a natural gas fired dryer. The natural gas fired burner is a Low-NOx burner design with a maximum NOx emission rate guarantee of 0.01 lbs/MMBtu of heat input while operating at maximum capacity of 12 MMBtu/hr. The particulate emissions generated as a result of the drying process are controlled with a MAC pulse jet fabric filter. The filter media is a composite polyester material designed to withstand a continuous operating temperature of 250°F to 300°F. The average operating temperature of the dryer exhaust is expected to be approximately 220°F, well below the filter media design temperature range. Refer to Attachment E for the manufacturers' data on these control devices.

2.0 Emissions Calculations

The following section describes the calculations used to estimate the potential emissions of the project and the allowable emission rates as set forth in the Florida Administrative Code. Compliance with the allowable emissions standards are demonstrated in this section with potential emissions calculations using AP-42 emission factors and several conservative assumptions. Additionally, compliance with the allowable emission standard is ensured with a manufacturers' guarantee on the emissions control system for each unit of well below the allowable emission rate.

2.1 Potential Emissions

The potential emissions for the proposed installation will include total particulate matter (PM), particulate matter with an aerodynamic diameter of less than 10 microns (PM_{10}), and trace amounts of nitrous oxides (NOx) and carbon monoxide (CO).

The particulate potential emissions are calculated based on manufacturers' performance guarantees for each dust collector. In other cases, such as the combustion products generated by the natural gas fired dryer, the potential emissions are based on 8,760 hours per year of operation.

2.1.1. Particulate Emissions

The most predominant criteria pollutant of concern will be particulate matter including both PM and PM_{10}. As a measure of conservatism, it will be assumed that all of the particulate matter generated is entirely PM_{10}. As can be seen from Table 1, the total potential particulate emissions for this project are 13.6 tons/year.

The potential particulate emission calculations for the proposed flyash processing system were calculated based on manufacturers' guarantees. The potential emissions for units 1 through 6 are all based on a manufacturer's guaranteed outlet grain loading of 0.015 gr/scf. The manufacturer of the unit 6 (Gas-Fired Dryer Stack) fabric filter has guaranteed that particulate emissions from the control device will not exceed 7 tons/year. This is equivalent to an outlet grain loading of 0.0083 gr/scf.

In addition to the manufacturers' guarantee, the AWMA Air Pollution Engineering Manual further supports the ability of the fabric filters to meet an outlet grain loading of much less than 0.015 gr/scf (Reference 1, p.115).

The potential particulate emissions for unit 7, the Natural Gas Fired Dryer, were also calculated based on the manufacturer's guarantee that the unit will meet a limit of 7 tons/year.

2.1.2 Natural Gas Combustion

Emission unit 7, Natural Gas Fired Dryer, will generate very small quantities of NOx and CO. The potential emissions for these pollutants are based on manufacturers' guarantees of 0.01 lb/MMBtu of NOx and 0.144 lb/MMBtu of CO. Refer to Attachment E for the manufacturer's data on the Natural Gas Fired Dryer's Low-NOx Burner.

Table 1: Potential Emissions Calculations

Description of New Emission Point		1 Separator A Filter-Receiver Vent	2 Separator B Filter-Receiver Vent	3 Separator Dust Collector Vent	4 Clean-up Vacuum Vent	5 Flyash Surge Bin Vent	6 Mineral Additive Storage Bin Vent	7 Gas-fired Dryer Stack
Particulate Control Equipment		Pulse Jet Filter	Pulse Jet Filter	Pulse Jet Filter	Pulse Jet Filter	Pulse Jet Filter	Pulse Jet Filter	Pulse Jet Filter
Control Equipment Location		Separator Building Roof	Separator Building Roof	Separator Building Roof	Outside at grade	Ammonia Process Structure Roof	Ammonia Process Structure Roof	Ammonia Process Structure Roof
Manufacturer		Fuller Bulk Handling	Fuller Bulk Handling	Z&Z Conveying	Max Vac	Fuller Bulk Handling	DCE	MAC Equipment
Model #		8TR10 x80	8TR10 x80	64-08(6)-20	AK15E	64DS8	VS20 KS5	144MCF756-450
Air Flow Rate	SCFM	1700	1400	4000	400	3900	400	22446
Exhaust Temperature	F	100	100	70	70	100	100	220
Outlet Particulate Loading *	gr/scf	0.015	0.015	0.015	0.015	0.015	0.015	0.0083
Operating Hours	hrs/yr	8760	8760	8760	8760	8760	8760	8760
Particulate Emissions	tons/yr	0.96	0.79	2.25	0.23	2.20	0.23	7.00
	lb/hr	0.2186	0.1800	0.5143	0.0514	0.5014	0.0514	1.5969
Combustion Control Equipment		na	na	na	na	na	na	Lo NOX Burner
Manufacturer		na	na	na	na	na	na	Eclipse
Model Number		na	na	na	na	na	na	AH-MA
Gas-fired Dryer Design Rating	MMBTU/hr	na	na	na	na	na	na	12.0
Operating Hours	hr/yr	8760	8760	8760	8760	8760	8760	8760
Burner NOX*	lb/MMBTU	na	na	na	na	na	na	0.010
NOX Emission Rate	tons/yr	0	0	0	0	0	0	0.5
Burner CO*	lb/MMBTU	na	na	na	na	na	na	0.144
CO Emission Rate	tons/yr	0	0	0	0	0	0	7.6

* Manufacturer's Guarantee.

NOTES:

(1) The manufacturer's guarantee for emission point 7 is given in units of tons/year. The outlet grain loading equivalent assumes 8,760 hrs/yr of operation at the rated exhaust flow rate.

TOTAL POTENTIAL EMISSIONS FOR PROJECT

Pollutant	Potential-to-Emit
Total PM	13.65 tpy
NOx	0.53 tpy
CO	7.57 tpy

2.2 Allowable Emissions

The Florida Administrative Code limits particulate emissions based on an outlet grain loading of 0.03 gr/dscf. The citation and applicability of this rule is further discussed in Section 3. The resulting allowable emission rate for each unit that corresponds to this outlet grain loading is calculated in Table 2.

As can be seen in Table 2, the total project allowable emissions based on a particulate limit of 0.03 gr/scf is 38 tons/year. Since the FDEP considers the STI facility part of the SJRPP for the purposed of Prevention of Significant Deterioration (PSD) applicability, the allowable particulate emissions must be further limited to below the PSD major modification threshold level of 15 tons/year. It is therefore requested that the particulate emissions be limited to the manufactures' guaranteed emission level as shown in Table 3.

Table 3
Requested PM_{10} Emission Limits

Emission Unit ID	Emission Unit Description	Requested PM_{10} Limit
1	Separator A Filter – Receiver Vent	0.015 gr/scf
2	Separator B Filter – Receiver Vent	0.015 gr/scf
3	Separator Dust Collector Vent	0.015 gr/scf
4	Clean-up Vacuum Vent	0.015 gr/scf
5	Flyash Surge Bin Vent	0.015 gr/scf
6	Mineral Additive Storage Bin Vent	0.015 gr/scf
7	Gas-fired Dryer Stack	7.0 tons/year *

* For the Gas-Fired Dryer Stack, a limit of 7.0 tons/year is requested as guaranteed by the manufacturer.

The compliance potential of each emission unit can be demonstrated by referencing the following:

(1) **Manufacturers' Guarantees.** Attachment E contains the manufacturers' guarantees for each control device that will be used. The highest guaranteed particulate emission rate of all the control devices is 0.015 gr/scf. This is well below the allowable limit of 0.03 gr/dscf and equivalent to the requested limits.

(2) **AWMA Reference on Fabric Filters.** Reference 1 discusses the control efficiency that can typically be expected of a well-designed and maintained

fabric filter. On page 115, Reference 1 indicates that fabric filters are capable of reducing particulate emissions to "less than 0.010 gr/dscf, and in a number of cases, to as low as 0.001-0.005 gr/dscf."

It is proposed that continued compliance with the requested particulate emission limits will be ensured through the use of an Operations and Maintenance Plan (O&M Plan). A copy of this plan is included in Attachment F.

Table 2: Equivalent Allowable Emissions Calculations

Description of New Emission Point		1 Separator A Filter-Receiver Vent	2 Separator B Filter-Receiver Vent	3 Separator Dust Collector Vent	4 Clean-up Vacuum Vent	5 Flyash Surge Bin Vent	6 Mineral Additive Storage Bin Vent	7 Gas-fired Dryer Stack
Particulate Control Equipment		Pulse Jet Filter	Pulse Jet Filter	Pulse Jet Filter	Pulse Jet Filter	Pulse Jet Filter	Pulse Jet Filter	Pulse Jet Filter
Control Equipment Location		Separator Building Roof	Separator Building Roof	Separator Building Roof	Outside at grade	Ammonia Process Structure Roof	Ammonia Process Structure Roof	Ammonia Process Structure Roof
Manufacturer		Fuller Bulk Handling	Fuller Bulk Handling	Z&Z Conveying	Max Vac	Fuller Bulk Handling	DCE	MAC Equipment
Model #		8TR10 x80	8TR10 x80	64-08(6)-20	AK15E	64DS8	VS20 KS5	144MCF756-450
Exhaust Flow Rate	scfm	1,700	1,400	4,000	400	3,900	400	22,000
	acfm	1,796	1,479	4,226	423	4,121	423	28,226
Exhaust Temperature	F	100	100	100	100	100	100	220
Operating Hours	hrs/yr	8,760	8,760	8,760	8,760	8,760	8,760	8,760
PM Allowable	gr/scf	0.03000	0.03000	0.03000	0.03000	0.03000	0.03000	0.03000
Rule Reference		Rule 62-296.711, FAC	ule 62-296.711, FAC	ule 62-296.711, FAC	ule 62-296.711, FAC	ule 62-296.711, FAC	ule 62-296.711, FAC	Rule 62-296.712, FAC
PM Allowable Emission Rate	tons/yr	1.91	1.58	4.51	0.45	4.39	0.45	24.78
	lb/hr	0.44	0.36	1.03	0.10	1.00	0.10	5.66

* manufacturer guarantee

TOTAL ALLOWABLE EMISSIONS (EQUIVALENT)

Pollutant	Equivalent Allowable Emissions
Total PM	38.07 tpy
VE	5 %

3.0 Applicability of State and Federal Regulations

Potentially applicable state and federal regulations were reviewed relative to the proposed project. The discussion below outlines the findings of this review.

3.1 New Source Performance Standards

The New Source Performance Standards (NSPS) were reviewed with regard to applicability to the proposed flyash processing system. Specifically, Subparts LL, OOO, and UUU were examined and determined NOT to apply to the proposed construction. The following sections discuss the standards and give the reasons why they do not apply.

3.1.1 Subpart LL – Standards of Performance for Metallic Mineral Processing Plants

Review of 40 CFR 60.380 and §60.671 indicates that the proposed facility would not be subject to this regulation. Section 60.380 states that this subpart is applicable to certain equipment at metallic mineral processing plants. Section 60.381 goes on to define *metallic mineral processing plant* as one that produces metallic mineral concentrates from ore, and specifies that *metallic mineral concentrates* contain at least one of several specific metals at a concentration that contributes to the concentrates' commercial value. Since the proposed facility does not handle ore, NSPS Subpart LL does not apply. Furthermore, while flyash and the proprietary mineral to be used by the proposed facility may contain trace levels of the specified metals, they have no impact on the commercial value of the flyash product.

3.1.2 Subpart OOO – Standards of Performance for Nonmetallic Mineral Processing Plants

Review of 40 CFR 60.670 and §60.671 indicates that the proposed facility would not be subject to this regulation. Section 60.670 states that certain operations at nonmetallic mineral processing plants are subject to this subpart. However, the definition of *nonmetallic mineral processing plant* in §60.671 includes only those facilities which process one or more of several listed minerals. The proposed STI facility does not meet this definition since it handles and produces only fly ash and a proprietary mineral that is not included in the definition of *nonmetallic mineral*. It is therefore concluded that the proposed installation would not be subject to this subpart.

3.1.3 Subpart UUU – Standards of Performance for Calciners and Dryers in Mineral Industries

Review of 40 CFR 60.730 and §60.731 indicates that the proposed facility would not be subject to this regulation. Section 60.730 states that dryers at mineral processing plants are subject to this subpart. However, the definition of a *mineral processing plant* in 60.731 includes only those facilities which process or produce one or more of several listed minerals, their concentrates, or mixtures of which the majority is one or more of the listed minerals. The proposed facility does not meet this definition since it handles and produces only fly ash and a proprietary mineral that is not included in the definition of a *mineral processing plant*. It is therefore concluded that the proposed installation would not be subject to this subpart.

3.2 State Regulations

The Florida Administrative Code (F.A.C.) Chapters 62-4, 62-210, 62-212, and 62-296 were reviewed with regard to applicability to the proposed flyash processing system. The following discussion examines the applicability of various rules which may or may not apply.

3.2.1 Construction Permits Required

Prior to construction of the proposed installation, non-exempt facilities must obtain a construction permit per rules 62-4.030, F.A.C., 62-210.300, F.A.C., and 62-212.300, F.A.C. Applications must be certified by a professional engineer registered in the State of Florida, made on Department forms, and filed in quadruplicate along with the appropriate processing fee (ref. 62-4.050, F.A.C.). A professional engineer registered in the State of Florida shall also certify supporting materials. An engineering report and owners' written guarantee shall accompany the application as specified in rule 62-4.210, F.A.C.

The St. Johns' River Power Park is a major facility as defined under rule 62-212.200 F.A.C. and 40 CFR 52.21(b)(4) with potential emissions above the 250 ton per year threshold. STI is proposing to limit the potential emissions of the project to below the PSD major modification de minimis levels by obtaining a federally enforceable permit that requires dust collectors be installed and maintained on each proposed unit. Given a federally enforceable permit issued for the emission units and associated dust collectors, the control efficiency of each dust collector may be factored into the potential emissions calculations. Further, STI is requesting particulate emission limits on each unit that correspond to the manufacturers' guarantees. As such, the proposed STI construction is not subject to review under the Prevention of Significant Deterioration program (ref. 62-212.400 F.A.C.) or Preconstruction Review for Nonattainment Areas (ref. 62-212.500 F.A.C.).

3.2.2 Operating Permits Required

Subsequent to construction of the proposed facility, SJRPP may be required to obtain a revised operating permit as required by rules 62-4.030, F.A.C. and 62-210.300, F.A.C.

3.2.3 Plant Operational Problems

STI shall immediately notify the Department if the facility is temporarily unable to comply with any condition of the permit due to breakdown of equipment by hazard of fire, wind, or by other cause (ref. 62-4.130, F.A.C.). Notification shall include information as specified under rule 62-4.130, F.A.C.

3.2.4 Odor

STI shall not discharge air pollutants which cause or contribute to an objectionable odor as required under rule 62-296.320(2), F.A.C. No objectionable odors are expected to occur as a result of the proposed equipment.

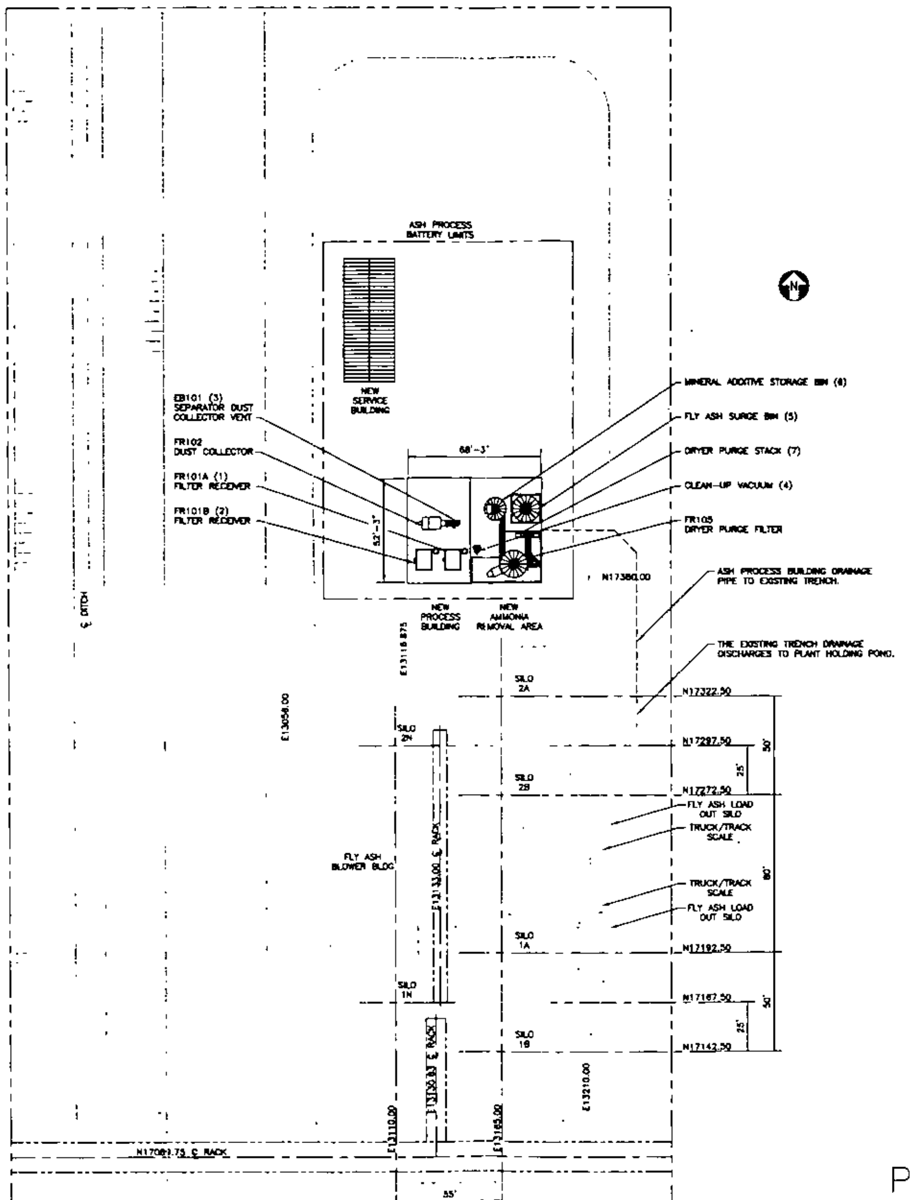
3.2.5 Particulate Matter Emissions Standards

Rule 62-296.700, F.A.C. applies to existing emissions units that emit particulate matter and are located in a particulate matter air quality maintenance area or in the area of influence of such an air quality maintenance area. Visible emissions from the handling, sizing, screening, crushing, or grinding of materials including fly ash and the mineral additive shall not exceed 5% opacity (ref. 62-296.711(2)(a), F.A.C.). Emissions of particulate from stacks associated with such handling shall not exceed 0.03 gr/dscf (ref. 62-296.711(2)(b), F.A.C.). Visible emissions from the operation of miscellaneous manufacturing process operations such as the dryer shall not exceed 5% opacity (ref. 62-296.711(2), F.A.C.). Emissions of particulate from stacks associated with such processes shall not exceed 0.03 gr/dscf (ref. 62-296.711(2), F.A.C.).

3.2.6 Compliance Demonstration Requirements

Rules 62-296.711(3)(a), F.A.C. and 62-296.712(3)(c), F.A.C. allows compliance with the particulate standards of the rules discussed above to be demonstrated with a visible emissions test indicating no visible emissions (5 percent opacity) provided the emission unit is equipped with a baghouse. The visible emissions test results will be submitted in lieu of a particulate stack test for each emission unit found to be subject to rules 62-296.711, F.A.C. and 62-296.712, F.A.C.

ATTACHMENT B



NOTE:
THE NUMBER ASSOCIATED WITH EQUIPMENT DESIGNATIONS INDICATE EMISSION POINTS.

9/27/99
PRELIMINARY

REV	DATE	BY	DESCRIPTION	APPD.

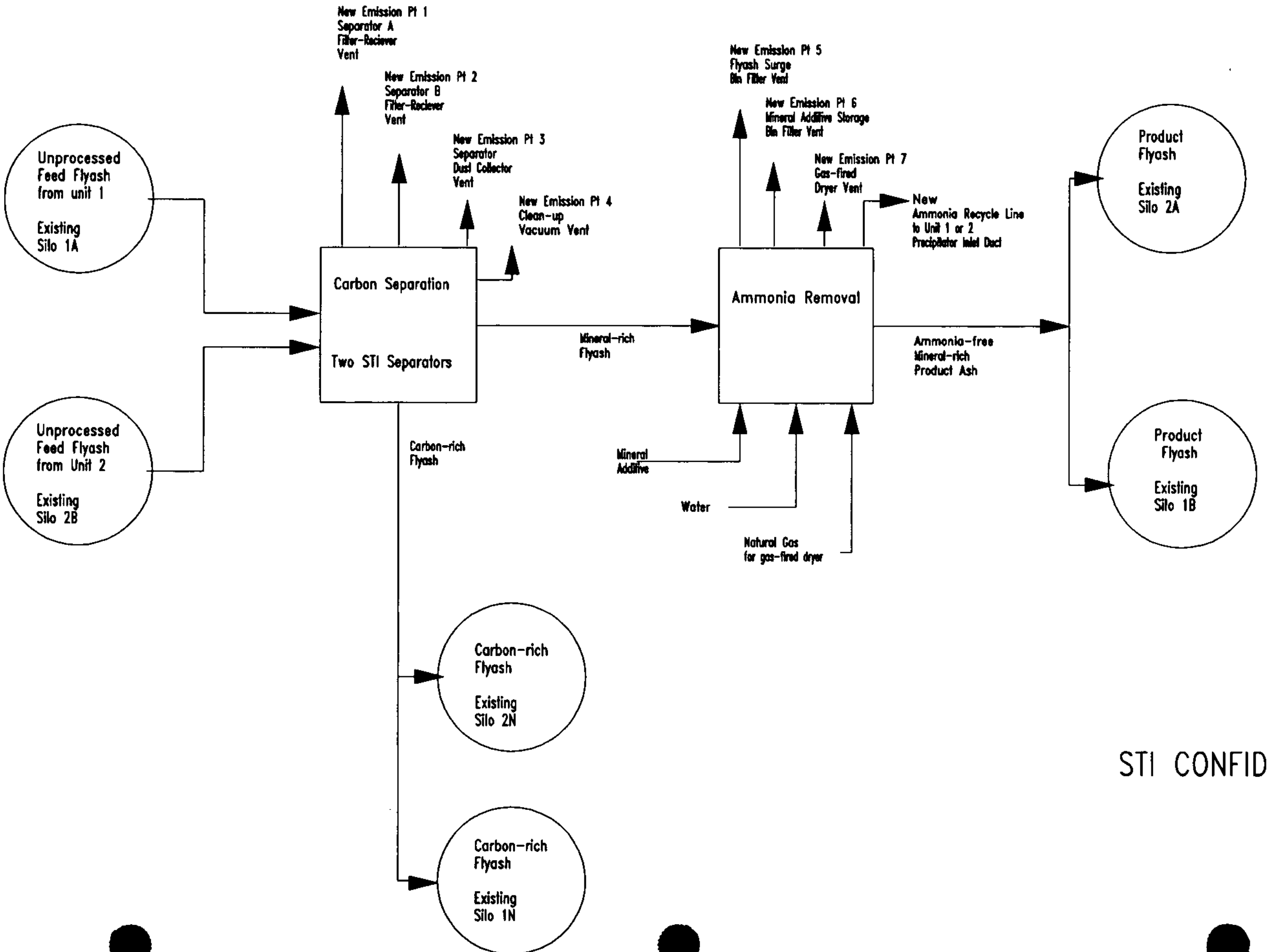
LAUREN Engineers, Inc.
901 South First Street Abilene, Tx. 79602
(915)670-9660 Fax (915)670-9672

PROJECT:
FLY ASH SEPARATION PROJECT
JACKSONVILLE ELECTRIC AUTHORITY
ST. JOHNS RIVER POWER PARK
SEPARATION TECHNOLOGIES, INC.

DRAWING TITLE:
SITE PLAN

CHECKED: JLC
SCALE: 1=30'
DATE: 9/17/99
1 of 1
DRAWING NO.
D-9929-PR1

ATTACHMENT C



STI CONFIDENTIAL

ATTACHMENT D

Control Technology Specifications
Emission Points 1 and 2
Separator A Filter – Flyash Receiving Bin Vent
Separator B Filter – Flyash Receiving Bin Vent

Control Equipment:	**Pulse Jet Fabric Filter**
Manufacturer:	**Fuller Bulk Handling**
Model #:	**8TR10 x80**

Control Technology Specifications
Emission Point 1
Separator A Filter – Flyash Receiving Bin Vent

Control Equipment:	**Pulse Jet Fabric Filter**
Manufacturer:	**Fuller Bulk Handling**
Model #:	**8TR10 x80**

FULLER BULK HANDLING

FULLER BULK HANDLING CORP.
3225 Schoenersville Road • P.O. Box 805
Bethlehem, PA 18016-0805
Tel: (610) 264-6055 • FAX: (610) 264-6735
http://www.fullerbulkhandling.com

3 September 1999

Mr. Frank Hrach
Separation Technologies, Inc.
10 Kearney Road
Needham, MA 02494

Dear Mr. Hrach:

Subject: Jacksonville Electric Project
Your PO #30619
Emissions Guarantee

We have modified the silo vent filter and the two (2) filter receivers on this project to meet the requested emissions guarantee of .015 grains per ACFM outlet grain loading. The modifications include changing the bag materials to meet this requirement

As we discussed, the vent filter change is minimal and requires no price change. However, the filter receivers, which are under a significantly higher grain loading, require a PTFE laminate on the bags at a total cost additon of $2600 for each unit, or a total contract change addition of $5,200.

We are proceeding with these changes as instructed in your phone conversation with Bill Beidleman on 2 September 1999. Please arrange to forward a change order to reflect this addition.

I have recently taken over the administration of this project. Should you have any questions or need information, please contact me directly at 610-264-6237 (fax -6459). I look forward to working with you.

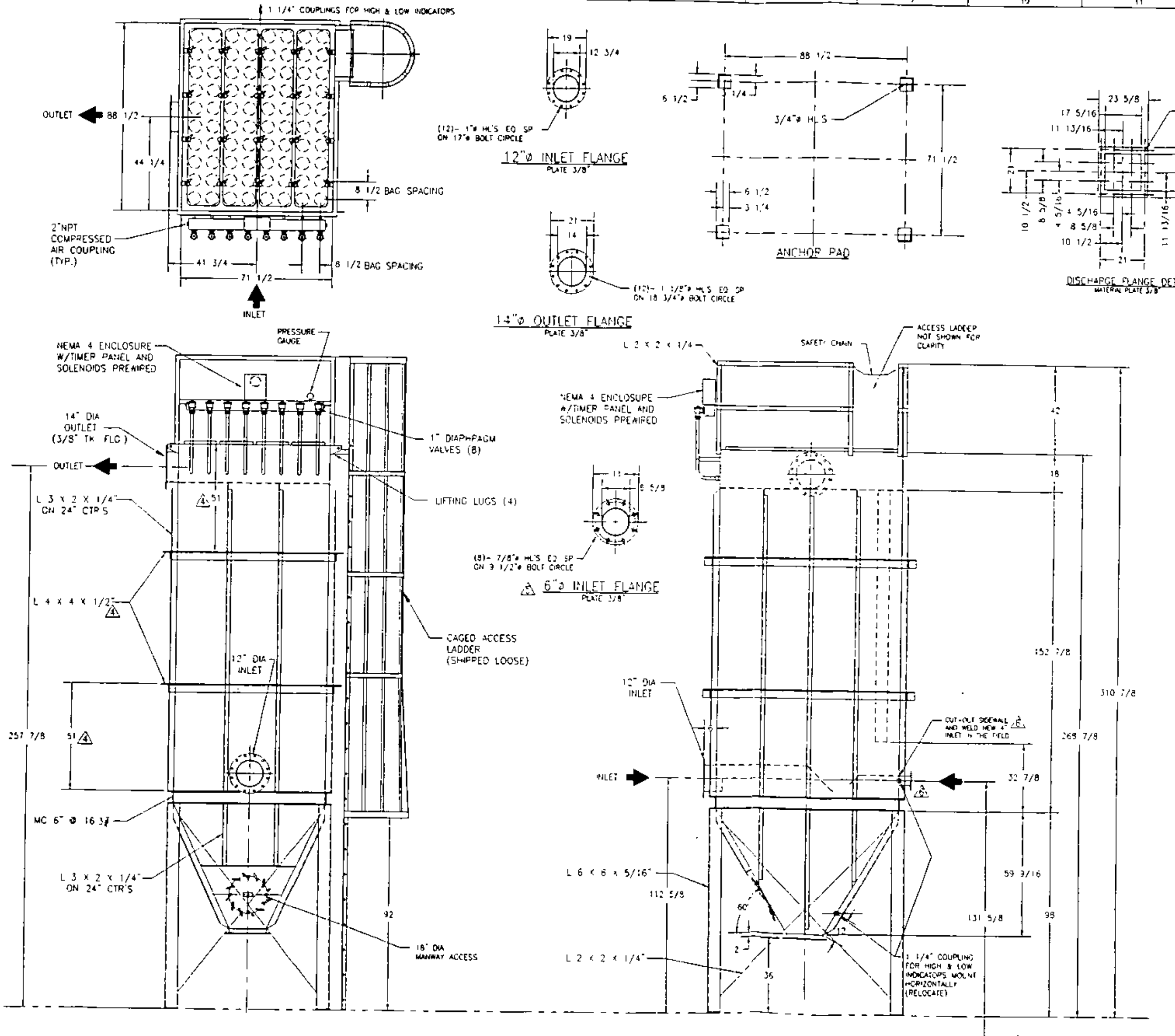
Sincerely,

FULLER BULK HANDLING CORPORATION

Donna Caldwell

Donna E. Caldwell
Contract Manager

cc: W E Beidleman, T LaFavor, B F Strobl



CERTIFIED
FOR CONSTRUCTION PURPOSES
DATE 01/27/99
SIGNATURE
CLEAN AIR MANAGEMENT CO., INC

SHIPPED LOOSE ITEMS
BAGS
CAGES
LADDER
DUST COLLECTOR W/INTEGRAL HANDRAIL,SUPPORT STRUCTURE
TIMER ENCLOSURE

GENERAL NOTES

1. ALL WELDED- #12 GA CARBON STEEL,HEAVY DUTY CONSTRUCTION
   - EXTERNAL WELDS CONTINUOUS, INTERNAL SEAMS SKIP WELDED REINFORCED FOR +/- 20" W.C. & 80 MPH EXPOSURE C WIND LOAD AT GRADE
2. (23) 6" DIA x 120" LG 16 OZ POLYESTER FILTER BAGS PROVIDING A TOTAL AREA OF 1,280 SQ FT
   (23) HEAVY DUTY #11 GA GALV CARBON STL (12) WIRE FILTER BAG CAGES
3. REVERSE / PULSE CLEANING SYSTEM CONSISTING OF: (8-10 SCFM @ 90-100 PSI COMPRESSED AIR REQUIRED)
   - 5" COMPRESSED AIR HEADER PIPE
   - (8) 1" DIA DIAPHRAGM VALVES
   - (8) 1/8" DIA SOLENOID VALVES MOUNTED & PREWIRED IN A NEMA 4 ENCLOSURE
   - NYLON TUBING BETWEEN SOLENOID & DIAPHRAGM VALVES (FACTORY INSTALLED)
4. SOLID STATE SEQUENTIAL TIMER BOARD ASSY, MOUNTED IN NEMA 4 ENCLOSURE (SHIPPED LOOSE)
5. PHOTOHELIC PRESSURE GAUGE
   - DWYER PHOTOHELIC SWITCH/GAUGE MODEL #3015 MOUNTED IN A NEMA4 ENCLOSURE
   - 30 FT 1/4" DIA NYLON TUBING AND NECESSARY FITTINGS
6. DIRTY AIR HOUSING W/ QUICK OPENING LIFT OFF & CLAMPED DOOR FOR ACCESS TO FILTER BAGS & CAGES
7. PYRAMIDAL HOPPER W 60° SIDE SLOPE
8. STRUCTURAL SUPPORTS PROVIDING 36" CLEARANCE BELOW HOPPER
9. EST WEIGHT 5800 LBS
10. PAINT
    - INTERIOR NOT PAINTED
    - EXTERIOR PRIMED & FINISH PAINTED WITH SHERWIN WILLIAMS SW4003 LIGHT TAN ENAMEL
11. GASKET TO BE NEOPRENE

APPLICATION DUST COLLECTOR
PRODUCT FLY ASH
AIR VOLUME 3,380 ACFM
OPERATING TEMPERATURE 200° F
AIR TO MEDIA RATIO 2.6 TO 1
TAG FILTER RECEIVER
PROCESS BUILDING
FR101

REV 6	01/27/99	ADDED 4"Ø INLET REMOVED 6" ONES
REV 5	01/19/99	ADDED (2)- 6"Ø INLETS
REV 4	12/28/98	ADDED 4 X 4 X 1/2" ANGLE REINFORCING
REV 3	12/18/98	FINALIZED ELECTRIC PANEL/CHG'D PAINT NOTE
REV 2	12/12/98	CORR'D BOTTOM FLANGE ORIENTATION
REV 1	11/02/98	PER CUSTOMER MARK UP

CAMCORP CLEAN AIR MANAGEMENT CO., INC

JOB NUMBER C98495-M
DWG NO 98495-1
CUSTOMER FULLER BULK HANDLING
BALTIMORE GAS & ELECTRIC
1000 BRANDON SHORES RD
BALTIMORE MD
TITLE MODEL 8TR10X80 DUST COLLECTOR FR101
DATE 10/06/98 DRN BY DOTY SCALE PS 24-00

CAMCO

CLEAN AIR MANAGEMENT CO., INC.

DUST COLLECTOR IOM MANUAL

CAMCO
CLEAN AIR MANAGEMENT CO., INC.
10200 W. 75TH ST., SUITE 100 • SHAWNEE MISSION, KS 66204
PHONE: 913-831-0740 • FAX: 913-831-9271

TABLE OF CONTENTS

*OPERATING PRINCIPLE	1-1
*RECEIVING and INSPECTION of UNIT	2-1
*ON SITE STORAGE RECOMMENDATIONS	3-1
*BAG & CAGE INSTALLATION	4-1
*SETTING UP YOUR UNIT	5-1
*COMPRESSED AIR REGULATOR INSTALLATION INSTRUCTIONS	6-1
*START - UP CHECKLIST	7-1
*START - UP DUST CONTROL SYSTEMS	8-1
*SHUT - DOWN PROCEDURES	9-1
*TROUBLE SHOOTING the DUST COLLECTOR	10-1
*TROUBLE SHOOTING the TIMER	11-1
*TROUBLE SHOOTING the COMPRESSED AIR SYSTEM	12-1
*SAFETY RECOMMENDATIONS	13-1
*ROUTINE MAINTENANCE	14-1
*MAGNAHELIC DIFFERENTIAL GAUGE INSTALLATION & INSTRUCTIONS	15-1
*FILTER/REGULATOR INSTRUCTIONS	16-1
*DIAPHRAGM & SOLENOID VALVE INSTRUCTIONS	17-1
*RECOMMENDED SPARE PARTS	18-1

CAMCO
CLEAN AIR MANAGEMENT CO., INC.

10200 W. 75TH ST., SUITE 100 • SHAWNEE MISSION, KS 66204
PHONE: 913-831-0740 • FAX: 913-831-9271

OPERATING PRINCIPLE

A. Solids laden air or gases enter the unit at the hopper or housing inlet.

B. Air passes through the filter media.

C. Solids are retained on the filter media surface.

D. Cleaning cycle consists of a momentary blast of 90-100 psig compressed air:

   1. Momentarily taking a row of bags off stream through pressure reversal.

   2. Flexing filter bags.

   3. Solids are released to fall towards hopper and through rotary valve or other discharge equipment.

CAMCO
CLEAN AIR MANAGEMENT CO., INC.

10200 W. 75TH ST., SUITE 100 • SHAWNEE MISSION, KS 66204
PHONE: 913-831-0740 • FAX: 913-831-9271

RECEIVING YOUR UNIT

Prior to accepting shipment, care must be taken to inspect all equipment received both for proper count and for damage. Any and all irregularities must be noted on the carriers copy of the shipping receipt to assist in settling any claims for damage or shortages. All equipment is shipped FOB point of origin whether on a prepaid or collect freight basis.

ANY CLAIM FOR DAMAGE IN TRANSIT OR SHORTAGES MUST BE BROUGHT AGAINST THE CARRIER BY THE PURCHASER.

Once your claim has been filed with the carrier contact CAMCO to notify us of the problem(s), then we will advise the appropriate repair procedure or recommend it to be returned to the factory depending on the extent of the damage.

INSPECTION OF UNIT

Housing, Air Header and Timer Assembly: Particular attention should be paid to the sheet metal housing of your collector. The unit should be inspected for dents, cracks, or rips. A dented housing may seriously affect the structural integrity of the unit. The air header and timer assembly are very delicate pieces of the unit and must be checked carefully for any signs of impact, warpage, or loose fittings. If any of these signs are present, note them on the shipping receipt and notify CAMCO immediately. The entire unit should be checked against the certified drawings for correctness and the manufacturer notified immediately if there are any discrepancies. No corrections may be made without the expressed written consent of the manufacturer.

Components: A count should be made of all pieces received and this should be verified against the carrier's manifest. Boxes should be inspected for rough handling which may have resulted in hidden damage.

CLEAN AIR MANAGEMENT CO., INC.

10200 W. 75TH ST., SUITE 100 • SHAWNEE MISSION, KS 66204
PHONE: 913-831-0740 • FAX: 913-831-9271

ON SITE STORAGE RECOMMENDATIONS

I. Baghouse, Bin Vent, Filter Receiver, Dirty Air Hopper and Housing

1. Housing can be stored outside.
2. Equipment must be blocked up to keep the flanges out of the dirt.
3. Many units are supplied with a plain finish bare steel interior. If storage of more than two weeks is anticipated, the interior should be prime coated before storage.
4. Covering the unit with a tarp is recommended to keep the interior from rusting or corroding as well as keeping the finish in new condition. However, the tarp is not absolutely necessary.

II. Baghouse, Bin Vent, Filter Receiver, and Clean Air Plenum

1. Unit can be stored outside.
2. Air header and diaphragm valves must be tarped for weather protection.
3. Unit must be positioned so water will not get in or remain inside the tubesheet area.
4. Unit must be blocked up to keep the flanges, bag cups, venturis and air header out of the water and dirt.
5. Ports on diaphragm valves must be plugged and taped to keep insects, dirt, and moisture out.
6. For extended storage, (more than 4 weeks) it is recommended to remove the timer panel and solenoid assembly. This component should be stored inside a cool dry area along with the copper or black nylon tubing. The solenoids should have all ports capped and taped to protect from insects, dirt, and moisture.
7. This unit should be tarped but is not absolutely necessary.

III. Bags & Cages

1. Bags must be stored inside a cool dry area protected from rodents and insects.
2. For extended storage the boxes for the bags should be wrapped with plastic wrap or stretch wrap to protect from moisture.
3. If the bags get wet for any reason, immediately lay them out with plenty of ventilation to dry in order to prevent mold and mildew.
4. It is recommended to store the cages inside a dry area if at all possible.
5. If an inside location is not available, cages can be stored outside as long as they are covered by a tarp.
6. Cages are generally stored horizontally on pallets to keep off the ground.

7. If cages can be stored horizontally, do not stack over three boxes high.
8. If the job site is in an area that may receive a significant snow load, the cages must be stored vertically in order to prevent being crushed by the weight of the snow. Do not stack more than one box high.

IV. Accessory Parts

1. This includes all gauges, bag clamps, nylon or copper tubing, valves, gaskets, and other parts not specifically called out.
2. These items should be stored inside a cool dry place protected from insects and rodents.

V. Fan and Fan Accessories

1. Fans can be stored outside on a pallet or skid to keep out of water and dirt.
2. Equipment should be covered with a tarp to protect from the bags.
3. Fan silencers, outlet dampers, and inlet boxes should also be tarped and stored on a pallet or skid.

VI. Ducting

1. Ducting can be stored outside on a pallet or skid to keep it off of the ground. It should be positioned so that water does not sit in the equipment.
2. If ducting is unpainted steel, it should be at least prime coated before storage.
3. If ducting is already finish coated, it should be tarped to protect the finish but is not absolutely necessary.

VII. Knife Gate

1. All limit switches, solenoids, and air cylinder ports must be capped and taped to prevent any moisture or dirt from entering.
2. Equipment can sit outside provided it is covered with a tarp and is on a pallet or skid to keep it out of the water and dirt.

VIII Isolation Dampers

1. All limit switches, solenoids, and air cylinder ports must be capped and taped to prevent any moisture or dirt from entering.
2. Equipment can sit outside provided it is covered with a tarp and is on a pallet or skid to keep it out of the water and dirt.

IX. Rotary Valve

1. Rotor and interior of valve should be well oiled with <u>vegetable</u> oil to prevent rust and to maintain compatibility with the product.
2. Unit can be stored outside provided it is covered with a tarp and is on a pallet or skid to keep it out of the water and dirt.

ON SITE STORAGE RECOMMENDATIONS (continued)

X. Butterfly (Wafer Valve)

1. All limit switches, solenoids, and air cylinder ports must be capped and taped to prevent any moisture or dirt from entering.
2. Unit can be stored outside provided it is covered with a tarp and is on a pallet or skid to keep it out of the water and dirt and sunlight.

XI. Level Indicators

* Store these items inside a cool dry area protected from rodents.

XII. AC Inverters

* Store these items and all other electrical controls inside a cool dry area protected from rodents.

CAMCO CLEAN AIR MANAGEMENT CO., INC. 10200 W. 75TH ST., SUITE 100 • SHAWNEE MISSION, KS 66204 • PHONE 913-831-0740 • FAX 913-831-9271

CLEAN AIR MANAGEMENT CO., INC.

10200 W. 75TH ST., SUITE 100 • SHAWNEE MISSION, KS 66204
PHONE: 913-831-0740 • FAX: 913-831-9271

SETTING UP YOUR UNIT

CAMCO dust collectors are shipped either in one piece, fully assembled, or in two or more sections depending on the unit size and weight. Before attempting to move the dust collector or any of its sections, review both the certified general assembly drawing supplied with your unit and the rigging and lifting guidelines included in this manual. Become familiar with the size and number of sections to be assembled, the orientation of inlet(s), outlet(s), access door(s), and compressed air header(s), as well as the number and location of lifting lugs.

Dust collectors of this type are manufactured from steel sheets and are quite flexible. Therefore, even though care has been taken to maintain dimensional accuracy and squareness, some difficulty should be anticipated, and temporary bracing in the field may be required.

The following sequential procedure will help to minimize any assembly difficulties:

STEP 1: Set up the supporting steel work for the dust collector level and square. Precision at this point will facilitate erection and bolt hole alignment of the dust collector sections to follow.

STEP 2: Place the hopper with its girth channel on the supporting steel work. Check for squareness, and for bolt hole alignment between the hopper flange and the girth channel. Apply the appropriate RTV silicone caulk around the periphery of the hopper flange, one bead on each side of the bolt holes.

STEP 3: Lift the dusty air plenum, with the tubesheet, into place. **DO NOT LOWER THE PLENUM ONTO THE HOPPER FLANGE UNTIL ALIGNMENT IS ACCOMPLISHED.** The silicone caulk makes horizontal movement flanges very difficult once load is applied. With the plenum suspended over the hopper (1/2" to 1"), begin bolt hole alignment, starting at the center of the plenum and working toward the ends by using tapered drift pins with about 3/16" tips. If the wall(s) has flexed out of square, it will be necessary to pry or pull it back into alignment. Depending on the size of the unit and the degree of difficulty, hydraulic jacks and come-along's may be required. When the mating holes are properly aligned, finish lowering the plenum. Install the remaining bolts, washers, and nuts and torque to appropriate specifications.

SETTING UP YOUR UNIT (continued)

STEP 4: Check the top of the dusty air plenum for squareness and bolt hole alignment between the dusty air plenum and the tubesheet. make sure that the silicone caulk has been applied between the top flange of the dusty air plenum and the underside of the tubesheet flange. Next, apply the caulk around the periphery of the top side of the tubesheet flange, one bead to each side of the bolt holes.

STEP 5: Lift the clean air plenum into place, and assemble in the same fashion as in STEP 3. Again, do not lower the clean air plenum completely until preliminary alignment is accomplished. Start drift pin alignment at the center of the plenum on the compressed air header side, since the header makes access to the flange more limited. When alignment is complete, install the remaining bolts, washers, and nuts and torque to appropriate specifications.

All CAMCO dust collectors are provided with lifting lugs for ease in handling of the units during field erection and installation. The number and location of these lifting lugs will vary depending on the model, size, and weight of the dust collector. Before attempting to rig and lift your dust collector, review the certified general assembly drawing supplied with your unit to verify the number and location of lifting lugs, as well as visually check this information on the actual unit. Large units are frequently shipped in several sections, so check the lifting lugs provided on each section. If these cannot be used or there is some question about lifting lug location, consult the engineering staff at CAMCO for proper location since proper care must be taken to prevent damage to the housing or its components.

Rigging and Lifting Guidelines

1. Do not lift the dust collector by any attachments other than the lifting lugs provided.

2. Use all of the lifting lugs provided on the dust collector, or a section of the dust collector, when making a lift.

3. If the lifting lugs are located below the roof line of the dust collector or below the top of the section of the dust collector, a vertical pull must be made to avoid crushing the top of the unit. Use spreader beams to accomplish this vertical pull.

4. Attach tag lines at several locations to be able to control the unit when lifted and to prevent spinning or swinging.

5. The dust collector should be lifted and lowered at a slow, uniform rate and not allowed to bounce or joggle since this can cause excessive impact stresses at the lift points.

Air Header: CAMCO ships the air header installed complete with diaphragm valves, except when units are over legal shipping width when the air header is installed.

Doors and Flanges: Hold downs on doors should only be hand tightened. Excessive pressure can distort the door panel itself resulting in leakage. All bolts on flanges should be tight. All holes in the dust collector must be plugged prior to start-up if not being connected.

SETTING UP YOUR UNIT (continued)

Electrical: A 120 volt 60 Hertz circuit is required to operate the dust collector's programming device. This time must be wired according to the wiring diagrams and provided with a circuit that is free from transient currents. The timer has a feature call "Demand Pulse" that allows the output terminals to be energized and de-energized by the high and low set points of a differential pressure switch such as a Dwyer Photohelic Series 3000. Refer to the enclosed timer wiring diagram for proper wiring. The "Demand Pulse" terminals are marked "Pressure Switch". Do not over fuse.

The circuit board timer has the pulse duration and the internal (time between valves firing) set at the time of manufacture of your equipment. Before applying power to the timer, always check these settings according to the table below. Since there are many variances in operations and conditions, these are presented only as initial start-up guidelines. If you experience problems in cleaning of the filter bags, please contact CAMCO.

TIMER BOARD ADJUSTMENTS
(Recommended at start-up)

VALVE SIZE	PULSE DURATION	INTERVAL
3/4"	.10 to .12 seconds	20 to 25 seconds
1"	.10 to .12 seconds	20 to 25 seconds
1-1/2"	.06 to .08 seconds	20 to 25 seconds

The firing sequence of the timer is factory set so that no two adjacent rows of the bags fire in succession to insure maximum cleaning and life of the filter media. If you are experience a high pressure drop across the filter bags in your dust collector, the pulse interval should be reduced.

Apply electrical power to the timer and make sure it is cycling completely through all rows of the unit. In some cases, the timer panel may have more "positions" than required, in which case, the position selector cable is attached to the proper numerical value corresponding to the number of diaphragm valves on the unit.

If your unit was shipped via common carrier rather than contract hauler, there is a possibility that the electrical box was not shipped installed on the unit. If this is the case, there is a mounting plate welded on the housing or the air header with the bolt pattern of the electrical box already drilled. Bolt on the box and install the nylon (or copper) tubing with the fittings provided making sure that the solenoids are hooked to their corresponding diaphragm valve.

Valves and Piping: After the unit has been installed, the diaphragm valves should be checked to make sure that the port marked "IN" is assembled to the distribution header. The "IN" connection of the solenoid valve is connected to the diaphragm valve by means of 1/4" nylon or 1/4" copper refrigeration tubing. Each nut on the brass compression fittings should be checked for tightness before the distribution header is pressurized. In most cases a slip fit fitting has been used. The integrity of the nylon tubing inside each fitting should be checked by pulling gently on each tube. If the tube pulls out, simply push it back into the fitting until it will not go any further. The solenoids are shipped with a plastic plug in the discharge side of the valve. These plugs must be removed for proper operation of the filter cleaning mechanism.

SETTING UP YOUR UNIT (continued)

Gauges: Check the pressure differential gauge to make sure that the high pressure tap is connected below the tubesheet and the low pressure tap is connected above the tubesheet. Verify that the gauge has been zeroed prior to connection when it is in its permanent mounting position.

Auxiliary Equipment: All auxiliary equipment must be installed according to its manufacturer's specifications and interlocked with the entire system as needed. Direction of rotation of each item must be checked prior to start-up of the entire system.

CAMCO
CLEAN AIR MANAGEMENT CO., INC.

10200 W. 75TH ST., SUITE 100 • SHAWNEE MISSION, KS 66204
PHONE: 913-831-0740 • FAX: 913-831-9271

BAG AND CAGE INSTALLATION

Installation of Bag and Cage Assembly - Bottom Loader

1. Inspect the cage for any signs of damage, warping, bent wires, or missing welds.

2. Inspect the filter bag for any signs of mold, mildew, ripped seams, or holes.

3. Be sure the wire cage has a bottom pan. Slip filter bag over the cage, centering the seam 1-1/2" or 2" either side of the split at the top of the cage roll band. Seam must be straight (not corkscrewed).

4. Pull bag up and over the full length of the cage and fold the entire extra length over and down into the top of the cage. Make sure the bag bottom is tight against the cage pan. Smooth out all folds and pleats on eh interior of the roll band.

5. Slip the assembled bag and cage up on the bag cup making sure to mate the male groove of the cage roll band top to the female groove the bag cup.

6. If you try to move the assembly up and down, you will be able to tell if the grooves are properly aligned.

7. Install the bag clamp on the assembly and tighten around the bag and cage at the point just above the groove on the cage. The clamp head should be located in the best direction for ease in tightening.

8. Tighten the clamp until secure. You should not be able to rotate the assembly by hand if it is tight enough.

9. Close the access door and tighten accordingly. You are ready to begin start-up procedures if all other preceding tasks and hook-ups are completed.

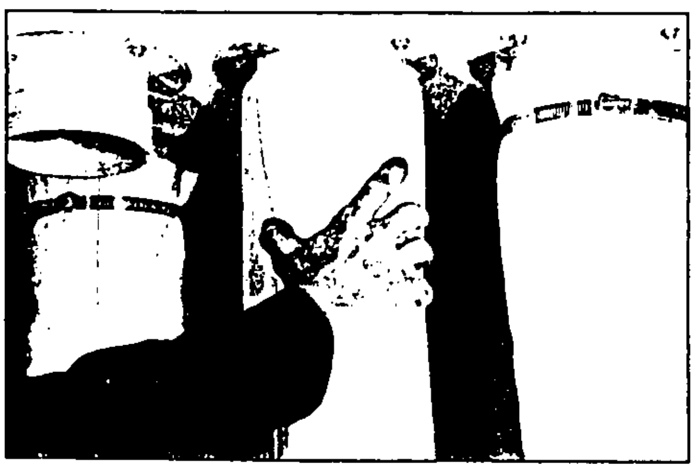
10. It is recommended to double check the tightness of the bag and cage assembly approximately one month after the initial start-up.

Bottom Bag Removal

The AVS pulse jet filters have bottom cage and bag removal from the interior of the housing. This is economical and convenient for small filter units.

Step 1 The cage is inserted into the full length of the bag.

Step 2 The remainder of the bag is tucked into the cage, being careful not to leave any creases along the rim of the cage.



Step 3 The bag and cage are then slid onto the permanently attached bag cup.

Step 4 A positive seal is achieved by used of hose type clamps.

Installation of Bag and Cage Assembly - Top Loader

1. Inspect the cage for any signs of damage, warping, bent wires, or missing welds.

2. Inspect the filter bag for any signs of mold, mildew, ripped seams, or holes.

3. Remove the blow pipe by loosening the bulkhead fitting on the air header end of the pipe and removing the bolt in the retaining clip on the opposite end of the pipe.

4. Lower the closed end of the bag through the hole in the tubesheet.

5. With your hands, "kidney shape" the snap band bag top in order to fit and align it within the tubesheet hole.

6. Fit the groove of the snap band to the I.D. of the tubesheet hole and allow it to expand and audibly snap into place. If the band will not snap into place initially, **do not** push on the "dimple" as doing this will permanently damage the snap band. Instead, kidney shape the snap band from the opposite side of the band. Then you can allow the band to expand and audibly snap into place.

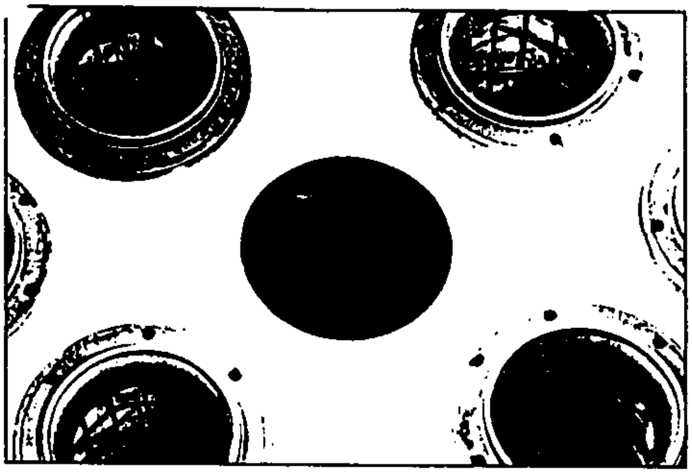
7. Check the fit of the snap band to the tubesheet. It should be even in height above the tubesheet around the entire circumference, which will confirm to the installer that the tubesheet is centered and well secured into the middle groove of the snap band.

8. Lower the cage into the bag and press the cage top down into the bag's snap band I.D. When in position, the rolled flange of the cage top will rest on the tubesheet and the bag and cage assembly will be rigidly mated. The O.D. of the cage top provides a compression fit to the I.D. of the snap band.

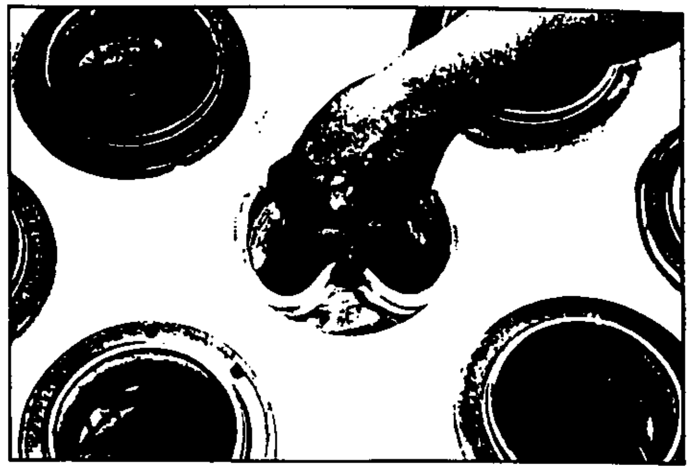
9. Replace the blow pipes in the opposite order stated in Step 3. Make sure that the orifices in the blow pipe are in the proper orientation to blow straight down the center of the bag and cage assembly.

10. Replace access doors and tighten accordingly. You are ready to begin start-up procedures if all other preceding tasks and hook-ups are completed.

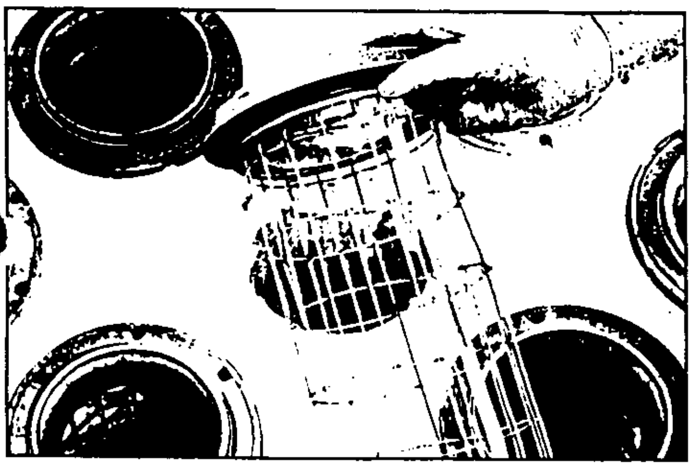
Top Bag Removal – ST Style



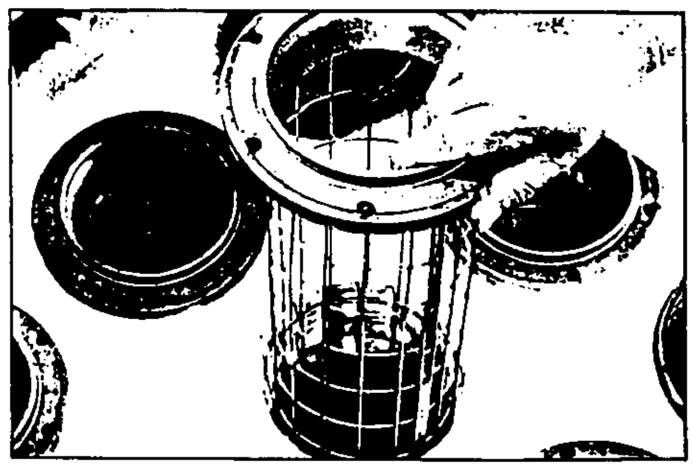
Step 1 Entry into the dirty side of the filter is unnecessary.



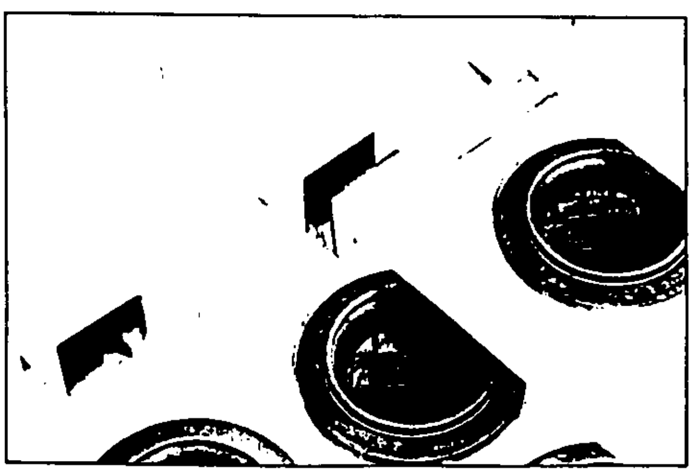
Step 2 No tools are required.



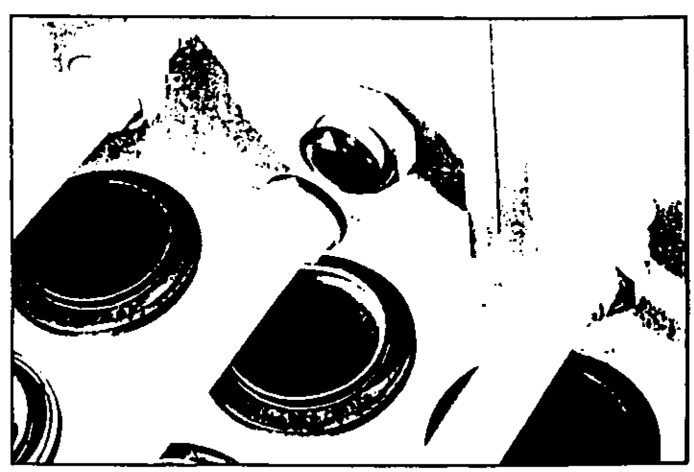
Step 3 Snap band with high profile lip seals secure the bag to the tube sheet.



Step 4 The cage snaps into place by merely lowering it into the bag and pushing down.



Step 5 The header pipes are easily installed by sliding the indexed end into the bracket.



Step 6 The header pipes can only fit one way, thus insuring alignment of the blow nozzles.

CAMCO

CLEAN AIR MANAGEMENT CO., INC.

10200 W. 75TH ST., SUITE 100 • SHAWNEE MISSION, KS 66204
PHONE: 913-831-0740 • FAX: 913-831-9271

COMPRESSED AIR REGULATOR INSTALLATION INSTRUCTIONS

With some dust collectors a filter/regulator is shipped loose with galvanized connectors and ball valves. The diaphragm valve header is supplied with (2) 1" couplings, (1 @ each end) to allow user to bring compressed air line in at either end. The other coupling is used as a drain valve.

INSTALLATION

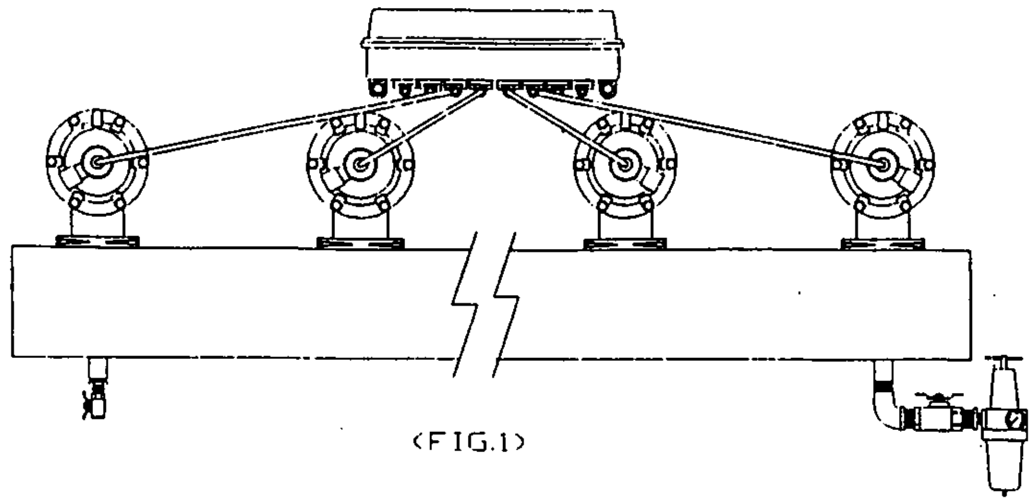
1. Choose end of header for compressed air inlet.

2. Assemble pipe fittings and ball valve as shown in Fig. 2-b, using Teflon tape on all pipe threads.

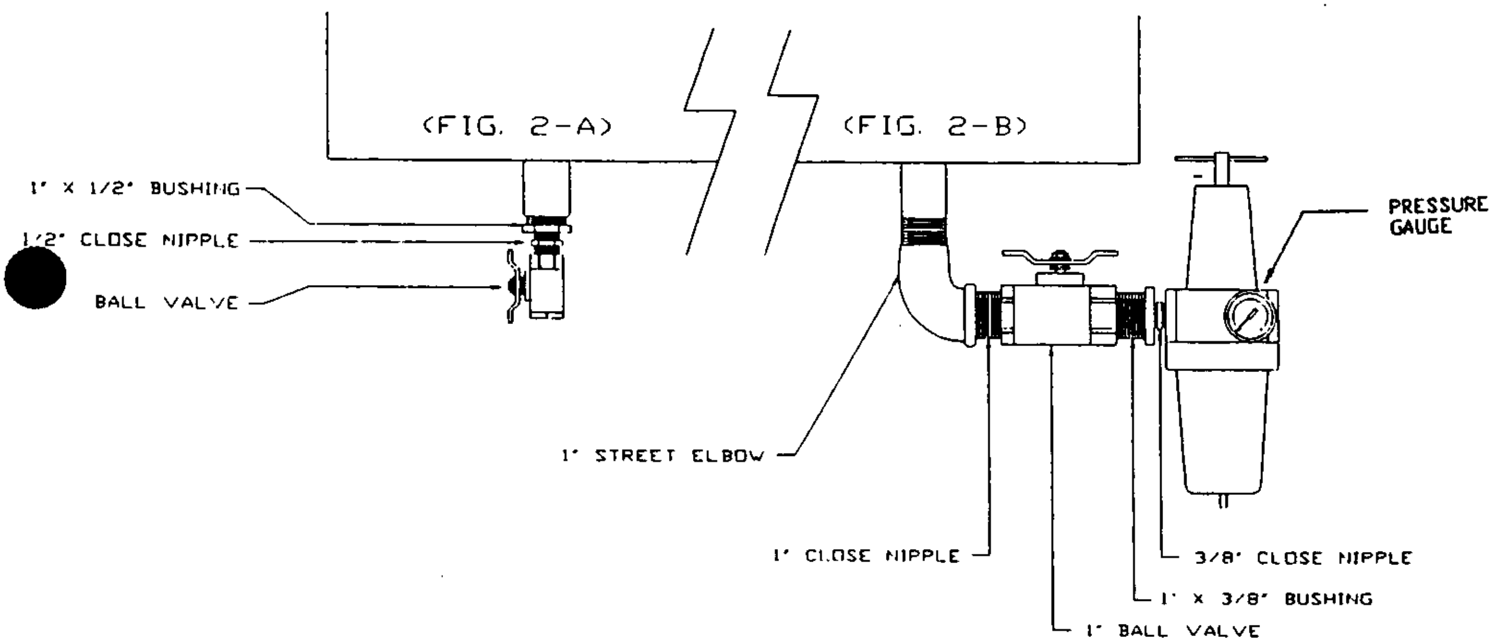
3. Connect the Filter/Regulator to the 3/8" close nipple so the air flow is in the direction of the arrows indicated on head of the unit.

4. Decide which side to connect pressure gauge to Regulator and put plug in the opposite side.

5. On opposite side of the valve header, install pipe fittings and ball valve as shown in Fig. 2-a and this will serve as a drain valve and air bleed off.



(FIG.1)



(FIG. 2-A)
(FIG. 2-B)
1" X 1/2" BUSHING
1/2" CLOSE NIPPLE
BALL VALVE
PRESSURE GAUGE
1" STREET ELBOW
1" CLOSE NIPPLE
3/8" CLOSE NIPPLE
1" X 3/8" BUSHING
1" BALL VALVE

CAMCO
CLEAN AIR MANAGEMENT CO., INC.

10200 W. 75TH ST., SUITE 100 • SHAWNEE MISSION, KS 66204
PHONE: 913-831-0740 • FAX: 913-831-9271

START-UP CHECKLIST

1. Installation

   Make sure the unit is secured to the floor or mounting surface. The ladder(s) and platform(s) must be tightened and set up according to OSHA requirements. Ducting and piping must be secured and routed out of the way of traffic whenever possible to avoid injury. Ducting must also be free of all debris including moisture.

2. Interior of the dirty air plenum

   A. In bottom bag removal collectors, inspect the filter bag assemblies referring to the "Bag and Cage Installation" section of this manual. Improperly installed bags may allow dusty air to enter the clean air plenum and will shorten bag life.

   B. Make sure that the filter bag assemblies hang straight and the bottoms do not touch each other or any part of the collector interior. If this occurs, the bags will have holes worn in them wherever they contact and will require replacement.

   C. High level alarms should be connected sufficiently below the air inlet(s) to avoid a plugged up inlet or blinded off filter bags.

3. Interior of clean air plenum

   A. All bolts on the flanges must be in place and properly tightened.

   B. The blow holes in the blow pipes must be centered over the Bags.

   C. The compressed air piping must be rigidly welded or bolted in place. In top removal collectors, the bulkhead fittings used to connect the compressed air piping must be tight against the collector wall, as well as tight on the ends of each blow pipe.

4. Exterior of dust collector

   A. Access doors, inspection ports, and spring loaded relief vents should seat effectively to prevent leakage.

B. All bolts must be properly tightened.

C. Operate any equipment connected to the dust discharge of the dust collector. Check the rotation of any motor driven equipment such as rotary airlocks, horizontal unloading valves, live bottom bin activators, and screw conveyors. Check slide gates and butterfly valves for binding.

5. Explosion relief panels - shear bolt style (when used)(see insert)

Inspect explosion relief vents (when used) for broken or damaged explosion bolts. **MAKE SURE THERE ARE NO STEEL BOLTS USED FOR THE INSTALLATION OF THE EXPLOSION RELIEF PANEL!!!** These bolts are made of a special high tech poly-vinyl chloride and are designed to relieve at a specific pressure. A magnet should be used to check for steel bolts.

6. Compressed air system

A. The timer should be correctly wired and mounted in its housing in a suitable location.

B. All the 1/4" copper or nylon tubing connections between the diaphragm and the solenoid valves must be tight, and the tubing must not be crimped.

C. The plugs (when used) must be removed from the exhaust ports of the solenoid valves, and the tubing from the diaphragm valves must be connected to the "IN" port on the solenoid valves.

D. The compressed air system must be equipped to supply clean, dry air to the pulsing air system. At this time, make sure that there is a suitable air pressure gauge on the air header for reading 0-160 psig.

E. Start the compressed air supply system and check for air leaks in all parts of the system. If air is heard escaping through one or more of the blow pipes (with the timer off), please refer to the "Troubleshooting the Compressed Air System" section of this manual. Gauge pressure at the air header(s) should be 90-100 psig.

F. With the compressed air system operating, energize the timer to begin pulsing. Check to see that all solenoids are firing by placing a finger over the exhaust port of the solenoid valve. When the solenoid valve being checked is triggered by an electrical pulse from the timer, a short blast of air should be felt by the finger at the exhaust port. Quickly move to the next solenoid valve in the firing order, noting any valves that do not fire or are stuck open, causing a continuous air flow out of the exhaust port of the valve. At this time, note the quality of the compressed air. It should be clean, dry, and oil free.

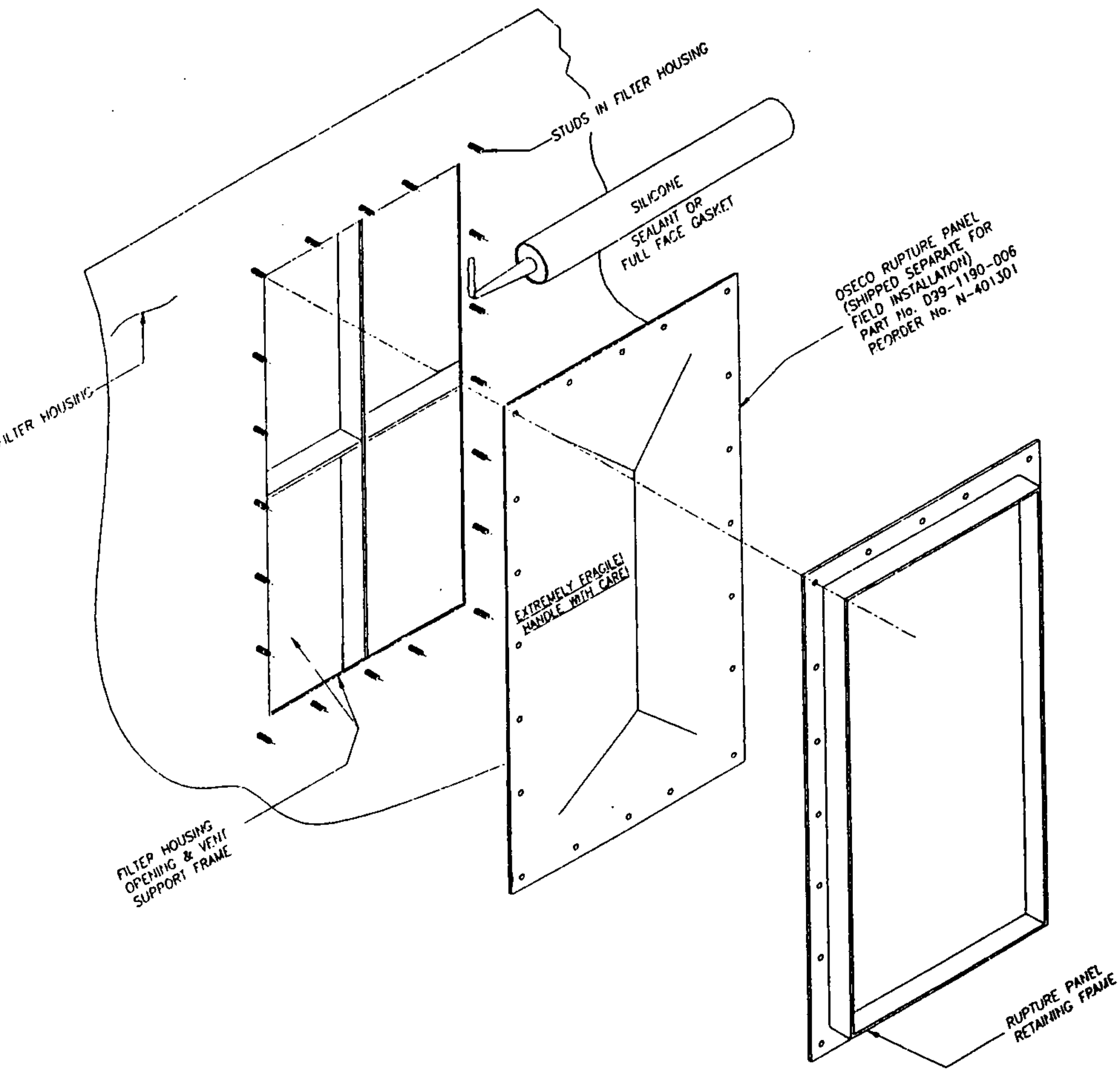
G. Allow the compressed air system to operate as long as possible to clear the system of dirt, rust, scale, welding slag, and metal chips that can cause the diaphragm valves to stick.

H. The pressure at the air header must recover to 90-100 psig before each pulse. Make sure that there is adequate compressed air delivery for full pressure recovery when all other systems connected to the same air supply are operating at full capacity.

CAMCO CLEAN AIR MANAGEMENT CO., INC. 10200 W. 75TH ST., SUITE 100 • SHAWNEE MISSION, KS 66204 • PHONE 913-831-0740 • FAX 913-831-9271

EXPLOSION RELIEF VENT
(RUPTURE STYLE INSTALLATION)

(RUPTURE PANEL IS SEALED & SANDWICHED BETWEEN FILTER HOUSING & RETAINING FRAME AS ILLUSTRATED BELOW)



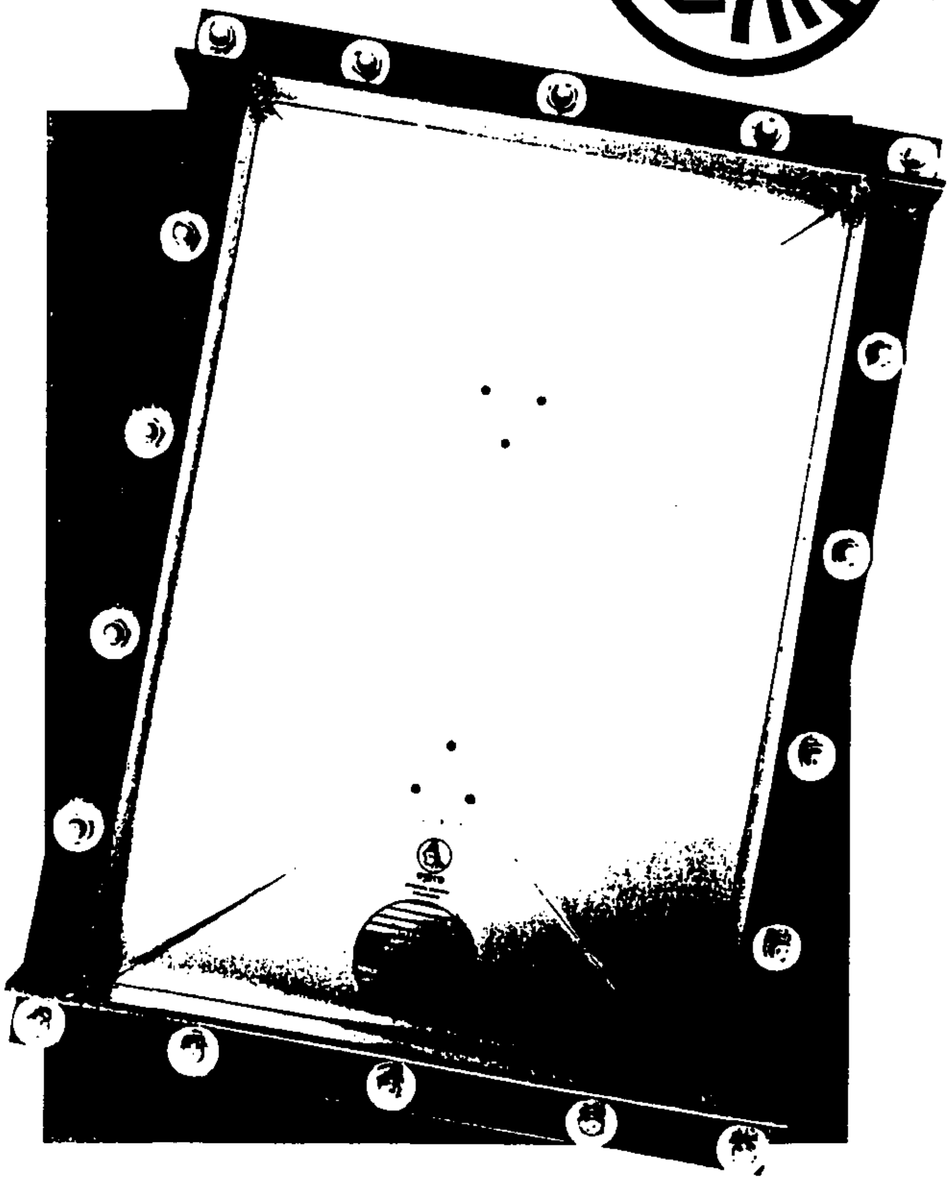
OSECO®

RUPTURE PANELS

The **OSECO Rupture Panel** is designed to limit the maximum pressure resulting from a deflagration in order to limit damage to an enclosure. The **OSECO Rupture Panel** does not prevent the occurrence of a deflagration but is intended to limit or minimize the damage from the pressure excursion generated by the deflagration.

Per National Fire Protection Association standard NFPA 68, deflagration is defined as *"burning which takes place at a flame speed below the velocity of sound in the unburned medium"*. NFPA 68 defines detonation as *"burning which takes place at a flame speed above the velocity of sound in the unburned medium"*. Explosion is defined by NFPA 68 as *"a bursting of a building or container as a result of development of internal pressure beyond the confinement capability of the building or container"*. Explosion venting has not yet been reduced to an exact science. OSECO suggests consulting NFPA 68 for information on determining vent area requirements and vent location.

The advanced technology of the **OSECO Rupture Panel** provides a reliable, high capacity relief with minimal fragmentation. The Rupture Panel is designed to bolt between Rupture Panel Frames which are either bolted or welded to the structure to be protected. The **OSECO Rupture Panels** can be installed onto existing equipment or new applications.



Some examples of industrial equipment to which the **OSECO Rupture Panel** can be used are *dust collectors and arrestors, conveyors, blenders, mixers, crushers, grinders, pulverizers, driers, ovens and furnaces, ducts, bins, silos* and *many more.*

The Name you need to know in Pressure Relief Products!

START-UP DUST CONTROL SYSTEMS (continued)

G. Observe the manometer or magnahelic differential pressure gauge reading. As the new filter bags become coated with dust, the efficiency of the filtering action increases, and the differential pressure across the filter bags will also increase. Slowly bring the collector to full load and note the final pressure drop across the filter bags. Never allow the pressure drop across the filter bags to exceed 17" w.g. maximum or filter bags may collapse.

Note: If the pressure drop continues to increase over 5" w.g. and does not stabilize, decrease the timer "off time" to fifteen seconds. Should adjustment of the timer "off time" fail to cause the pressure drop to stabilize below 5" w.g., shut down the collector and refer to "Troubleshooting the Collector", or call your CAMCO representative.

H. When the collector has stabilized, the timer "off time" interval may be slowly increased for the most economical use of compressed air. As the "off time" is increased, the differential pressure will also increase. Readings up to 6" w.g. are acceptable; however, we recommend operating at 3"-4" w.g. for maximum filter bag life. The timer "off time" may be decreased when lower differential pressure readings are desired. When adjusting the "off time" interval, proceed in small steps, allowing the differential pressure to stabilize for several hours between increments.

I. Check the main air flow with a pitot tube, or equivalent measuring device, to establish initial conditions. If the main air flow must be adjusted up or down to suit the process, repeat step 2-H above.

CAMCO
CLEAN AIR MANAGEMENT CO., INC.

10200 W. 75TH ST., SUITE 100 • SHAWNEE MISSION, KS 66204
PHONE: 913-831-0740 • FAX: 913-831-9271

SHUT-DOWN PROCEDURES

1. Dust control systems

   Reverse start-up procedure, shut down fan, then after 5 or 10 minute delay, shut down the timer and discharge system.

2. Pneumatic systems

   Reverse start-up procedure, shut down fan, then after 5 or 10 minutes delay, shut down the timer and discharge system.

CLEAN AIR MANAGEMENT CO., INC.

10200 W. 75TH ST., SUITE 100 • SHAWNEE MISSION, KS 66204
PHONE: 913-831-0740 • FAX: 913-831-9271

TROUBLESHOOTING THE DUST COLLECTOR

I. Excessive pressure drop across filter bags

The differential pressure gauge or manometer on your dust collector should read 6" w.g. or less. Higher readings and/or steadily increasing readings are an indication that the main air flow through the dust collector may be restricted, and a potential process problem such as poor suction at duct pickup points may exist. In extreme cases (over 17" w.g.) filter bags will be damaged. Check the following:

A. Pressure Gauge

Check the differential pressure gauge or manometer and the tubing leading to the dust collector for proper operation. Disconnect the lines at the gauge or manometer and clear with compressed air. Look for loose fittings, cracked, broken, or pinched tubing. Make sure the gauge is zeroed or that the manometer is level, zeroed, and contains the correct fluid.

B. Compressed Air System

Inspect the compressed air system as follows to make sure that all of the filter bags are being cleaned:

1. If none of the solenoid valves are operating, check the timer using the "Troubleshooting the Timer" section.

2. Check the air pressure at the header. It should recover to 60-100 psig before each pulse. If not, check to make sure that the compressed air supply system is in good operating condition, correctly sized, and supply lines are not too small or restricted. Listen for the sound of compressed air flowing continuously through one or more rows of filter bags, an indication of a valve or valves "stuck" in the pulsing position. The usual causes for this condition is either a leak in the tubing to the solenoid pilot valve or dirt in the solenoid and/or diaphragm valves.

3. Check that all solenoid pilot valves are firing in sequence by holding a finger over each solenoid exhaust port as described in item 6A-6H in the "Start up checklist" section.

TROUBLESHOOTING THE DUST COLLECTOR (continued)

C. Bags Loaded with Dust.

A condition known as blinding. If the dust is dry, see paragraph 1-4; if the dust is wet, see paragraphs 5 and 6.

1. Dust not discharging from the hopper

   Check hopper for over-loading or bridging across the dust discharge. Correct by repairing dust discharge equipment, replacing with higher capacity equipment, or installing hopper vibrators, etc. as required to keep the hopper clear.

2. Air flow too high

   If the main air flow is too high to allow dust to drop off of the filter bags, an excessive pressure drop across the dust collector will result and dust will build up in the system. In many cases this high pressure drop in turn leads to a reduction in the main air flow so that it is necessary to remove the dust accumulation from the filter bags (and the rest of the system) before measuring the main air flow volume.

   Visually inspect the bags for heavy caking; if caking is evident, see the note below and take the necessary action to clean the bags. Next, measure the main air flow with a pitot tube or equivalent devise and compare with the original volume for which the unit was designed. If the flow is too high, cut back the main fan to prevent a recurrence of the problem.

3. Particle size and dust load

   If possible, compare the dust particle size and loading with the original design specifications. Finer dust may cause a higher pressure drop. Do not hesitate to call the factory; we have experience with many kinds of dusts.

4. Bags too tight

   Bags that have shrunk on their cages may not flex sufficiently during the compressed air pulse to loosen caked dust. If the bags were cleaned or laundered, pull a bag tight around its cage; you should be able to "gather" a small fold of material between your fingers.

4. Water leaks

   Inspect the dust collector housing and ductwork for holes, cracks, or loose gasketing where water could enter the collector.

5. Condensation

If moisture has been condensing inside the collector, check the dew point temperature of the incoming air stream. It may be necessary to insulate the collector and/or the ductwork leading to the collector to keep surface temperatures above the dew point and prevent condensation of the filter bags.

NOTE: Collectors that have had blinded or caked bags can possibly be put into service by running the pulsing air system for 15 to 30 minutes with a 10 second timer "off time" and without the main fan or blower. If the pressure drop is not lower when the main fan is started again, take the bags out of the collector and remove the caked dust by special dry-cleaning. Make sure the timer "off time" has been reset to specifications prior to re-start. Information pertaining to filter bag cleaning may be obtained by calling your CAMCO sales representative.

II. Extremely low pressure drop

A. Pressure Gauge

Check the differential pressure gauge or manometer and the tubing leading to the dust collector as in I-A of this section.

B. Holes in filter bags or bags incorrectly installed.

Inspect the filter bags for holes, rips, tears, or excessive wear. Make sure that the filter bags were installed correctly according to the "Bag & Cage Installation" section.

C. Ductwork and Dampers

Inspect the ductwork to and from the dust collector for air leaks or blockage. Make sure that any dampers in the system are correctly positioned to allow air to flow through the dust collector.

D. Leaks in the Housing

Check the tube sheets (flat steel sheets from which the filter bags are suspended) and the dust collector housing for holes, cracks or loose gasketing that would permit air to bypass the dust collector or filter bags.

III. Continuous flow of dust in the clean air exhaust (primary dusting)

A. Holes in the filter bags or bags incorrectly installed.

Inspect the filter bags as in II-B this section.

CAMCO CLEAN AIR MANAGEMENT CO., INC. 10200 W. 75TH ST., SUITE 100 • SHAWNEE MISSION, KS 66204 • PHONE 913-831-0740 • FAX 913-831-9271

B. Holes in the tube sheets

Check the tube sheets for holes, cracks or loose bolts that would permit dusty air to bypass the filter bags.

IV. Puff of dust in the clean air exhaust after each pulse (secondary dusting)

A. Air header pressure too high

Check air header pressure gauge. If the pulsing air pressure is over 80 psig, filter bags may flex excessively and allow fine dust to pass through the bag material.

B. Worn filter bags

Inspect the filter bags for wear. Thin bags may not stop fine dust when flexed by a compressed air pulse.

C. Residual dust

If dust has gotten into the clean air plenum because of a dropped or torn bag, hole in tube sheet, etc., the pulsing air may stir up the dust and allow it to escape into the clean air exhaust after each pulse. Residual dust may also be driven down inside the filter bags by the pulsing air; if the filter bags are filled with several inches of dust, clean both the clean air plenum and the filter bags to avoid further problems.

V. Short filter bag life

This is often a complicated problem to diagnose and we recommend calling the factory for advice. The following list may be helpful in performing some preliminary checks:

A. Temperature

operating temperature above the recommended limit of the filter bag material (220 degrees F max.)

B. Chemical attack

Bag material degrades due to attack from certain chemicals in the dust or gasses in the air stream.

C. High Moisture

High moisture content in the collector may cause certain filter bag material to shrink or degrade (more rapidly at elevated temperatures).

D. Localized abrasion

Abrasion of the bags at the dusty air inlet; a dust impingement baffle may be required.

E. Internal bag supports gone bad

Corroded, rusted or broken filter cages can cause excessive bag wear. Stainless steel or coated cages are available.

CAMCO
CLEAN AIR MANAGEMENT CO., INC.

10200 W. 75TH ST., SUITE 100 • SHAWNEE MISSION, KS 66204
PHONE: 913-831-0740 • FAX: 913-831-9271

TROUBLESHOOTING THE TIMER

1. Check for mechanical damage.

2. If the "Power On" indicator is not on, check for 120 VAC power input. The "hot" line connection must be connected to terminal "L1", as this is the fused terminal.

3. Check for a blown fuse; if replacement is necessary, use only 2 AMP standard 3AG fuse (1-1/4" long). **Do not use a slow-blow type fuse.**

4. Check the wiring from the timer to the solenoids for open or short circuits.

5. After performing steps 1-4, if the timer is still not functioning properly (no output voltage, sequencing problems, etc.) please contact your CAMCO representative.

National Controls Corporation

Subsidiary of Tolthelm Corp.

1725 Western Drive
West Chicago, IL 60185

Models DNC-T2003 thru DNC-T2032

Operating Logic:

Input power is applied to the control at all times. For "On Demand" cleaning, closure of isolated control contacts (pressure switch) initiates the "Off" time. At the end of the off time the control energizes solenoid no. 1 to provide a cleaning pulse; it then transfers to the next compartment initiating the off time again. This cycle continues until the control contacts open. The control remembers the last output activated and will activate the next one in line when the control contacts reclose. For "continuous" cleaning the pressure switch terminals should be shorted together. A program wire allows for field selection of number of outputs required.

Specifications:

Time Delay:

On Time: Adjustable from 50 to 500 milliseconds
Off Time: Range A—adjustable from 1.5 to 30 seconds
Range B—adjustable from 8.5 to 180 seconds
Repeatability: ± 3% over temperature and voltage ranges

Input:

Operating Voltage: 105 to 135 volts A.C. 50/60 Hz

Output:

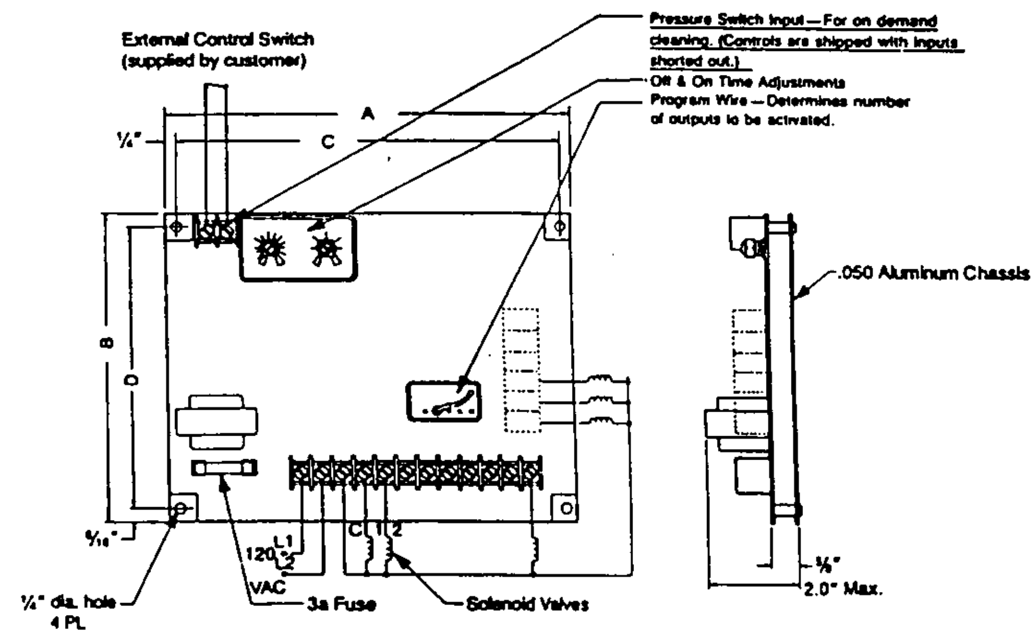
Type: Solid-state switch rated at 200 VA max. per output. Number of outputs to be activated is determined by position of program wire.

Protection:

Transient Voltage: 30 joule varistor
Short Circuit Protection: 3 amp. fuse

Environmental:

Operating Temperature: $-40°$ to $150°F$ ($-40°C$ to $66°C$)



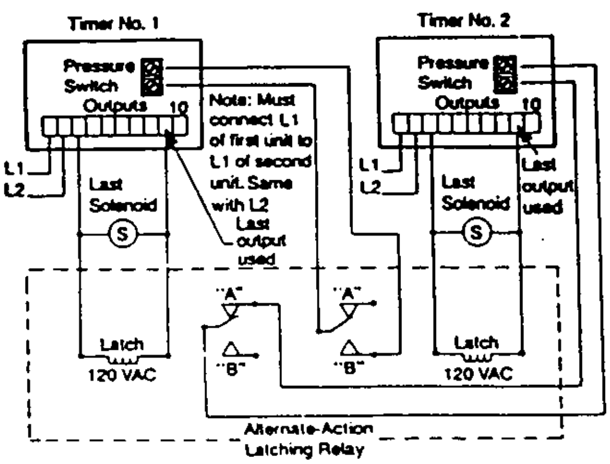
Size And Hook-up Diagram of Dust Collector Controls,
(Exact location of components varies from model to model)

Model	Off Time Sec.	Max. No. of Outputs	Dimensions-In. A	B	C	D	Size of NEMA 4 Enclosure Reqd	Programmable No. of Outputs
DNC-T2003-A10	1.5-30	3	6¾"	4⅞"	6¼"	4¼"	8" x 6" x 3½"	1-3
DNC-T2003-B10	8-180							
DNC-T2006-A10	1.5-30	6	8¾"	6⅞"	8¼"	6¼"	10" x 8" x 4"	2-6
DNC-T2006-B10	8-180							
DNC-T2010-A10	1.5-30	10	8¾"	6⅞"	8¼"	6¼"	10" x 8" x 4"	3-10
DNC-T2010-B10	8-180							
DNC-T2020-A10	1.5-30	20	10¾"	8⅞"	10¼"	8¼"	12" x 10" x 5"	11-20
DNC-T2020-B10	8-180							
DNC-T2032-A10	1.5-30	32	12¾"	10⅞"	12¼"	10¼"	14" x 12" x 6"	17-32
DNC-T2032-B10	8-180							

UL Recognized Component: File #E65038 **CSA Certified** File #LR33434

Accessories:

	Description	Part Number
Enclosure.........	National Controls offers NEMA-4 type enclosures for mounting our controls. These enclosures are made of heavy gauge steel and have a continuous hinge type cover. All seams are continuously welded. The finish is gray hammer-tone enamel inside and out over phosphalized surfaces.	
for T2003........	8"x6"x3¼"..	BOX-A0806-CHNF
for T2006........	10"x8"x4"..	BOX-A1008-CHNF
for T2010........	10"x8"x4"..	BOX-A1008-CHNF
for T2020........	12"x10"x5"..	BOX-A1210-CHNF
for T2032.........	14"x12"x6"..	BOX-A1412-CHNF
Pilot Lamp........	NEMA-4 rated red light..	ASL-OORED-NEMA4
On/Off Switch...	NEMA-4 rated switch with legend plate..	MSW-ODPST-O11



To expand the number of outputs to 64 or less, any two timers can be connected via a dual coil alternate action latch relay as shown.

The output pulse from the last compartment used in timer 1 causes the latching relay to transfer to the "A" position shown, thus stopping timer 1 and starting timer 2. When the last compartment used in timer 2 pulses, the reverse happens as the latching relay transfers to position "B".

Important Notice to Users

Our timers are capable of use in a wide array of devices and in various applications.

Any device or system incorporating a timer should be so designed that, in the event of failure, malfunction or normal wear-out of the timer, the device or system will become inoperative in a manner which will prevent property damage or bodily injury.

CAUTION SENSITIVE CIRCUITRY: Testing and trouble shooting this circuit board with a grounded test instrument or applying any external voltage to pressure switch terminals will cause serious damage to circuit boards components. Failure to comply will void any warranty.

Some Don'ts:

1. Do not mount controls in high vibration areas without shock mounts.
2. Do not mount controls in areas of high dust or corrosive atmospheres without a protective enclosure.
3. Do not use a converter or inverter for the power source.
4. Do not mount control in high transient voltage are as without an isolation transformer.
5. Do not leave control box door open.
6. Do not allow a local repair shop to repair the controls as we employ some very sophisticated components that could be further damaged. For service call us directly. Toll-free 800/323-2593. In IL 312/932-6900

National Controls Corporation

1725 Western Drive
West Chicago, IL 60185
Toll-free 800-323-2593
or in IL 708-231-5900

CLEAN AIR MANAGEMENT CO., INC.

10200 W. 75TH ST., SUITE 100 • SHAWNEE MISSION, KS 66204
PHONE: 913-831-0740 • FAX: 913-831-9271

SAFETY RECOMMENDATIONS

Because this unit may be under pressure, do not attempt to open any device doors or panels while fans or blowers are running. The unit has air hoses and valves with a maximum recommended operating pressure of 100 psig. To eliminate the danger of bursting, care must be taken to insure maximum desired pressure is not exceeded.

Before servicing any portion of the compressed air system, the air supply must be shut off and any pressure relieved.

If your unit is equipped with a discharge auger or an airlock, be sure chain guards are installed before start-up and servicing is attempted only after electrical power is locked out.

While servicing the filter, it is very important that there are no open flames, welding or grinding sparks. Dust laden air could be highly explosive and extreme care must be taken.

Before entering any dust collector:

1. Run cleaning mechanism 20 minutes with the fan off to clean filter bags.
2. Discharge solids from hopper.
3. Shut off compressed air supply and relieve pressure in the header.
4. Lock out electrical power on all rotating equipment.
5. On toxic operation, purge collector housing and install a blank in the inlet duct.
6. Install catwalks and safety cables.
7. Secure access doors in an open position or remove doors
8. Use Buddy system.
9. Wear a respirator.
10. Use common sense.

CAMCO
CLEAN AIR MANAGEMENT CO., INC.

10200 W. 75TH ST., SUITE 100 • SHAWNEE MISSION, KS 66204
PHONE: 913-831-0740 • FAX: 913-831-9271

ROUTINE MAINTENANCE

A. Inspection

Frequency will vary as widely as there are operating conditions. In general proceed as follows:

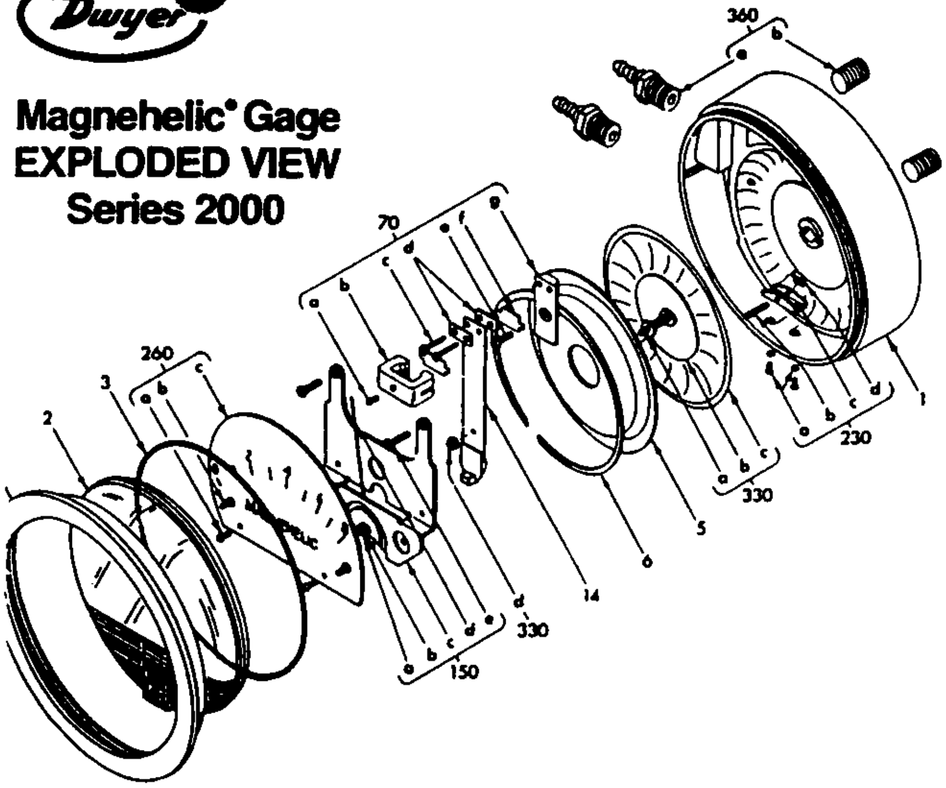
1. Daily - Check unit differential pressure.
2. Weekly - Check timer and solenoid valves for function. This usually is only listening to check uniform time in interval between blasts.
3. Monthly - Lubricate fan, rotary valve and screw conveyor. Check seals on latter two for dust loss.
4. Quarterly - On Top Access Units, check for dust accumulation in clean air plenum.

B Repairs

1. Filter bags - Generally replacement, although some applications can be laundered.
2. Solenoid Valves - Repair kits are available if the valve is stuck open or fails to operate.
3. Diaphragm Valves - Repair kits are available if the valve is stuck open or fails to operate due to a ruptured diaphragm.
4. Rotary Valves - Usually a matter of periodic seal and blade replacement. More detailed information is supplied with the valve.
5. Screw Conveyors - Periodic replacement of "V" belts and shaft seals. Inspect hanger bearings during filter bag change. Failure will be detected by the squeal.
6. Fans - "v" belt tension and replacement of bearings if running rough. Make sure rotor balance is maintained.

Dwyer

Magnehelic® Gage EXPLODED VIEW Series 2000



1. Case
2. Cover with zero adjust assy.
3. "O" ring seal
4. Bezel
5. Diaphragm sealing plate
6. Retaining ring
70. Range Spring assembly
   a. Clamp set screw
   b. Clamp
   c. Mounting screws (2 req'd)
   d. Clamping shoe (2 req'd)
   e. Clamp plate screw
   f. Spacer (2 req'd)
   g. Clamp plate
14. Range Spring with magnet
150. Wishbone Assembly - consists of:
   a. Front jewel
   b. Locking nut
   c. Wishbone
   d. Pointer
   e. Mounting screws (2 req'd)
   f. Helix assembly (not shown)
   g. Pivots (2 req'd) (not shown)
   h. Rear jewel (not shown)
230. Zero adjust assembly - consists of:
   a. Foot screws with washers (2 req'd)
   b. Adjust screw
   c. Foot
   d. Finger
260. Scale Assembly - consists of:
   a. Mounting screws (2 req'd)
   b. Bumper pointer stop (2 req'd)
   c. Scale
330. Diaphragm Assembly - consists of: (Arbor press needed to install)
   a. Linkage assy., complete
   b. Front plate
   c. Diaphragm
   d. Rear plate (not shown)
   e. Plate washer (not shown)
360. Mounting Hardware Kit
   a. Adapter - pipe plug ⅛" NPT to rubber tubing - (2 req'd)
   b. Pipe plug ⅛" NPT - (2 req'd)
   c. Mounting lug (3 req'd)
   d. Long screw (3 req'd)
   e. Short screw (3 req'd)

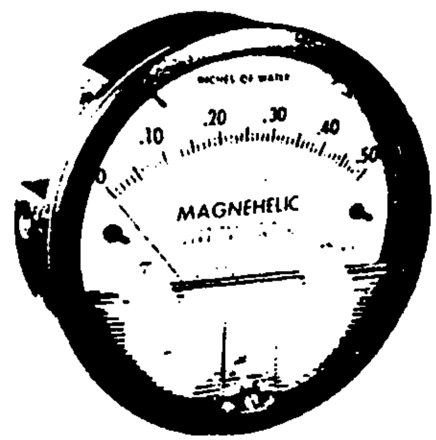
Ordering Instructions:

When corresponding with the factory regarding Magnehelic® gage problems, refer to the call-out numbers in this view. Be sure to include model number, pressure range, and any special options. Field repair is not recommended; contact the factory for repair service information.

OPERATING INSTRUCTIONS and PARTS LIST

Dwyer

Magnehelic® Differential Pressure Gage



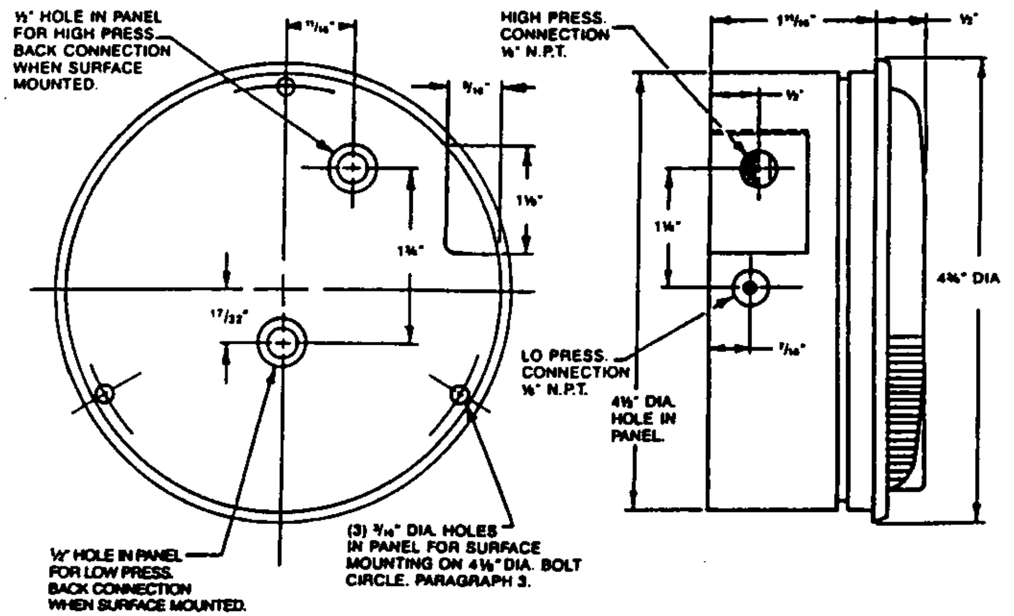
SPECIFICATIONS

Dimensions: 4-3/4" dia. X 2-3/16" deep.
Weight: 1 lb. 2 oz.
Finish: Baked dark gray enamel.
Connections: 1/8 N.P.T. high and low pressure taps, duplicated, one pair side and one pair back.
Accuracy: Plus or minus 2% of full scale, at 70°F. (Model 2000-0, 3%; 2000-00, 4%).
Pressure Rating: 15 PSI.
Ambient Temperature Range: 20° to 140°F.
Standard gage accessories include two 1/8" N.P.T. plugs for duplicate pressure taps, two 1/8" pipe thread to rubber tubing adapters, and three flush mounting adapters with screws.

Caution: For use with air or compatible gases only.

For repeated over-ranging or high cycle rates, contact factory.

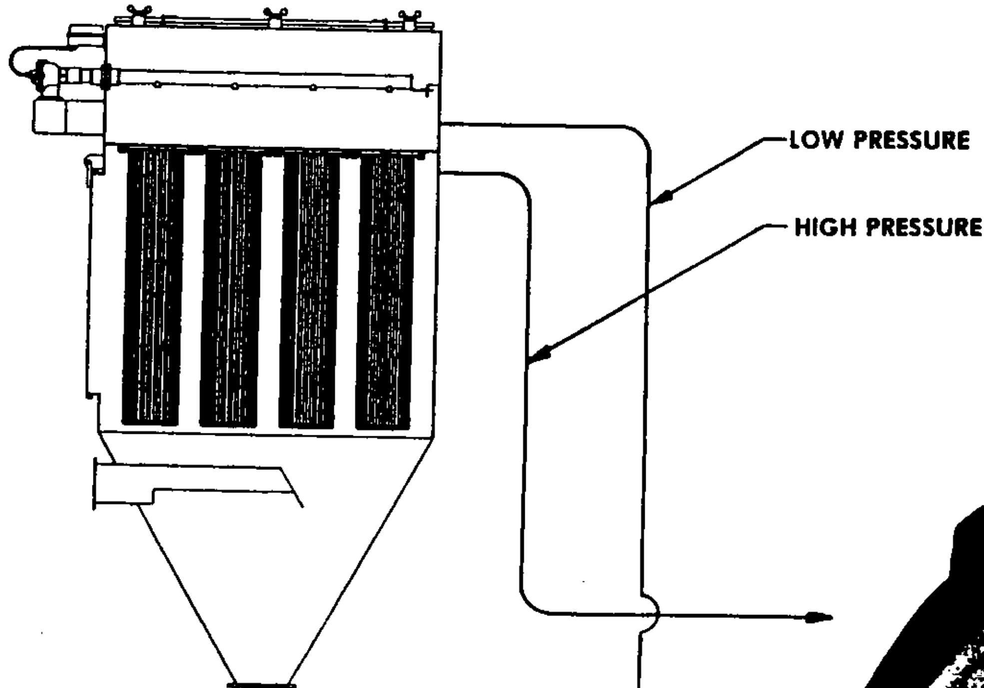
Hydrogen Gas Precautionary Note: The rectangular rare earth magnet used in the standard gage may not be suitable for use with hydrogen gas since a toxic and explosive gas may form. For hydrogen service, consult the factory for an alternate gage construction.



BULLETIN NO. 27

OPERATING INSTRUCTIONS and PARTS LIST

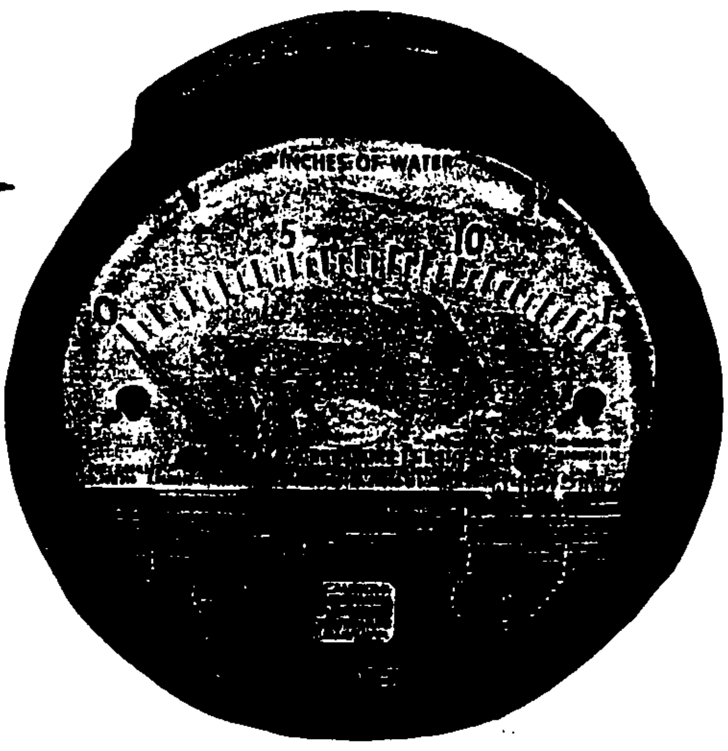
Magnehelic® Differential Pressure Gage



SPECIFICATIONS

Dimensions: 4-3/4" dia. × 2-3/16" deep.
Weight: 1 lb. 2 oz.
Finish: Baked dark gray enamel.
Connections: 1/8 N.P.T. high and low pressure taps, duplicated, one pair side and one pair back.
Accuracy: Plus or minus 2% of full scale, at 70°F. (Model 2000-0, 3%; 2000-00, 4%).
Pressure Rating: 15 PSI.
Ambient Temperature Range: 30° to 140° F.
Standard gage accessories include two 1/8" N.P.T. plugs for duplicate pressure taps, two 1/8" pipe thread to rubber tubing adapters, back mounting stud with two washers and jam nut and three flush mounting adapters with screws.

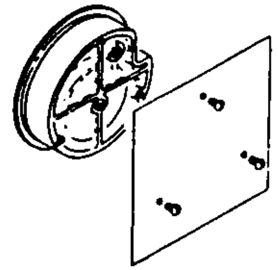
Caution: For use with air or compatible gases only.



1. Select a location free from excessive vibration and where the ambient temperature will not exceed 140°F. Also, avoid direct sunlight which accelerates discoloration of the clear plastic cover. Sensing lines may be run any necessary distance. Long tubing lengths will not affect accuracy but will increase response time slightly. Do not restrict lines. If pulsating pressures or vibration cause excessive pointer oscillation, consult the factory for ways to provide additional damping.

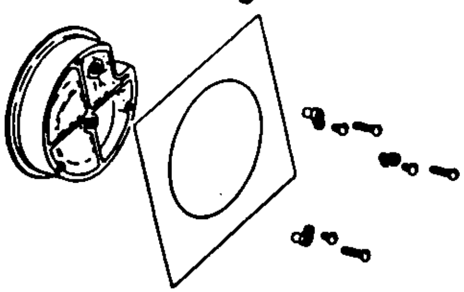
2. All standard Magnehelic gages are calibrated with the diaphragm vertical and should be used in that position for maximum accuracy. If gages are to be used in other than vertical position, this should be specified on the order. Many higher range gages will perform within tolerance in other positions with only rezeroing. Low range Model 2000-00 and metric equivalents must be used in the vertical position only.

3. Surface Mounting



Locate mounting holes, 120° apart on a 4-1/8" dia. circle. Use No. 6-32 machine screws of appropriate length.

4. Flush Mounting



Provide a 4½" dia. opening in panel. Insert gage and secure in place with No. 6-32 machine screws of appropriate length, with adaptors, Part No. 360c, firmly secured in place. To 'unt gage on 1¼"-2" pipe, order optional ,) pipe mounting kit

5. To zero the gage after installation

Set the indicating pointer exactly on the zero mark, using the external zero adjust screw on the cover at the bottom. Note that the zero check or adjustment can only be made with the high and low pressure taps both open to atmosphere.

Operation

Positive Pressure: Connect tubing from source of pressure to either of the two high pressure ports. Plug the port not used. Vent one or both low pressure ports to atmosphere.

Negative Pressure: Connect tubing from source of vacuum or negative pressure to either of the two low pressure ports. Plug the port not used. Vent one or both high pressure ports to atmosphere.

Differential Pressure: Connect tubing from the greater of two pressure sources to either high pressure port and the lower to either low pressure port. Plug both unused ports.

When one side of gage is vented in a dirty, dusty atmosphere, we suggest an A-331 Filter Vent Plug be installed in the open port to keep inside of gage clean.

a. For portable use or temporary installation, use 1/8" pipe thread to rubber tubing adapter and connect to source of pressure with rubber or Tygon tubing.

b. For permanent installation, 1/4" O.D., or larger, copper or aluminum tubing is recommended. See accessory bulletin S-101 for fittings.

Maintenance: No lubrication or periodic servicing is required. Keep case exterior and cover clean. Occasionally disconnect pressure lines to vent both sides of gage to atmosphere and re-zero. Optional vent valves, (bulletin S-101), should be used in permanent installations.

Calibration Check: Select a second gage or manometer of known accuracy and in an appropriate range. Using short lengths of rubber or vinyl tubing, connect the high pressure side of the Magnehelic gage and the test gage to two legs of a tee. Very slowly apply pressure through the third leg. Allow a few seconds for pressure to equalize, fluid to drain, etc., and compare readings. If accuracy unacceptable, gage may be returned to factory for recalibration. To calibrate in the field, use the following procedure.

Calibration:

1. With gage case, P/N 1, held firmly, loosen bezel, P/N 4 by turning counterclockwise. To avoid damage, a canvas strap wrench or similar tool should be used.
2. Lift out plastic cover and "O" ring.
3. Remove scale screws and scale assembly. Be careful not to damage pointer.
4. The calibration is changed by moving the clamp, P/N. 70-b. Loosen the clamp screw(s) and move slightly toward the helix if gage is reading high, and away if reading low. Tighten clamp screw and install scale assembly.
5. Place cover and 0-ring in position. Make sure the hex shaft on inside of cover is properly engaged in zero adjust screw, P/N 230-b.
6. Secure cover in place by screwing bezel down snug. Note that the area under the cover is pressurized in operation and therefore gage will leak if not properly tightened.
7. Zero gage and compare to test instrument. Make further adjustments as necessary.

Caution: If bezel binds when installing, lubricate threads sparingly with light oil or molybdenum disulphide compound.

Warning: Attempted field repair may void your warranty. Recalibration or repair by the user is not recommended. For best results, return gage to the factory. Ship prepaid to.

Dwyer Instruments, Inc.
Attn. Repair Dept.
55 Ward St.
Wakarusa, IN 46573

Trouble Shooting Tips:

• *Gage won't indicate or is sluggish.*

1. Duplicate pressure port not plugged.
2. Diaphragm ruptured due to overpressure.
3. Fittings or sensing lines blocked, pinched, or leaking.
4. Cover loose or "O" ring damaged, missing.
5. Pressure sensors, (static tips, Pitot tube, etc.) improperly located.
6. Ambient temperature too low. For operation below 20°F, order gage with low temperature, (LT) option.

• *Pointer stuck-gage can't be zeroed.*

1. Scale touching pointer.
2. Spring/magnet assembly shifted and touching helix.
3. Metallic particles clinging to magnet and interfering with helix movement.
4. Cover zero adjust shaft broken or not properly engaged in P/N 230-b adjusting screw.

We generally recommend that gages needing repair be returned to the factory. Parts used in various sub-assemblies vary from one range of gage to another, and use of incorrect components may cause improper operation or failure. Gages repaired at the factory are carefully calibrated and tested to assure "like-new" operation. After receipt and inspection, we will be happy to quote repair costs before proceeding.

Consult factory for assistance on unusual applications or conditions.

Use with air or compatible gases only.

Installation & Maintenance Instructions

2–WAY DIRECT–ACTING SOLENOID VALVES
NORMALLY OPEN OR NORMALLY CLOSED OPERATION
BRASS OR STAINLESS STEEL CONSTRUCTION – 1/8", 1/4", OR 3/8" NPT

SERIES 8262 8263

Form No.V5256R8

IMPORTANT: See separate solenoid installation and maintenance instructions for information on: Wiring, Solenoid Temperature, Causes of Improper Operation, and Coil or Solenoid Replacement.

DESCRIPTION

Series 8262 and 8263 valves are 2–way direct–acting general service solenoid valves. Valves bodies are of rugged brass or stainless steel. Series 8262 or 8263 valves may be provided with a general purpose or explosionproof solenoid enclosure. Series 8262 and 8263 valves with suffix "P" in the catalog number are designed for dry inert gas and non–lubricated air service.

OPERATION

Normally Open: Valve is open when solenoid is de–energized; closed when is energized.

Normally Closed: Valve is closed when solenoid is de–energized; open when energized.

IMPORTANT: No minimum operating pressure required.

Manual Operation

Manual operator allows manual operation when desired or during an electrical power outage. Depending upon basic valve construction, three types of manual operators are available:

Push Type Manual Operator

To engage push type manual operator, push stem at base of valve body upward as far as possible. Valve will now be in the same position as when the solenoid is energized. To disengage manual operator, release stem. Manual operator will return to original position.

Screw Type Manual Operator

To engage screw type manual operator, rotate stem at base of the valve body clockwise until it hits a stop. Valve will now be in the same position as when the solenoid is energized. To disengage, rotate stem counterclockwise until it hits a stop.

⚠ CAUTION: **For valve to operate electrically, manual operator stem must be fully rotated counterclockwise.**

Stem/Lever Type Manual Operator

To engage manual operator, turn stem/lever clockwise until it hits a stop. Valve will now be in the same position as when the solenoid is energized. To disengage manual operator, turn stem/lever counterclockwise until it hits a stop.

⚠ CAUTION: **For valve to operate electrically, manual operator stem/lever must be fully rotated counterclockwise.**

Flow Metering Devices

Valves with suffix "M" in catalog number are provided with a metering device for flow control. Turn stem to right to reduce flow; left to increase flow.

INSTALLATION

Check nameplate for correct catalog number, pressure, voltage, frequency, and service. Never apply incompatible fluids or exceed pressure rating of the valve. Installation and valve maintenance to be performed by qualified personnel.

Note: Inlet port will either be marked "I" or "IN". Outlet port will be marked "2" or "OUT".

Future Service Considerations.

Provision should be made for performing seat leakage, external leakage, and operational tests on the valve with a nonhazardous, noncombustible fluid after disassembly and reassembly.

Temperature Limitations

For maximum valve ambient and fluid temperatures, refer to charts below. Check catalog number, coil prefix, suffix, and watt rating on nameplate to determine the maximum temperatures.

Wattage	Catalog Number Coil Prefix	Coil Class	Max. Ambient Temp. °F	Max. Fluid Temp. °F
6, 10.5, 12.4	none, DA or S	A	77	180
6,10.5 12.4	DF, FT or SF	F	125	180
6,10.5, 12.4	HT	H	140	180
9,10.7	none, DP or SP	F	77	180
9.7	none, FT or HT	A, F or H	77	120
11.2	none, FT or HT	A, F or H	77	150
16.7	none, DP or SP	F	77	200
17.1	none, KP SP or SD	F	125	180
17.1	HB, KB SS or SV	H	140	180

Catalog Nos.8262B200 and 8262 C200 AC construction only and Catalog Nos.8262B214 and 8262 D200 AC and DC construction are limited to 140°F fluid temperature.

Valves with Suffix V or W that are designed for AC service and normally closed operation are for use with No. 2 and 4 fuel oil service. These valves have the same maximum temperatures per the above table except Suffix W valves are limited to a maximum fluid temperature of 140°F.

Listed below are valves with Suffix V in the catalog number that are acceptable for higher temperatures.

Catalog Number Coil Prefix	Max. Ambient Temp.°F	Max. Fluid Temp.°F
FT8262, HB8262 FT8263, HB8263 8262G, 8263G	125	250*
HT or HB 8262G HT or HB 8263G	140	250

*The only exception is the 8262G and 8263G series (Class F coil) at 50 Hertz rated 11.1 and 17.1 watts are limited to 210°F fluid temperature.

Positioning

This valve is designed to perform properly when mounted in any position. However, for optimum life and performance, the solenoid should be mounted vertically and upright to reduce the possibility of foreign matter accumulating in the solenoid base sub–assembly area.

ASCO Valves Automatic Switch Co. 50–60 Hanover Road, Florham Park, New Jersey 07932

National Controls Corporation
Subsidiary of Tohheim Corp.
1725 Western Drive
West Chicago, IL 60185

Models DNC-T2003 thru DNC-T2032

Operating Logic:

Input power is applied to the control at all times. For "On Demand" cleaning, closure of isolated control contacts (pressure switch) initiates the "Off" time. At the end of the off time the control energizes solenoid no. 1 to provide a cleaning pulse; it then transfers to the next compartment initiating the off time again. This cycle continues until the control contacts open. The control remembers the last output activated and will activate the next one in line when the control contacts reclose. For "continuous" cleaning the pressure switch terminals should be shorted together. A program wire allows for field selection of number of outputs required.

Specifications:

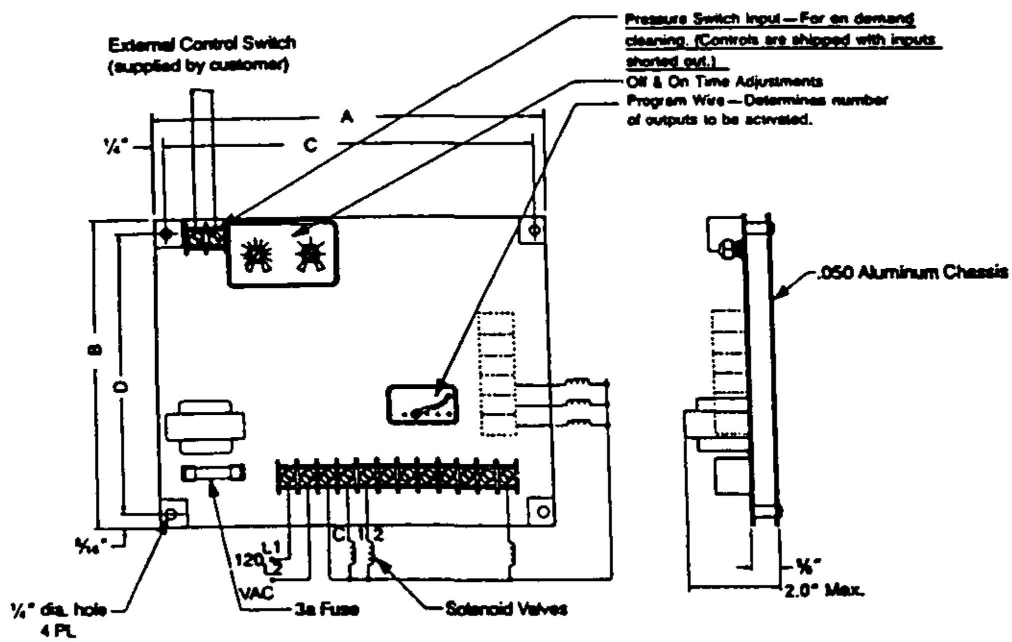
Time Delay:
On Time: Adjustable from 50 to 500 milliseconds
Off Time: Range A—adjustable from 1.5 to 30 seconds
Range B—adjustable from 8.5 to 180 seconds
Repeatability: ± 3% over temperature and voltage ranges

Input:
Operating Voltage: 105 to 135 volts A.C. 50/60 Hz

Output:
Type: Solid-state switch rated at 200 VA max. per output. Number of outputs to be activated is determined by position of program wire.

Protection:
Transient Voltage: 30 joule varistor
Short Circuit Protection: 3 amp. fuse

Environmental:
Operating Temperature: −40° to 150°F (−40°C to 66°C)



Size And Hook-up Diagram of Dust Collector Controls,
(Exact location of components varies from model to model)

Model	Off Time Sec.	Max. No. of Outputs	Dimensions-In. A	B	C	D	Size of NEMA 4 Enclosure Reqd	Programmable No. of Outputs
DNC-T2003-A10	1.5-30	3	6¾"	4¼"	6¼"	4¼"	8" x 6" x 3½"	1-3
DNC-T2003-B10	8-180							
DNC-T2006-A10	1.5-30	6	8¾"	6¼"	8¼"	6¼"	10" x 8" x 4"	2-6
DNC-T2006-B10	8-180							
DNC-T2010-A10	1.5-30	10	8¾"	6¼"	8¼"	6¼"	10" x 8" x 4"	3-10
DNC-T2010-B10	8-180							
DNC-T2020-A10	1.5-30	20	10¾"	8¼"	10¼"	8¼"	12" x 10" x 5"	11-20
DNC-T2020-B10	8-180							
DNC-T2032-A10	1.5-30	32	12¾"	10¼"	12¼"	10¼"	14" x 12" x 6"	17-32
DNC-T2032-B10	8-180							

UL Recognized Component: File #E65038
CSA Certified File #LR33434

OPERATING INSTRUCTIONS AND PARTS LIST

PHOTOHELIC® PRESSURE SWITCH/GAGE*

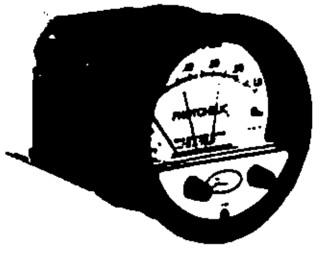
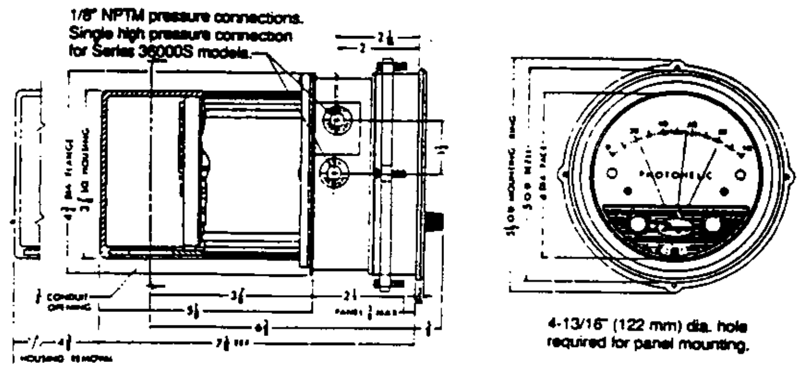


Figure 1 Series 3000 Photohelic® Switch/Gage.



NOTE: Detailed dimension drawings are available from our Customer Service Dept. for PHOTOHELIC® switch/gages as installed in two optional enclosures. For weatherproof housing, request no. 13-700132-00. For explosion-proof housing, request no. 13-700113-01.

The Photohelic® Switch/Gage is a very versatile, precise pressure switch combined with the time-proven Magnehelic® pressure gauge. Models are available with one or two phototransistor actuated relays. Gage reading is unaffected by switch operation. Easy to adjust set points have knob controls. Applied pressure and switch set points are fully visible at all times. Deadband is one pointer width — less than 1% of full scale. Double-pole double-throw relays can be easily interlocked to provide variable deadband control. For positive, negative or differential pressures; single positive pressure only on 36000S models. Full scale ranges available from 0-.25 in W.C. to 0-6000 psig.

PHOTOHELIC SENSING — HOW IT WORKS

In a typical control application, the Photohelic switch/gage controls between high and low pressure set points. When pressure changes, reaching either set point pressure, the beam from an LED to the limiting phototransistor will be cut off by the helix-driven light shield. The resulting signal change is electronically amplified to actuate its DPDT slave relay and switching occurs. Dead band between make and break is 1% of full scale or less — just enough to assure positive, chatter-free operation.

*Patent No. 3,862,416

SPECIFICATIONS

1. Dimensions: 5" Diameter × 8¼" Length.
2. Weight: 4 Lbs. 12 oz.
3. Gage Bezel: 5" O.D. × 4" I.D. across gage face. Fits panels up to 5/8" thick. 4¹³⁄₁₆" diameter hole required. Optional, 122 mm.
4. Gage Connections: 1/8" N.P.T.
5. Finish: Baked Dark Gray Epoxy Enamel.
6. Pressure Rating: -20" Hg. to 25 psig (-.67 to 1.7 bar). MP option; 35 psig (2.4 bar), HP option; 80 psig (5.5 bar). 36003S-36010S; 150 psig (10.3 bar). 36020S and higher; 1.5 × full scale pressure.
7. Ambient Temperature Range: 20 Deg. to 120 Deg. F standard. Low temperature model available.
8. Standard Accessories: Two (2) brass 1/8" N.P.T. to rubber tubing adapters, two (2) 1/8" N.P.T. pipe plugs, mounting ring, snap ring and screws for flush panel mounting. Instructions.
9. Contact Rating: 10A @ 24 VDC / 120VAC; 6A @ 240VAC.
10. Power Required: 117 V., 50, 60 Hz. A.C., 5 watts average (220V. and 240V. units also available).
11. Conduit Opening: 3/4" Conduit.
12. Accuracy: 2 percent of full scale (3% on -0 and 4% on -00 Ranges) at 70 Deg. F.
13. Series 3000 models are for use with air or compatible gases. Series 36000S models are for use with compatible gases and liquids.

For repeated over-ranging or high cycle rates, refer to factory.

DWYER INSTRUMENTS, INC.
P. O. BOX 373 MICHIGAN CITY, INDIANA 46360 U.S.A.
Telephone 219/879-8000
Fax 219/872-9057

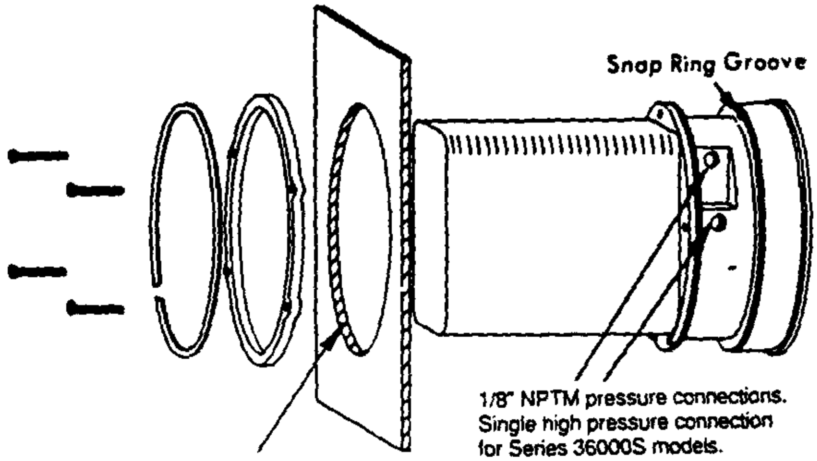


Figure 2
Through Panel Mounting

INSTALLATION

1. **Location:** All parts of the Dwyer PHOTOHELIC® pressure switch/gage are ruggedly constructed and will stand a moderate amount of vibration, physical shock, and handling. Normal care in handling and installation is all that is required. In cases where instrument panel vibration is severe, the panel should be spring mounted or the amplifier-relay unit mounted remotely on a more stable surface.

   Select a location where the ambient temperature will not exceed 120°F. Pneumatic pressure sensing lines may be run any necessary distance. For example, 250 foot sensing lines will not affect accuracy but will damp the reading slightly. Do not restrict lines. If pulsating pressure or vibration causes excessive pointer oscillation or relay chatter, consult factory for additional damping means. See accessory Bulletin S-101 for fittings.

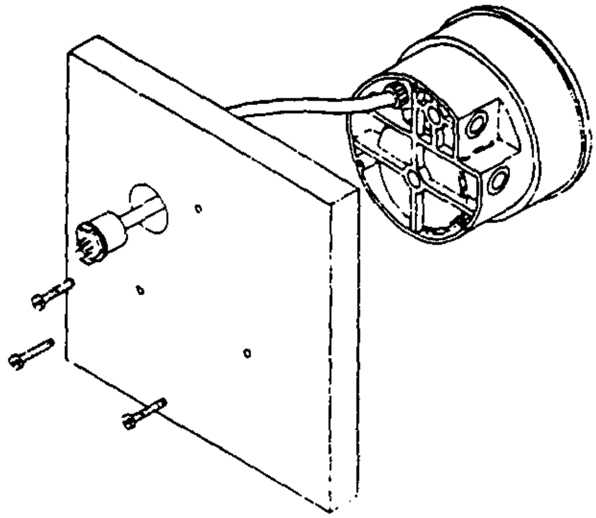
2. **Position:** The PHOTOHELIC® may be mounted as an integral package or the amplifier-load relay assembly and housing may be mounted remotely from the indicating gage-phototransistor unit. Extention cords with 7 pin plugs and receptacles are available from Dwyer for interconnection of the two units.

   The unit may be mounted in any desired position, scale vertical or horizontal, without affecting its accuracy, but must be rezeroed if position is changed from horizontal to vertical or vice versa. The -0 and -00 models must be mounted with the scale vertical.

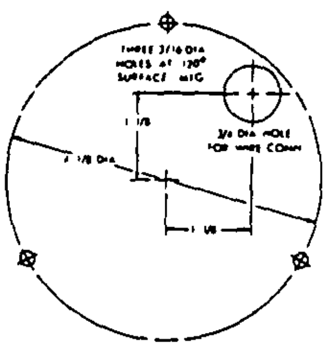
3. **Mounting:** The PHOTOHELIC® is normally mounted before making electrical connections, as the electrical enclosure is independent of the mounting means and may be removed at any time.

   A. **Panel Mounting:** Normal mounting is flush or through panel as shown in Fig. 2. Be sure to allow 4-3/8" extra space behind the unit for electrical enclosure removal. Make a single 4 13/16" diameter hole in the panel. Insert the entire PHOTOHELIC® unit from the front, then slip on the mounting ring and snap ring from the rear. Seat the snap ring in its groove, back up the mounting ring against snap ring and tighten the four (4) 2" No. 6-32 clamp screws provided. If behind panel space is critical, the amplifier-relay unit can be mounted remotely. See the Remote-Relay Mounting Instructions for details

B. **Gage Mountings with Relays Remote:** Where it is desirable to mount the amplifier-relay unit separate from the gage-phototransistor unit, the gage may be mounted either as shown in Fig. 2 (except less amplifier-relay portion) or surface mounted as shown in Fig. 3A. Use the layout shown in Fig. 3B to locate holes. The complete package cannot be surface mounted.



A
Surface Mounting

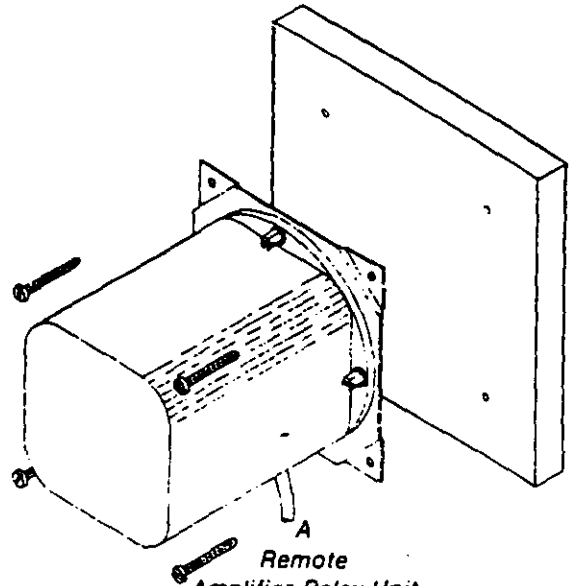


B
Hole Layout (Front)

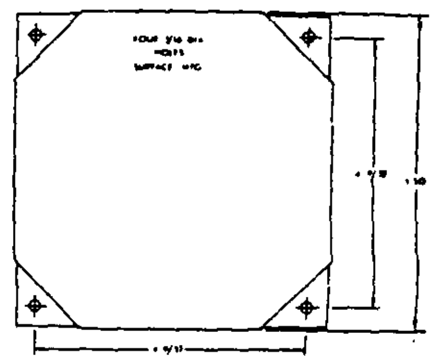
Figure 3

Remote Relays Mounting: The amplifier — relay unit may be mounted remotely as shown in Fig. 4A. Use the hole layout as shown in Fig. 4B for this option.

Additional mounting information for special requirements is available from the factory.



A
Remote
Amplifier-Relay Unit



B
Hole Layout

Figure 4

4. **Pneumatic Connections & Zeroing:** After installation but before making pressure connections, set the indicating pointer exactly on the zero mark, using the zero adjust screw located at the bottom of the front cover. Note that this adjustment can only be made with the high and low pressure taps both open to atmosphere.

Connect the high and low pressure taps to positive, negative, or differential pressure sensing points. Use ¼" diameter metal or other instrument tubing and ⅛" N.P.T. adaptors at the Dwyer PHOTOHELIC® pressure switch gage. Adaptors for rubber or soft plastic tubing are furnished with the instrument for use where this type of connection is preferred.

If the PHOTOHELIC® is not used to sense differential pressure, one of the pressure taps must be left open to atmosphere. This will allow the reference pressure to enter. In this case, installation of a Dwyer No. A-331 Filter Plug or similar fitting in the reference pressure tap is recommended to reduce the possibility of dust entering the instrument.

NOTE: If the Photohelic switch/gage is over pressured, pointer may "jump" from full scale back to zero and remain there until the excess pressure condition is relieved. Users should be aware of possible false zero pressure indications under this condition.

ELECTRICAL CONNECTIONS

1. **Cover:** The amplifier-relay unit has an easy to remove housing. Remove the three (3) screws as shown in Fig. 5 and slide the housing off. Make all the electrical connections before reinstalling and refastening the housing.

2. **Conduit:** Electrical access to the connection box portion of the relay housing is by bottom opening for ¾" conduit. Use of flexible conduit is recommended. It should be supported from the panel or other suitable surface to prevent the wiring system from exerting undue strain on the instrument. See Fig. 5.

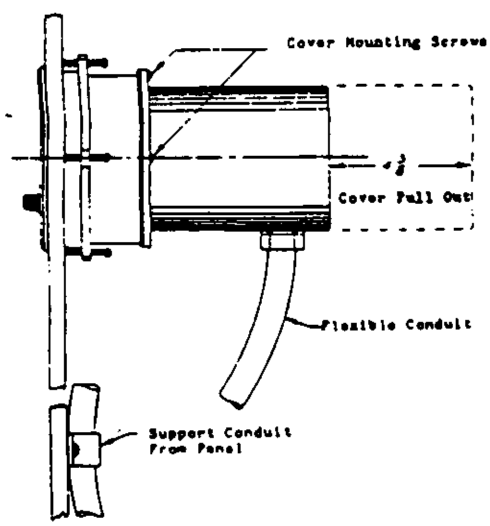
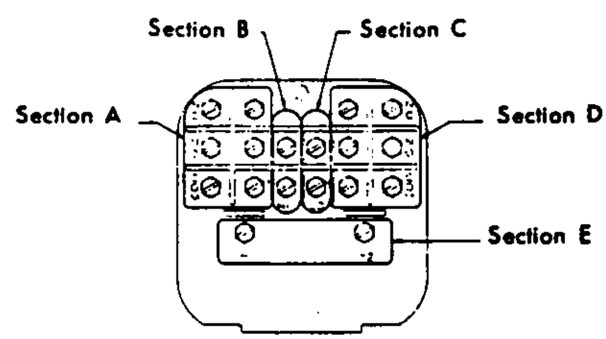


Figure 5
Mounting Details

3. **Terminal or Connection Board Layout:** In Fig. 6. "Terminal Board," **Section A** contains the connections for the load or slave relay actuated by the high or right set-point. This relay is a double pole, double throw type. The two top connections are normally closed, the two middle connections are normally open, and the bottom connections are the common pair. The relay is in its normal or De-Energized position when pressure is below the right hand set-point.

Section D is exactly the same as **Section A** except that its load or slave relay is controlled by the low or left set-point. The De-Energized position is below the left hand pointer set-point.

Section B contains the external connections to the holding coil circuit for the high or right set-point relay and **Section C** contains similiar connections for the low or left set-point relay. The function and use of these connections varies somewhat depending on the circuit style of the instrument. See paragraphs 5 and 6 for details.



CAUTION: Do not apply electrical current to terminals in sections B and C.

Figure 6
Terminal Board

Section E contains the power connections for the control unit transformer primary. The transformer in turn supplies reduced voltage power for the LED, phototransistor, amplifier unit, and load relay pull in and holding coils. Connections must always be made to this section in order to put the unit in operation. Standard units are designed for 117 V.A.C. input to the transformer. Special units are also available for other voltages.

Separate Ground Wire attachment is provided for by a No. 6-32 screw on the mounting bracket near the conduit opening. An additional ground wire connection is located on the side of the gage body for use when the amplifier-relay unit is mounted remotely.

Single Set-Point instruments are furnished with the right or high set-point components and circuitry in place. These are connected to Sections A and B of the terminal board. The left or low set-point components are omitted.

4. **Circuit Style:** The PHOTOHELIC® is available with several factory installed optional internal circuits. They are identified as to style by a label shown in Fig. 7. This label is mounted prominently on the terminal board of each instrument. The letter H denotes a circuit in which the relay can be made to latch or remain energized after pressure increase to its set-point.

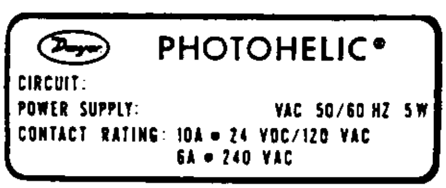


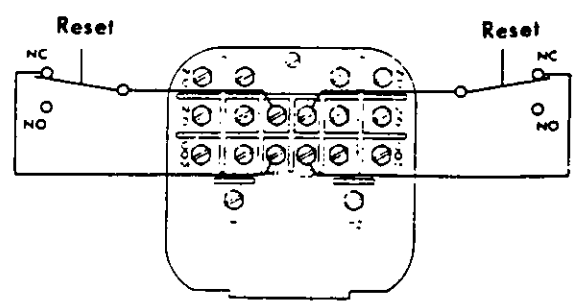
Figure 7
Circuit Label

The letter L denotes a circuit in which the relay can be made to latch or remain de-energized after pressure decrease to its set-point. Two letters are required to fully identify a dual set-point unit. Thus, circuit style HH, which is standard, is a dual set-point circuit which has provisions for latching on pressure increase to either set-point. Single relay units are identified by the letters SR followed by H for the standard unit or L for the special low latch unit. Units for use with other than standard 117 VAC will be so indicated on the label.

5. **Dual Set Point Automatic Reset:** Circuit Style HH is used for simple on-off switching applications. To place in service, connect load circuits to the appropriate terminals in Section A (Fig. 6) for the right set-point and Section D for the left set-point. Note that the N.O. contacts are open when the gage pressure pointer is to the left of the set-point pointers. No connections are necessary in Sections B and C. Make external ground connections as required and connect power to Section E for the control unit. To use circuit style LL for automatic reset, a jumper wire must be installed between the upper and lower terminals in sections B and/or C.

6. **Dual Set Point Manual Reset:** Circuit Style HH may also be used for manual reset applications where it is desired to have maintained contact on either relay following pressure increase above its set-point. Load or signal connections are made to the appropriate terminals in Sections A and D (as in paragraph 5 above). Connect terminals in Sections B and C through normally closed switches or push buttons as shown in Fig. 8. Use of "dry-circuit" type switches such as Dwyer Part No. A-601 with paladium, gold, etc. or rotary wiping action type contacts is recommended. Make external ground connections as required and connect power to Section E for the control unit.

Circuit style LL is used for manual reset applications which require that contact be maintained following pressure decrease below the set-point. Load connections are made to the appropriate terminals in Sections A and D. A normally open type manual reset switch such as Dwyer Part No. A-601 is connected to the terminals in sections B and C. The circuit must be "armed" by momentarily closing the switch while the black pointer is to the right of the set-point. From that point on, the circuit will latch on pressure decrease below the set-point and remain latched on pressure increase until manually reset with the optional switch.



CAUTION: Do not apply electrical current to terminals in sections B and C.

Figure 8
Manual Reset with Circuit HH

7. **Dual Set Point Automatic and Manual Reset Combinations:** Circuit style HH may be used with either set-point wired and operating as in paragraph 5 above and other set-point wired and operating as in paragraph 6.

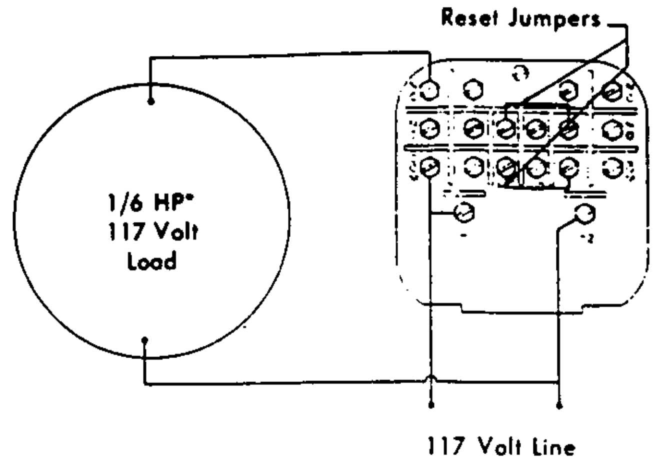
8. **High Low Limit Control — Dual Set-Point:** Circuit Style HH may be used to control fans, dampers, pumps, etc., between the set-points of a PHOTOHELIC.® To accomplish this, use one set-point relay to reset the other as shown in the wiring diagram Fig. 9. In this typical application, the load (for instance a fan) would be connected to the N.C. contacts of the right set-point relay, Section A (Fig. 6). On pressure rise to the right set-point, its relay would pull in and hold even though pressure might then fall below that set-point. If the pressure continued to fall to the left set-point, its relay would automatically be DE-ENERGIZED, return to its normal position and in so doing, open the holding coil circuit from Section B (Fig. 6). The right set-point relay would thus be reset and the cycle could repeat.

9. **Dual Set-Point Special Purpose Circuits:** Circuit Style LL may be used where manual reset following maintained contact on pressure decrease to either set-point is desired. Circuit Styles HL and LH are combination units. For special combinations of features, special units, and detailed instructions regarding their use, consult the factory.

10. **Single Set-Point PHOTOHELIC:®** The single set-point PHOTOHELIC® is furnished with the right set-point only. Terminals in Section A and B (Fig. 6) are connected to this relay. Circuit Style SRH is wired for automatic reset as in paragraph 5 above. Manual reset is accomplished by adding a normally closed reset switch or push button to the circuit as described in paragraph 6 above.

11. **Single Set-Point Special:** Manual reset after actuation on falling pressure can be obtained by using Circuit Style SRL. Consult the factory for special units and detailed instructions regarding their use.

12. **Placing in Service:** In normal operation each relay is de-energized when the pressure applied to the instrument is below its set-point. Special low-latching units will ordinarily have to be reset before placing on the line in normal operation.



Note: For larger motors, use the Photohelic® in a maintained contact, 117 Volt Control or Push Button Circuit of the motor starter.

Figure 9
High-Low Limit Control
(Circuit HH)

13. **Failure Mode:** The PHOTOHELIC® circuit design provides certain protection in the event of a loss of pressure or electrical power. In either case, both relays will de-energize, returning to their normal "zero pressure" state. The exceptions to this are models with center zero ranges. Because the relays on all standard models are always energized when the indicating (black) pointer is to the right of their respective set points, the relay action on loss of pressure will depend on set-point position, since either of them could be located to the left of zero. As an example; if the left pointer were set at -2 in. w.c. and negative pressure was -3 in. w.c., a loss of that pressure would allow the black pointer to return to the center and thus cause the low set-point relay to energize.

If the LED should burn out, only the left-low relay will de-energize. The right-high relay will react as if pressure were above its set-point and will remain energized even though pressure might be below that setting. In this situation, only termination of electrical power will allow the right-high relay to de-energize.

MAINTENANCE AND SERVICE

Dwyer PHOTOHELIC® Switch/Gages are precision instruments, expertly assembled and calibrated at the factory. They require no lubrication or periodic servicing. If the interior is protected from dust, dirt, corrosive gases and fluids, years of trouble-free service may be expected. Zero adjustment should be checked and reset occasionally to maintain accuracy. Any repairs necessary to either the Dwyer Magnehelic® pressure gage or the electronic components should be performed by a trained instrument mechanic. In most cases, this is best accomplished by returning the complete PHOTOHELIC® Switch/Gage to the Dwyer factory.

PHOTOHELIC®
PRESSURE SWITCH/GAGE

MODELS AND RANGES

Model Number	Range, Inches of Water	Minor Div.
3000-00	0- 25	005
3000-0	0- 50	01
3001	0-1 0	02
3002	0-2 0	05
[illegible]	0-3 0	10
3004	0-4 0	10
3005	0-5 0	10
3006	0-6 0	.20
3008	0-8 0	20
3010	0-10	20
3015	0-15	50
3020	0-20	50
3025	0-25	50
3030	0-30	1 0
3040	0-40	1 0
3050	0-50	1 0
3060	0-60	2.0
3080	0-80	2 0
3100	0-100	2 0
3150	0-150	5 0

Model Number	Range, Zero Center Inches of Water	Minor Div.
3300-0	.25-0-.25	.01
3301	.5-0-.5	.02
3302	1-0-1	.05
3304	2-0-2	.10
3310	5-0-5	20
3320	10-0-10	.50
3330	15-0-15	1.0

Model Number	Range PSIG	Minor Div. PSIG
3201	0-1	.02
3202	0-2	.05
3203	0-3	.10
3204	0-4	.10
3205	0-5	.10
3210	0-10	.20
3215	0-15	.50
3220	0-20	.50
3230	0-30	1.0
36003S	0-30	1.0
36006S	0-60	2.0
36010S	0-100	2.0
36020S	0-200	5.0
36030S	0-300	10
36060S	0-600	20
36100S	0-1000	20
36300S	0-3000	100
36600S	0-6000	200

Dual Scale Air Velocity Units*		
Model Number	Range, Inches of Water	Range, Air Velocity FPM
3000-00AV	0- 25	300- 2000
3000-0AV	0- 50	500- 2800
3001-AV	0-1 0	500- 4000
3002-AV	0-2 0	1000- 5600
3010-AV	0-10	2000-12500

*For use with pitot tube

Model Number	Range, MM of Water	Minor Div. MM
3000-6MM	0-6	20
3000-10MM	0-10	50
3000-25MM	0-25	50
3000-50MM	0-50	1.0
3000-80MM	0-80	2.0
3000-100MM	0-100	2.0

Model Number	Range, Zero Center MM of Water	Minor Div. MM
3300-20MM	10-0-10	.50

Model Number	Range, CM of Water	Minor Div. CM
3000-15CM	0-15	.50
3000-20CM	0-20	.50
3000-25CM	0-25	.50
3000-50CM	0-50	1.0
3000-80CM	0-80	2 0
3000-100CM	0-100	2.0
3000-150CM	0-150	5.0
3000-200CM	0-200	5.0
3000-250CM	0-250	5.0
3000-300CM	0-300	10.0

Model Number	Range, Zero Center CM of Water	Minor Div. CM
3300-4CM	2-0-2	.10
3300-10CM	5-0-5	.20
3300-30CM	15-0-15	1.0

Model Number	Range, Pascals	Minor Div. Pascals
3000-60Pa	0-60	2.0
3000-125Pa	0-125	5.0
3000-250Pa	0-250	5.0
3000-500Pa	0-500	10.0
3000-750Pa	0-750	25.0

Model Number	Range, Zero Center Pascals	Minor Div. Pascals
3300-250Pa	125-0-125	5.0
3300-500Pa	250-0-250	10.0

Model Number	Range Kilo-pascals	Minor Div. Kilo-pascals
3000-1kPa	0-1.0	.02
3000-1 5kPa	0-1.5	05
3000-2kPa	0-2.0	05
3000-3kPa	0-3.0	10
3000-4kPa	0-4.0	10
3000-5kPa	0-5.0	.10
3000-8kPa	0-8.0	20
3000-10kPa	0-10	.20
3000-15kPa	0-15	.50
3000-20kPa	0-20	.50
3000-25kPa	0-25	.50
3000-30kPa	0-30	1.0

Model Number	Range, Zero Center Kilo-pascals	Min Div Kil pasc
3300-1kPa	.5-0- .5	[illegible]
3300-3kPa	1 5-0-1.5	[illegible]

Note: The Photohelic® pressure switch/gage may be used in an Underwriters Laboratories approved industrial control panel if the usage conforms to U/L specifications for the acceptance of unlisted components.

Control Technology Specifications
Emission Point 2
Separator B Filter – Flyash Receiving Bin Vent

Control Equipment:	**Pulse Jet Fabric Filter**
Manufacturer:	**Fuller Bulk Handling**
Model #:	**8TR10 x80**

FULLER BULK HANDLING

FULLER BULK HANDLING CORP.
3225 Schoenersville Road • P.O. Box 805
Bethlehem, PA 18016-0805
Tel: (610) 264-6055 • FAX: (610) 264-6735
http://www.fullerbulkhandling.com

3 September 1999

Mr. Frank Hrach
Separation Technologies, Inc.
10 Kearney Road
Needham, MA 02494

Dear Mr. Hrach:

Subject: Jacksonville Electric Project
Your PO #30619
Emissions Guarantee

We have modified the silo vent filter and the two (2) filter receivers on this project to meet the requested emissions guarantee of .015 grains per ACFM outlet grain loading. The modifications include changing the bag materials to meet this requirement

As we discussed, the vent filter change is minimal and requires no price change. However, the filter receivers, which are under a significantly higher grain loading, require a PTFE laminate on the bags at a total cost additon of $2600 for each unit, or a total contract change addition of $5,200.

We are proceeding with these changes as instructed in your phone conversation with Bill Beidleman on 2 September 1999. Please arrange to forward a change order to reflect this addition.

I have recently taken over the administration of this project. Should you have any questions or need information, please contact me directly at 610-264-6237 (fax -6459). I look forward to working with you.

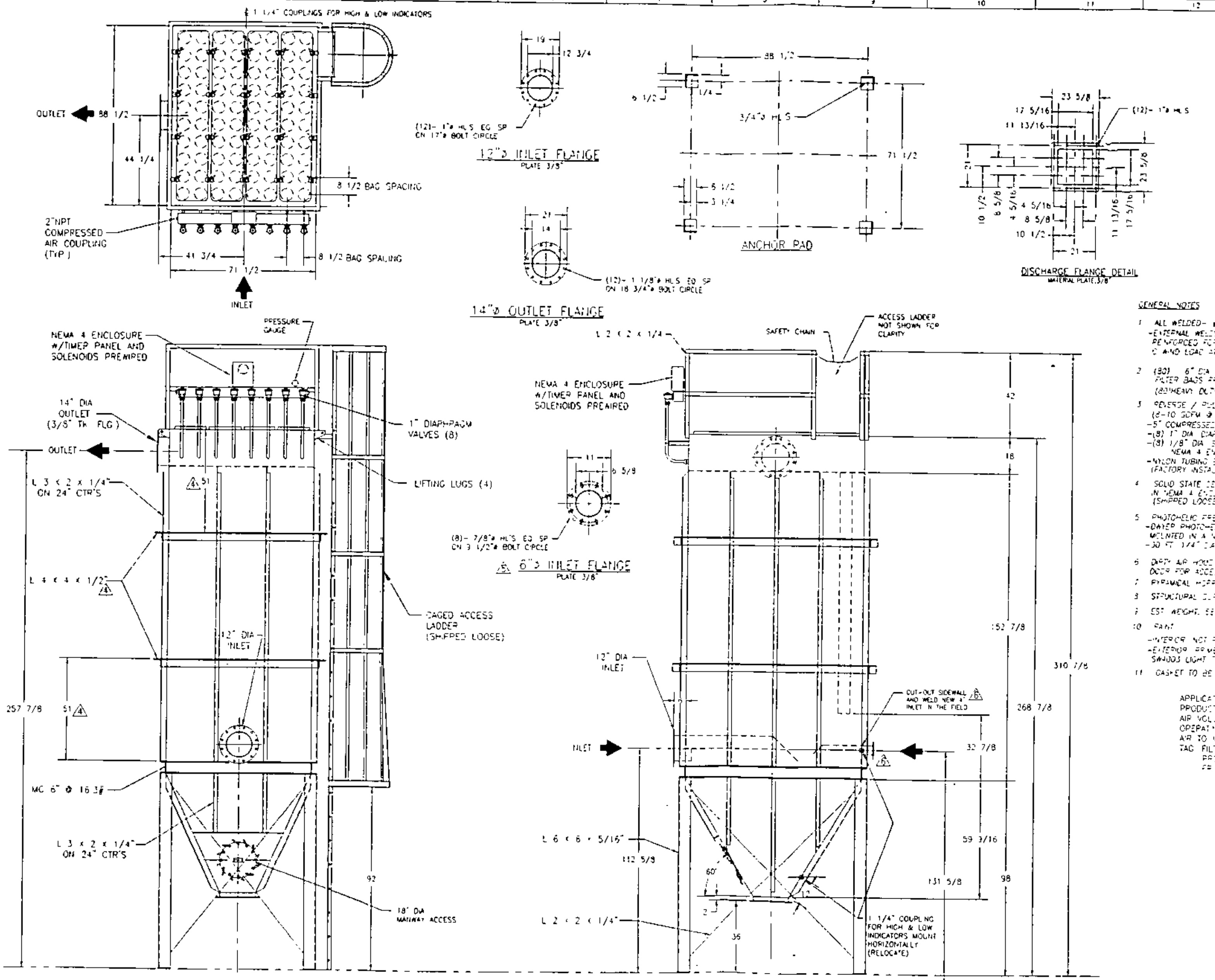
Sincerely,

FULLER BULK HANDLING CORPORATION

Donna Caldwell

Donna E. Caldwell
Contract Manager

cc: W E Beidleman, T LaFavor, B F Strobl



CERTIFIED
FOR CONSTRUCTION PURPOSES
DATE 01/27/99
SIGNATURE
CLEAN AIR MANAGEMENT CO., INC.

SHIPPED LOOSE ITEMS
BAGS
CAGES
LADDER
DUST COLLECTOR W/INTEGRAL HANDRAIL,SUPPORT STRUCTURE
TIMER ENCLOSURE

GENERAL NOTES

1. ALL WELDED- #12 GA. CARBON STEEL,HEAVY DUTY CONSTRUCTION
   -EXTERNAL WELDS CONTINUOUS, INTERNAL SEAMS SKIP WELDED
   REINFORCED FOR +/- 20" W.C. & 80 MPH EXPOSURE
   C WIND LOAD AT GRADE
2. (80) 6" DIA x 120" LG. 16 OZ. POLYESTER FILTER BAGS PROVIDING A TOTAL AREA OF 1,290 SQ. FT.
   (80)HEAVY DUTY #11 GA. GALV CARBON STL (12) WIRE FILTER BAG CAGES
3. REVERSE / PULSE CLEANING SYSTEM CONSISTING OF:
   (8-10 SCFM @ 90-100 PSI COMPRESSED AIR REQUIRED)
   -5" COMPRESSED AIR HEADER PIPE
   -(8) 1" DIA. DIAPHRAGM VALVES
   -(8) 1/8" DIA. SOLENOID VALVES MOUNTED & PREWIRED IN A NEMA 4 ENCLOSURE
   -NYLON TUBING BETWEEN SOLENOID & DIAPHRAGM VALVES (FACTORY INSTALLED)
4. SOLID STATE SEQUENTIAL TIMER BOARD ASSY MOUNTED IN NEMA 4 ENCLOSURE (SHIPPED LOOSE)
5. PHOTOHELIC PRESSURE GAUGE
   -DWYER PHOTOHELIC SWITCH/GAUGE MODEL #3015 MOUNTED IN A NEMA4 ENCLOSURE
   -30 FT. 1/4" DIA. NYLON TUBING AND NECESSARY FITTINGS
6. DIRTY AIR HOUSING W/ QUICK OPENING LIFT OFF & CLAMPED DOOR FOR ACCESS TO FILTER BAGS & CAGES
7. PYRAMIDAL HOPPER W/60° SIDE SLOPE
8. STRUCTURAL SUPPORTS PROVIDING 36" CLEARANCE BELOW HOPPER
9. EST. WEIGHT: 5500 LBS
10. PAINT
   -INTERIOR NOT PAINTED
   -EXTERIOR PRIMED & FINISH PAINTED WITH SHERWIN WILLIAMS SW4003 LIGHT TAN ENAMEL
11. GASKET TO BE NEOPRENE

APPLICATION: DUST COLLECTOR
PRODUCT: FLY ASH
AIR VOLUME: 3,380 ACFM
OPERATING TEMPERATURE: 200° F
AIR TO MEDIA RATIO: 2.6 TO 1
TAG: FILTER RECEIVER
PROCESS BUILDING
FR 01

REV 6	01/27/99	ADDED 4"Ø INLET, REMOVED 6" ONES
REV 5	01/19/99	ADDED (2)- 6"Ø INLETS
REV 4	12/28/98	ADDED 4 x 4 x 1/2" ANGLE REINFORCING
REV 3	12/18/98	FINALIZED ELECTRIC PANEL/CHG'D PAINT NOTE
REV 2	12/12/98	CORR'D. BOTTOM FLANGE ORIENTATION
REV 1	11/02/98	PER CUSTOMER MARK-UP

CAMCORP CLEAN AIR MANAGEMENT CO., INC.

JOB NUMBER: C98495-M	DWG NO: 98495-1

CUSTOMER: FULLER BULK HANDLING
BALTIMORE GAS & ELECTRIC
1000 BRANDON SHORES RD
BALTIMORE MD

TITLE: MODEL 81R10X80 DUST COLLECTOR FR101

DATE	DWN BY	CHK'D BY	APPR'D BY	SCALE	REV NO
10/06/98	DOTY			PS 24-00	#6

CAMCO

CLEAN AIR MANAGEMENT CO., INC.

DUST COLLECTOR IOM MANUAL

CAMCO
CLEAN AIR MANAGEMENT CO., INC.

10200 W. 75TH ST., SUITE 100 • SHAWNEE MISSION, KS 66204
PHONE: 913-831-0740 • FAX: 913-831-9271

TABLE OF CONTENTS

*OPERATING PRINCIPLE	1-1
*RECEIVING and INSPECTION of UNIT	2-1
*ON SITE STORAGE RECOMMENDATIONS	3-1
*BAG & CAGE INSTALLATION	4-1
*SETTING UP YOUR UNIT	5-1
*COMPRESSED AIR REGULATOR INSTALLATION INSTRUCTIONS	6-1
*START - UP CHECKLIST	7-1
*START - UP DUST CONTROL SYSTEMS	8-1
*SHUT - DOWN PROCEDURES	9-1
*TROUBLE SHOOTING the DUST COLLECTOR	10-1
*TROUBLE SHOOTING the TIMER	11-1
*TROUBLE SHOOTING the COMPRESSED AIR SYSTEM	12-1
*SAFETY RECOMMENDATIONS	13-1
*ROUTINE MAINTENANCE	14-1
*MAGNAHELIC DIFFERENTIAL GAUGE INSTALLATION & INSTRUCTIONS	15-1
*FILTER/REGULATOR INSTRUCTIONS	16-1
*DIAPHRAGM & SOLENOID VALVE INSTRUCTIONS	17-1
*RECOMMENDED SPARE PARTS	18-1

CAMCO
CLEAN AIR MANAGEMENT CO., INC.

10200 W. 75TH ST., SUITE 100 • SHAWNEE MISSION, KS 66204
PHONE: 913-831-0740 • FAX: 913-831-9271

OPERATING PRINCIPLE

A. Solids laden air or gases enter the unit at the hopper or housing inlet.

B. Air passes through the filter media.

C. Solids are retained on the filter media surface.

D. Cleaning cycle consists of a momentary blast of 90-100 psig compressed air:

1. Momentarily taking a row of bags off stream through pressure reversal.
2. Flexing filter bags.
3. Solids are released to fall towards hopper and through rotary valve or other discharge equipment.

CAMCO
CLEAN AIR MANAGEMENT CO., INC.

10200 W. 75TH ST., SUITE 100 • SHAWNEE MISSION, KS 66204
PHONE: 913-831-0740 • FAX: 913-831-9271

RECEIVING YOUR UNIT

Prior to accepting shipment, care must be taken to inspect all equipment received both for proper count and for damage. Any and all irregularities must be noted on the carriers copy of the shipping receipt to assist in settling any claims for damage or shortages. All equipment is shipped FOB point of origin whether on a prepaid or collect freight basis.

ANY CLAIM FOR DAMAGE IN TRANSIT OR SHORTAGES MUST BE BROUGHT AGAINST THE CARRIER BY THE PURCHASER.

Once your claim has been filed with the carrier contact CAMCO to notify us of the problem(s), then we will advise the appropriate repair procedure or recommend it to be returned to the factory depending on the extent of the damage.

INSPECTION OF UNIT

Housing, Air Header and Timer Assembly: Particular attention should be paid to the sheet metal housing of your collector. The unit should be inspected for dents, cracks, or rips. A dented housing may seriously affect the structural integrity of the unit. The air header and timer assembly are very delicate pieces of the unit and must be checked carefully for any signs of impact, warpage, or loose fittings. If any of these signs are present, note them on the shipping receipt and notify CAMCO immediately. The entire unit should be checked against the certified drawings for correctness and the manufacturer notified immediately if there are any discrepancies. No corrections may be made without the expressed written consent of the manufacturer.

Components: A count should be made of all pieces received and this should be verified against the carrier's manifest. Boxes should be inspected for rough handling which may have resulted in hidden damage.

CAMCO
CLEAN AIR MANAGEMENT CO., INC.

10200 W. 75TH ST., SUITE 100 • SHAWNEE MISSION, KS 66204
PHONE: 913-831-0740 • FAX: 913-831-9271

ON SITE STORAGE RECOMMENDATIONS

I. Baghouse, Bin Vent, Filter Receiver, Dirty Air Hopper and Housing

1. Housing can be stored outside.
2. Equipment must be blocked up to keep the flanges out of the dirt.
3. Many units are supplied with a plain finish bare steel interior. If storage of more than two weeks is anticipated, the interior should be prime coated before storage.
4. Covering the unit with a tarp is recommended to keep the interior from rusting or corroding as well as keeping the finish in new condition. However, the tarp is not absolutely necessary.

II. Baghouse, Bin Vent, Filter Receiver, and Clean Air Plenum

1. Unit can be stored outside.
2. Air header and diaphragm valves must be tarped for weather protection.
3. Unit must be positioned so water will not get in or remain inside the tubesheet area.
4. Unit must be blocked up to keep the flanges, bag cups, venturis and air header out of the water and dirt.
5. Ports on diaphragm valves must be plugged and taped to keep insects, dirt, and moisture out.
6. For extended storage, (more than 4 weeks) it is recommended to remove the timer panel and solenoid assembly. This component should be stored inside a cool dry area along with the copper or black nylon tubing. The solenoids should have all ports capped and taped to protect from insects, dirt, and moisture.
7. This unit should be tarped but is not absolutely necessary.

III. Bags & Cages

1. Bags must be stored inside a cool dry area protected from rodents and insects.
2. For extended storage the boxes for the bags should be wrapped with plastic wrap or stretch wrap to protect from moisture.
3. If the bags get wet for any reason, immediately lay them out with plenty of ventilation to dry in order to prevent mold and mildew.
4. It is recommended to store the cages inside a dry area if at all possible.
5. If an inside location is not available, cages can be stored outside as long as they are covered by a tarp.
6. Cages are generally stored horizontally on pallets to keep off the ground.

7. If cages can be stored horizontally, do not stack over three boxes high.
8. If the job site is in an area that may receive a significant snow load, the cages must be stored vertically in order to prevent being crushed by the weight of the snow. Do not stack more than one box high.

IV. Accessory Parts

1. This includes all gauges, bag clamps, nylon or copper tubing, valves, gaskets, and other parts not specifically called out.
2. These items should be stored inside a cool dry place protected from insects and rodents.

V. Fan and Fan Accessories

1. Fans can be stored outside on a pallet or skid to keep out of water and dirt.
2. Equipment should be covered with a tarp to protect from the bags.
3. Fan silencers, outlet dampers, and inlet boxes should also be tarped and stored on a pallet or skid.

VI. Ducting

1. Ducting can be stored outside on a pallet or skid to keep it off of the ground. It should be positioned so that water does not sit in the equipment.
2. If ducting is unpainted steel, it should be at least prime coated before storage.
3. If ducting is already finish coated, it should be tarped to protect the finish but is not absolutely necessary.

VII. Knife Gate

1. All limit switches, solenoids, and air cylinder ports must be capped and taped to prevent any moisture or dirt from entering.
2. Equipment can sit outside provided it is covered with a tarp and is on a pallet or skid to keep it out of the water and dirt.

VIII Isolation Dampers

1. All limit switches, solenoids, and air cylinder ports must be capped and taped to prevent any moisture or dirt from entering.
2. Equipment can sit outside provided it is covered with a tarp and is on a pallet or skid to keep it out of the water and dirt.

IX. Rotary Valve

1. Rotor and interior of valve should be well oiled with vegetable oil to prevent rust and to maintain compatibility with the product.
2. Unit can be stored outside provided it is covered with a tarp and is on a pallet or skid to keep it out of the water and dirt.

ON SITE STORAGE RECOMMENDATIONS (continued)

X. Butterfly (Wafer Valve)

1. All limit switches, solenoids, and air cylinder ports must be capped and taped to prevent any moisture or dirt from entering.
2. Unit can be stored outside provided it is covered with a tarp and is on a pallet or skid to keep it out of the water and dirt and sunlight.

XI. Level Indicators

* Store these items inside a cool dry area protected from rodents.

XII. AC Inverters

* Store these items and all other electrical controls inside a cool dry area protected from rodents.

CAMCO

CLEAN AIR MANAGEMENT CO., INC.

10200 W. 75TH ST., SUITE 100 • SHAWNEE MISSION, KS 66204
PHONE: 913-831-0740 • FAX: 913-831-9271

SETTING UP YOUR UNIT

CAMCO dust collectors are shipped either in one piece, fully assembled, or in two or more sections depending on the unit size and weight. Before attempting to move the dust collector or any of its sections, review both the certified general assembly drawing supplied with your unit and the rigging and lifting guidelines included in this manual. Become familiar with the size and number of sections to be assembled, the orientation of inlet(s), outlet(s), access door(s), and compressed air header(s), as well as the number and location of lifting lugs.

Dust collectors of this type are manufactured from steel sheets and are quite flexible. Therefore, even though care has been taken to maintain dimensional accuracy and squareness, some difficulty should be anticipated, and temporary bracing in the field may be required.

The following sequential procedure will help to minimize any assembly difficulties:

STEP 1: Set up the supporting steel work for the dust collector <u>level</u> and <u>square.</u> Precision at this point will facilitate erection and bolt hole alignment of the dust collector sections to follow.

STEP 2: Place the hopper with its girth channel on the supporting steel work. Check for squareness, and for bolt hole alignment between the hopper flange and the girth channel. Apply the appropriate RTV silicone caulk around the periphery of the hopper flange, one bead on each side of the bolt holes.

STEP 3: Lift the dusty air plenum, with the tubesheet, into place. **DO NOT LOWER THE PLENUM ONTO THE HOPPER FLANGE UNTIL ALIGNMENT IS ACCOMPLISHED.** The silicone caulk makes horizontal movement flanges very difficult once load is applied. With the plenum suspended over the hopper (1/2" to 1"), begin bolt hole alignment, starting at the center of the plenum and working toward the ends by using tapered drift pins with about 3/16" tips. If the wall(s) has flexed out of square, it will be necessary to pry or pull it back into alignment. Depending on the size of the unit and the degree of difficulty, hydraulic jacks and come-along's may be required. When the mating holes are properly aligned, finish lowering the plenum. Install the remaining bolts, washers, and nuts and torque to appropriate specifications.

SETTING UP YOUR UNIT (continued)

STEP 4: Check the top of the dusty air plenum for squareness and bolt hole alignment between the dusty air plenum and the tubesheet. make sure that the silicone caulk has been applied between the top flange of the dusty air plenum and the underside of the tubesheet flange. Next, apply the caulk around the periphery of the top side of the tubesheet flange, one bead to each side of the bolt holes.

STEP 5: Lift the clean air plenum into place, and assemble in the same fashion as in STEP 3. Again, do not lower the clean air plenum completely until preliminary alignment is accomplished. Start drift pin alignment at the center of the plenum on the compressed air header side, since the header makes access to the flange more limited. When alignment is complete, install the remaining bolts, washers, and nuts and torque to appropriate specifications.

All CAMCO dust collectors are provided with lifting lugs for ease in handling of the units during field erection and installation. The number and location of these lifting lugs will vary depending on the model, size, and weight of the dust collector. Before attempting to rig and lift your dust collector, review the certified general assembly drawing supplied with your unit to verify the number and location of lifting lugs, as well as visually check this information on the actual unit. Large units are frequently shipped in several sections, so check the lifting lugs provided on each section. If these cannot be used or there is some question about lifting lug location, consult the engineering staff at CAMCO for proper location since proper care must be taken to prevent damage to the housing or its components.

Rigging and Lifting Guidelines

1. Do not lift the dust collector by any attachments other than the lifting lugs provided.
2. Use all of the lifting lugs provided on the dust collector, or a section of the dust collector, when making a lift.
3. If the lifting lugs are located below the roof line of the dust collector or below the top of the section of the dust collector, a vertical pull must be made to avoid crushing the top of the unit. Use spreader beams to accomplish this vertical pull.
4. Attach tag lines at several locations to be able to control the unit when lifted and to prevent spinning or swinging.
5. The dust collector should be lifted and lowered at a slow, uniform rate and not allowed to bounce or joggle since this can cause excessive impact stresses at the lift points.

Air Header: CAMCO ships the air header installed complete with diaphragm valves, except when units are over legal shipping width when the air header is installed.

Doors and Flanges: Hold downs on doors should only be hand tightened. Excessive pressure can distort the door panel itself resulting in leakage. All bolts on flanges should be tight. All holes in the dust collector must be plugged prior to start-up if not being connected.

SETTING UP YOUR UNIT (continued)

Electrical: A 120 volt 60 Hertz circuit is required to operate the dust collector's programming device. This time must be wired according to the wiring diagrams and provided with a circuit that is free from transient currents. The timer has a feature call "Demand Pulse" that allows the output terminals to be energized and de-energized by the high and low set points of a differential pressure switch such as a Dwyer Photohelic Series 3000. Refer to the enclosed timer wiring diagram for proper wiring. The "Demand Pulse" terminals are marked "Pressure Switch". Do not over fuse.

The circuit board timer has the pulse duration and the internal (time between valves firing) set at the time of manufacture of your equipment. Before applying power to the timer, always check these settings according to the table below. Since there are many variances in operations and conditions, these are presented only as initial start-up guidelines. If you experience problems in cleaning of the filter bags, please contact CAMCO.

TIMER BOARD ADJUSTMENTS
(Recommended at start-up)

VALVE SIZE	PULSE DURATION	INTERVAL
3/4"	.10 to .12 seconds	20 to 25 seconds
1"	.10 to .12 seconds	20 to 25 seconds
1-1/2"	.06 to .08 seconds	20 to 25 seconds

The firing sequence of the timer is factory set so that no two adjacent rows of the bags fire in succession to insure maximum cleaning and life of the filter media. If you are experience a high pressure drop across the filter bags in your dust collector, the pulse interval should be reduced.

Apply electrical power to the timer and make sure it is cycling completely through all rows of the unit. In some cases, the timer panel may have more "positions" than required, in which case, the position selector cable is attached to the proper numerical value corresponding to the number of diaphragm valves on the unit.

If your unit was shipped via common carrier rather than contract hauler, there is a possibility that the electrical box was not shipped installed on the unit. If this is the case, there is a mounting plate welded on the housing or the air header with the bolt pattern of the electrical box already drilled. Bolt on the box and install the nylon (or copper) tubing with the fittings provided making sure that the solenoids are hooked to their corresponding diaphragm valve.

Valves and Piping: After the unit has been installed, the diaphragm valves should be checked to make sure that the port marked "IN" is assembled to the distribution header. The "IN" connection of the solenoid valve is connected to the diaphragm valve by means of 1/4" nylon or 1/4" copper refrigeration tubing. Each nut on the brass compression fittings should be checked for tightness before the distribution header is pressurized. In most cases a slip fit fitting has been used. The integrity of the nylon tubing inside each fitting should be checked by pulling gently on each tube. If the tube pulls out, simply push it back into the fitting until it will not go any further. The solenoids are shipped with a plastic plug in the discharge side of the valve. These plugs must be removed for proper operation of the filter cleaning mechanism.

SETTING UP YOUR UNIT (continued)

Gauges: Check the pressure differential gauge to make sure that the high pressure tap is connected below the tubesheet and the low pressure tap is connected above the tubesheet. Verify that the gauge has been zeroed prior to connection when it is in its permanent mounting position.

Auxiliary Equipment: All auxiliary equipment must be installed according to its manufacturer's specifications and interlocked with the entire system as needed. Direction of rotation of each item must be checked prior to start-up of the entire system.

CLEAN AIR MANAGEMENT CO., INC.

10200 W. 75TH ST., SUITE 100 • SHAWNEE MISSION, KS 66204
PHONE: 913-831-0740 • FAX: 913-831-9271

BAG AND CAGE INSTALLATION

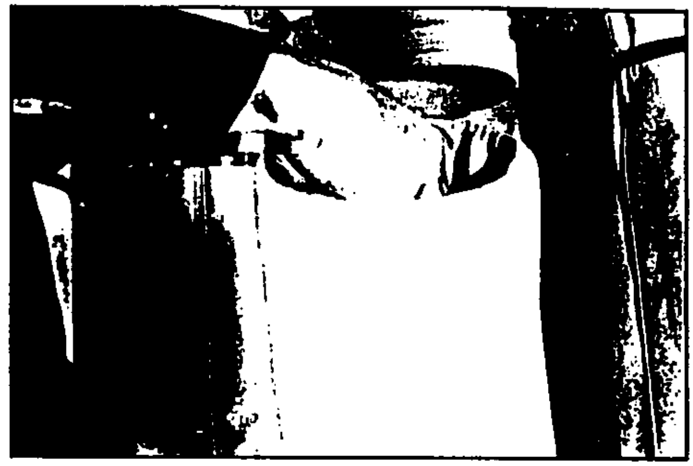
Installation of Bag and Cage Assembly - Bottom Loader

1. Inspect the cage for any signs of damage, warping, bent wires, or missing welds.
2. Inspect the filter bag for any signs of mold, mildew, ripped seams, or holes.
3. Be sure the wire cage has a bottom pan. Slip filter bag over the cage, centering the seam 1-1/2" or 2" either side of the split at the top of the cage roll band. Seam must be straight (not corkscrewed).
4. Pull bag up and over the full length of the cage and fold the entire extra length over and down into the top of the cage. Make sure the bag bottom is tight against the cage pan. Smooth out all folds and pleats on eh interior of the roll band.
5. Slip the assembled bag and cage up on the bag cup making sure to mate the male groove of the cage roll band top to the female groove the bag cup.
6. If you try to move the assembly up and down, you will be able to tell if the grooves are properly aligned.
7. Install the bag clamp on the assembly and tighten around the bag and cage at the point just above the groove on the cage. The clamp head should be located in the best direction for ease in tightening.
8. Tighten the clamp until secure. You should not be able to rotate the assembly by hand if it is tight enough.
9. Close the access door and tighten accordingly. You are ready to begin start-up procedures if all other preceding tasks and hook-ups are completed.
10. It is recommended to double check the tightness of the bag and cage assembly approximately one month after the initial start-up.

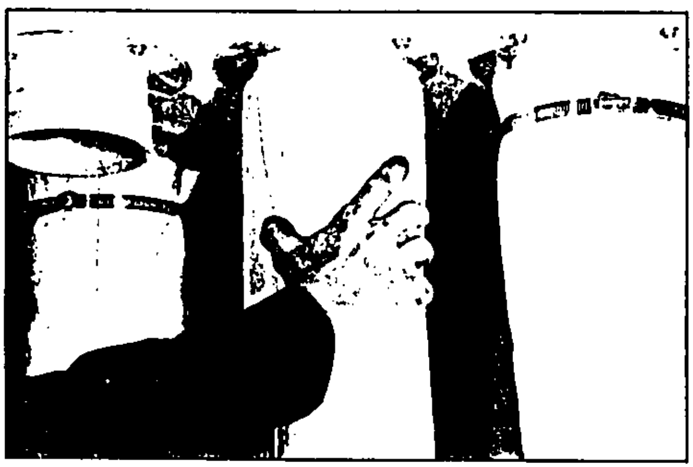
Bottom Bag Removal

The AVS pulse jet filters have bottom cage and bag removal from the interior of the housing. This is economical and convenient for small filter units.

Step 1 The cage is inserted into the full length of the bag.



Step 2 The remainder of the bag is tucked into the cage, being careful not to leave any creases along the rim of the cage.



Step 3 The bag and cage are then slid onto the permanently attached bag cup

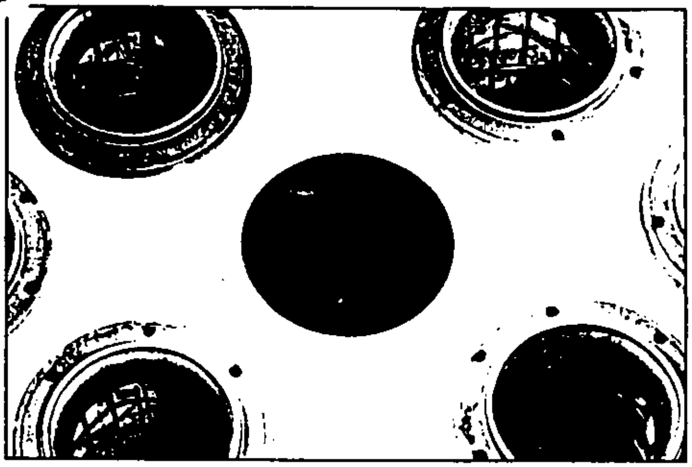
Step 4 A positive seal is achieved by used of hose type clamps.

Installation of Bag and Cage Assembly - Top Loader

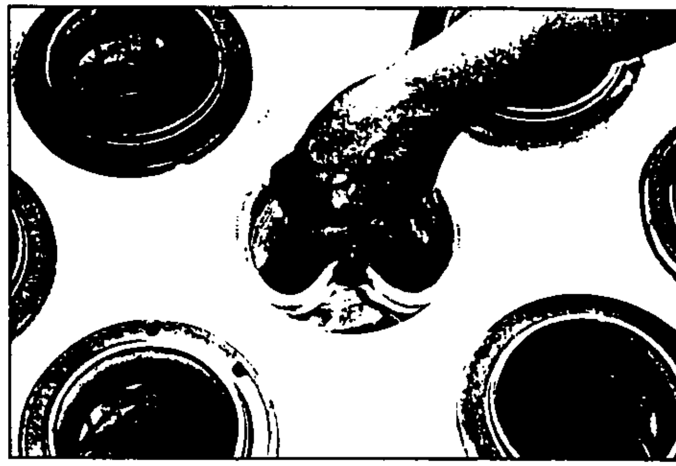
1. Inspect the cage for any signs of damage, warping, bent wires, or missing welds.
2. Inspect the filter bag for any signs of mold, mildew, ripped seams, or holes.
3. Remove the blow pipe by loosening the bulkhead fitting on the air header end of the pipe and removing the bolt in the retaining clip on the opposite end of the pipe.
4. Lower the closed end of the bag through the hole in the tubesheet.
5. With your hands, "kidney shape" the snap band bag top in order to fit and align it within the tubesheet hole.
6. Fit the groove of the snap band to the I.D. of the tubesheet hole and allow it to expand and audibly snap into place. If the band will not snap into place initially, **do not** push on the "dimple" as doing this will permanently damage the snap band. Instead, kidney shape the snap band from the opposite side of the band. Then you can allow the band to expand and audibly snap into place.
7. Check the fit of the snap band to the tubesheet. It should be even in height above the tubesheet around the entire circumference, which will confirm to the installer that the tubesheet is centered and well secured into the middle groove of the snap band.
8. Lower the cage into the bag and press the cage top down into the bag's snap band I.D. When in position, the rolled flange of the cage top will rest on the tubesheet and the bag and cage assembly will be rigidly mated. The O.D. of the cage top provides a compression fit to the I.D. of the snap band.
9. Replace the blow pipes in the opposite order stated in Step 3. Make sure that the orifices in the blow pipe are in the proper orientation to blow straight down the center of the bag and cage assembly.
10. Replace access doors and tighten accordingly. You are ready to begin start-up procedures if all other preceding tasks and hook-ups are completed.

BAG AND CAGE INSTALLATION (continued)

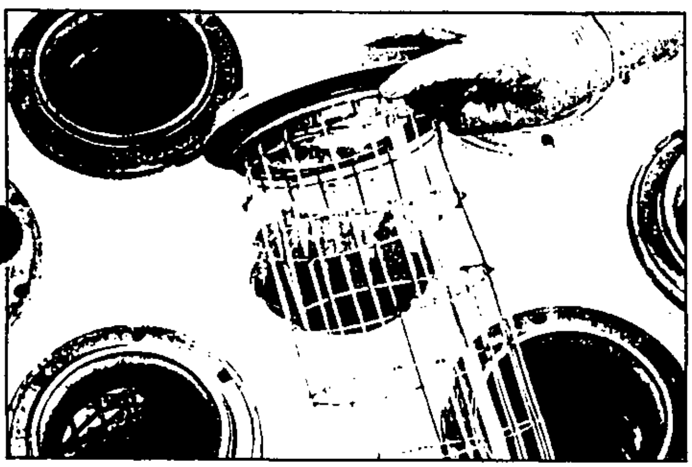
Top Bag Removal – ST Style



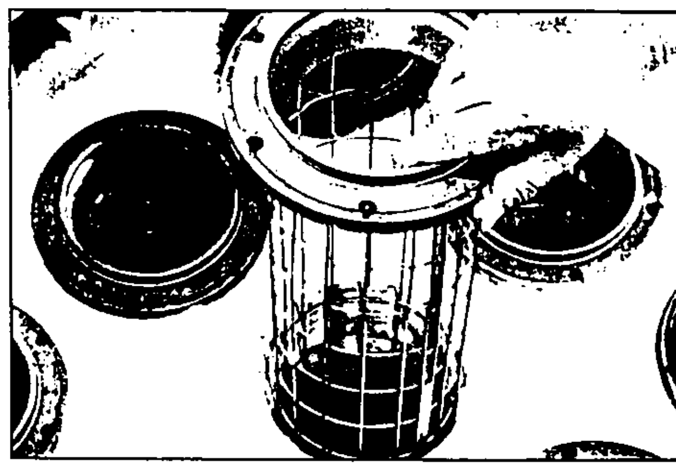
Step 1 Entry into the dirty side of the filter is unnecessary.



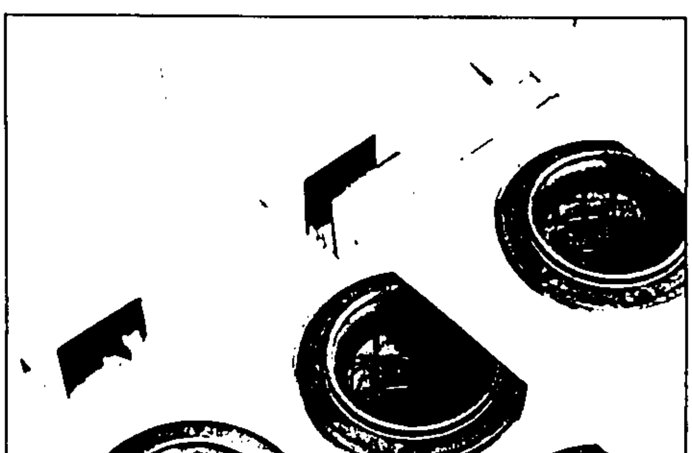
Step 2 No tools are required.



Step 3 Snap band with high profile lip seals secure the bag to the tube sheet.



Step 4 The cage snaps into place by merely lowering it into the bag and pushing down.



Step 5 The header pipes are easily installed by sliding the indexed end into the bracket.

Step 6 The header pipes can only fit one way, thus insuring alignment of the blow nozzles.

CAMCO
CLEAN AIR MANAGEMENT CO., INC.

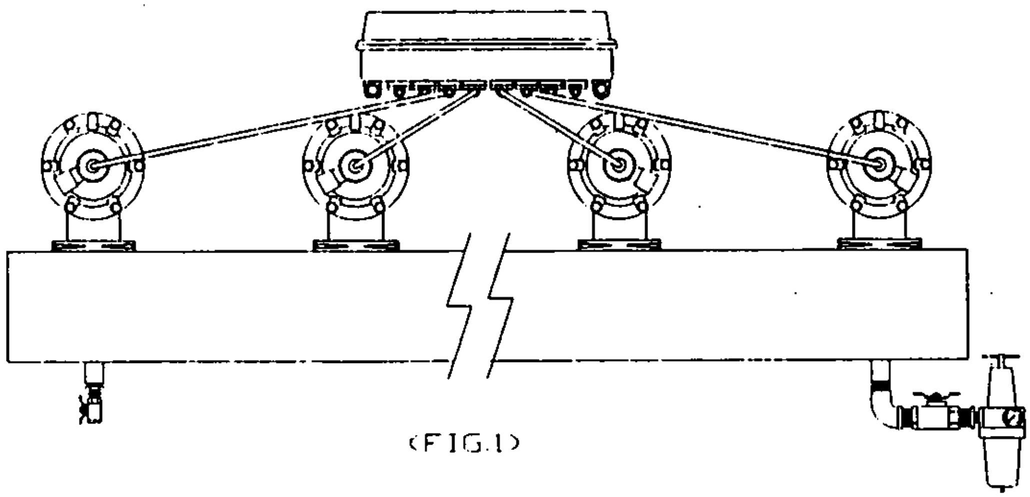
10200 W. 75TH ST., SUITE 100 • SHAWNEE MISSION, KS 66204
PHONE: 913-831-0740 • FAX: 913-831-9271

COMPRESSED AIR REGULATOR INSTALLATION INSTRUCTIONS

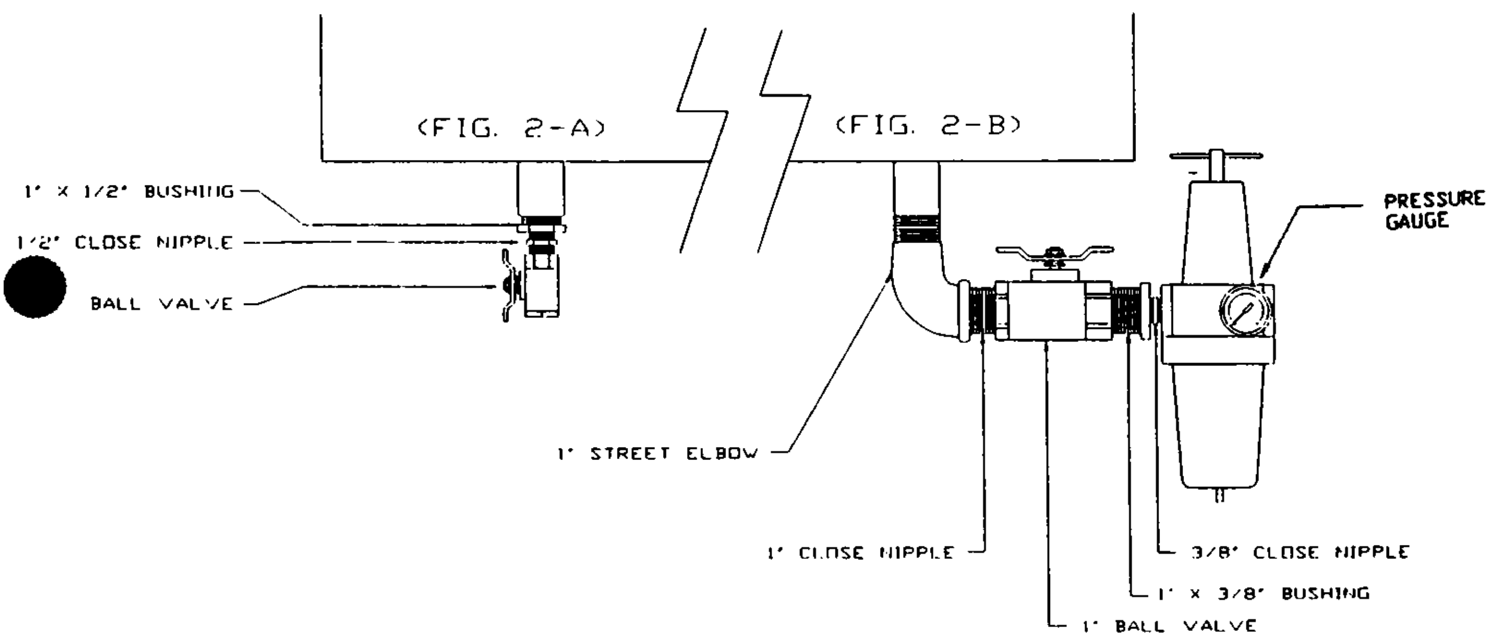
With some dust collectors a filter/regulator is shipped loose with galvanized connectors and ball valves. The diaphragm valve header is supplied with (2) 1" couplings, (1 @ each end) to allow user to bring compressed air line in at either end. The other coupling is used as a drain valve.

INSTALLATION

1. Choose end of header for compressed air inlet.
2. Assemble pipe fittings and ball valve as shown in Fig. 2-b, using Teflon tape on all pipe threads.
3. Connect the Filter/Regulator to the 3/8" close nipple so the air flow is in the direction of the arrows indicated on head of the unit.
4. Decide which side to connect pressure gauge to Regulator and put plug in the opposite side.
5. On opposite side of the valve header, install pipe fittings and ball valve as shown in Fig. 2-a and this will serve as a drain valve and air bleed off.



(FIG.1)


(FIG. 2-A)
(FIG. 2-B)
1" x 1/2" BUSHING
1/2" CLOSE NIPPLE
BALL VALVE
PRESSURE GAUGE
1" STREET ELBOW
1" CLOSE NIPPLE
3/8" CLOSE NIPPLE
1" x 3/8" BUSHING
1" BALL VALVE

CAMCO

CLEAN AIR MANAGEMENT CO., INC.

10200 W. 75TH ST., SUITE 100 • SHAWNEE MISSION, KS 66204
PHONE: 913-831-0740 • FAX: 913-831-9271

START-UP CHECKLIST

1. Installation

   Make sure the unit is secured to the floor or mounting surface. The ladder(s) and platform(s) must be tightened and set up according to OSHA requirements. Ducting and piping must be secured and routed out of the way of traffic whenever possible to avoid injury. Ducting must also be free of all debris including moisture.

2. Interior of the dirty air plenum

   A. In bottom bag removal collectors, inspect the filter bag assemblies referring to the "Bag and Cage Installation" section of this manual. Improperly installed bags may allow dusty air to enter the clean air plenum and will shorten bag life.

   B. Make sure that the filter bag assemblies hang straight and the bottoms **do not** touch each other or any part of the collector interior. If this occurs, the bags will have holes worn in them wherever they contact and will require replacement.

   C. High level alarms should be connected sufficiently below the air inlet(s) to avoid a plugged up inlet or blinded off filter bags.

3. Interior of clean air plenum

   A. All bolts on the flanges must be in place and properly tightened.

   B. The blow holes in the blow pipes must be centered over the Bags.

   C. The compressed air piping must be rigidly welded or bolted in place. In top removal collectors, the bulkhead fittings used to connect the compressed air piping must be tight against the collector wall, as well as tight on the ends of each blow pipe.

4. Exterior of dust collector

   A. Access doors, inspection ports, and spring loaded relief vents should seat effectively to prevent leakage.

B. All bolts must be properly tightened.

C. Operate any equipment connected to the dust discharge of the dust collector. Check the rotation of any motor driven equipment such as rotary airlocks, horizontal unloading valves, live bottom bin activators, and screw conveyors. Check slide gates and butterfly valves for binding.

5. Explosion relief panels - shear bolt style (when used)(see insert)

Inspect explosion relief vents (when used) for broken or damaged explosion bolts. **MAKE SURE THERE ARE NO STEEL BOLTS USED FOR THE INSTALLATION OF THE EXPLOSION RELIEF PANEL!!!** These bolts are made of a special high tech poly-vinyl chloride and are designed to relieve at a specific pressure. A magnet should be used to check for steel bolts.

6. Compressed air system

A. The timer should be correctly wired and mounted in its housing in a suitable location.

B. All the 1/4" copper or nylon tubing connections between the diaphragm and the solenoid valves must be tight, and the tubing must not be crimped.

C. The plugs (when used) must be removed from the exhaust ports of the solenoid valves, and the tubing from the diaphragm valves must be connected to the "IN" port on the solenoid valves.

D. The compressed air system must be equipped to supply clean, dry air to the pulsing air system. At this time, make sure that there is a suitable air pressure gauge on the air header for reading 0-160 psig.

E. Start the compressed air supply system and check for air leaks in all parts of the system. If air is heard escaping through one or more of the blow pipes (with the timer off), please refer to the "Troubleshooting the Compressed Air System" section of this manual. Gauge pressure at the air header(s) should be 90-100 psig.

F. With the compressed air system operating, energize the timer to begin pulsing. Check to see that all solenoids are firing by placing a finger over the exhaust port of the solenoid valve. When the solenoid valve being checked is triggered by an electrical pulse from the timer, a short blast of air should be felt by the finger at the exhaust port. Quickly move to the next solenoid valve in the firing order, noting any valves that do not fire or are stuck open, causing a continuous air flow out of the exhaust port of the valve. At this time, note the quality of the compressed air. It should be clean, dry, and oil free.

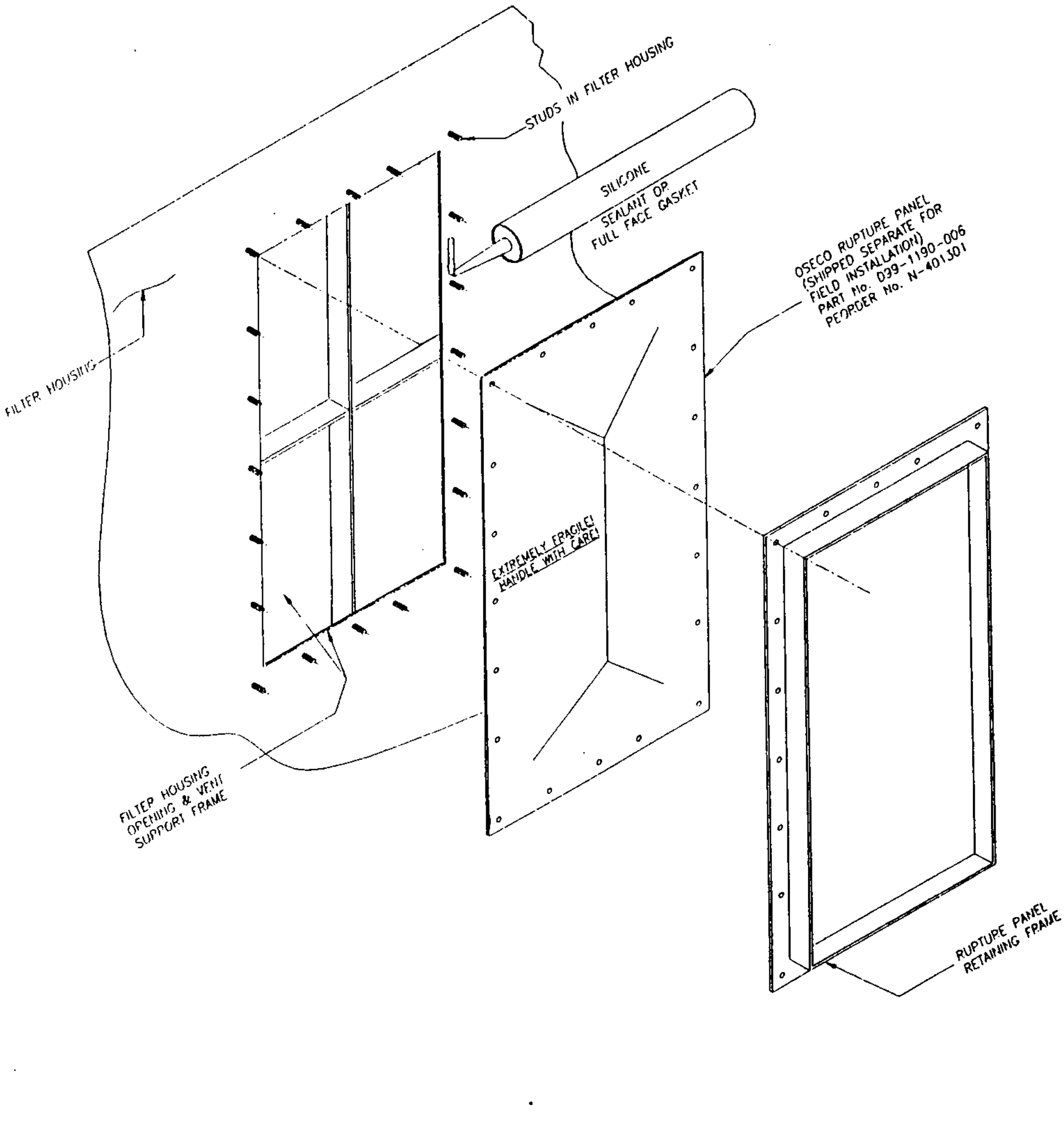
G. Allow the compressed air system to operate as long as possible to clear the system of dirt, rust, scale, welding slag, and metal chips that can cause the diaphragm valves to stick.

H. The pressure at the air header must recover to 90-100 psig before each pulse. Make sure that there is adequate compressed air delivery for full pressure recovery when all other systems connected to the same air supply are operating at full capacity.

CAMCO CLEAN AIR MANAGEMENT CO., INC. 10200 W. 75TH ST., SUITE 100 • SHAWNEE MISSION, KS 66204 • PHONE 913-831-0740 • FAX 913-831-9271

EXPLOSION RELIEF VENT
(RUPTURE STYLE INSTALLATION)

(RUPTURE PANEL IS SEALED & SANDWICHED BETWEEN FILTER HOUSING & RETAINING FRAME AS ILLUSTRATED BELOW)



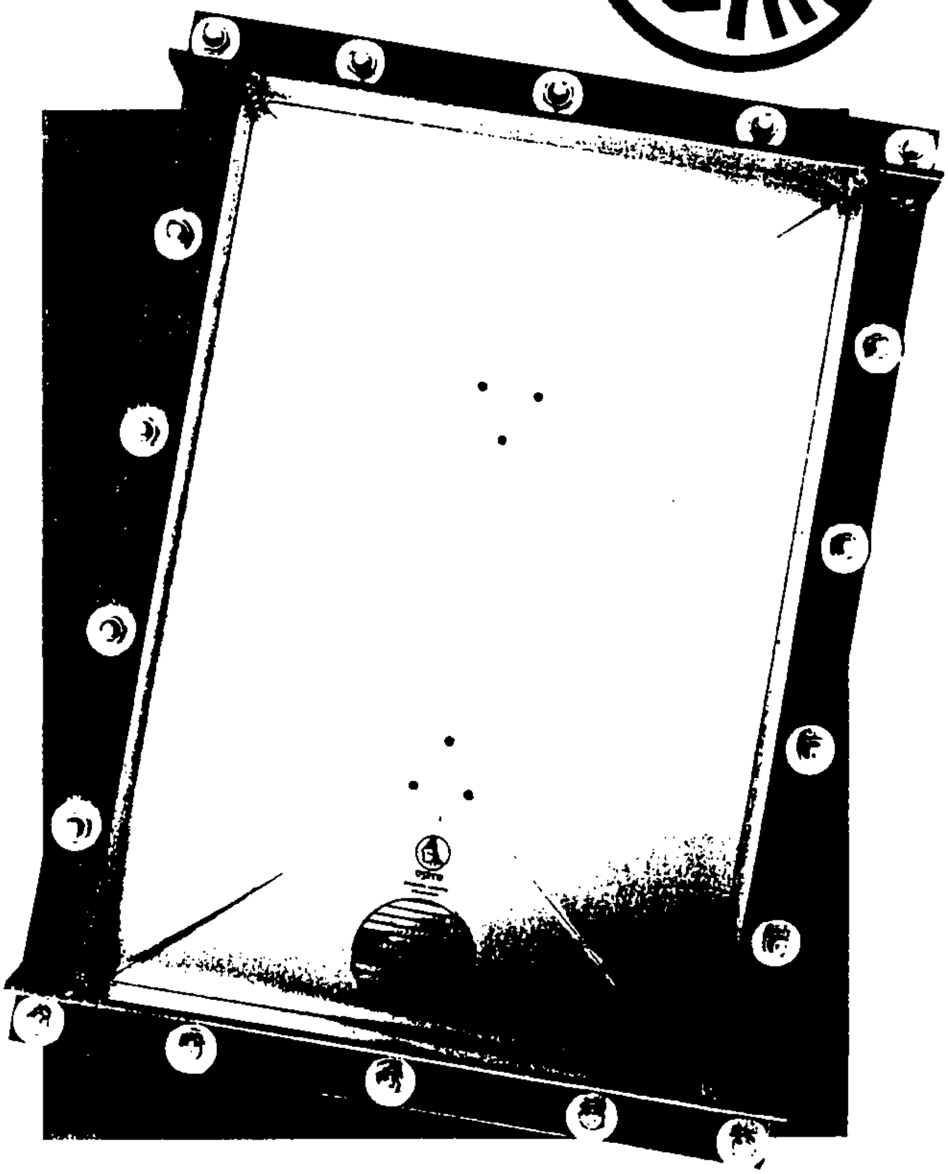
OSECO®

RUPTURE PANELS

The **OSECO Rupture Panel** is designed to limit the maximum pressure resulting from a deflagration in order to limit damage to an enclosure. The **OSECO Rupture Panel** does not prevent the occurrence of a deflagration but is intended to limit or minimize the damage from the pressure excursion generated by the deflagration.

Per National Fire Protection Association standard NFPA 68, deflagration is defined as *"burning which takes place at a flame speed below the velocity of sound in the unburned medium"*. NFPA 68 defines detonation as *"burning which takes place at a flame speed above the velocity of sound in the unburned medium"*. Explosion is defined by NFPA 68 as *"a bursting of a building or container as a result of development of internal pressure beyond the confinement capability of the building or container"*. Explosion venting has not yet been reduced to an exact science. **OSECO** suggests consulting NFPA 68 for information on determining vent area requirements and vent location.

The advanced technology of the **OSECO Rupture Panel** provides a reliable, high capacity relief with minimal fragmentation. The Rupture Panel is designed to bolt between Rupture Panel Frames which are either bolted or welded to the structure to be protected. The **OSECO Rupture Panels** can be installed onto existing equipment or new applications.



Some examples of industrial equipment to which the **OSECO Rupture Panel** can be used are *dust collectors and arrestors, conveyors, blenders, mixers, crushers, grinders, pulverizers, driers, ovens and furnaces, ducts, bins, silos* and *many more*.

the Name you need to know in Pressure Relief Products!

CAMCO
CLEAN AIR MANAGEMENT CO., INC.

10200 W. 75TH ST., SUITE 100 • SHAWNEE MISSION, KS 66204
PHONE: 913-831-0740 • FAX: 913-831-9271

START-UP DUST CONTROL SYSTEMS

1. Fan or blower system

   A. Start the fan or blower and check rotation.

   B. Check dust pickup points for proper suction; balance air flow in individual ducts.

   C. Check for air leakage at all flanged connections.

2. Equipment start-up sequence

   A. The compressed air supply system must be started first.

   B. When the pressure gauge on the compressed air header indicates that the system is at full pressure (90-100 psig), the sequential timer can be energized.

   C. Dust take away equipment such as rotary airlocks, screw conveyors, horizontal unloading valves, live bottom bin activators, and pneumatic conveying systems can now be started in their correct sequence.

   D. Check that all access doors, hatches, ports, and other openings are closed and latched or bolted.

   E. The main exhaust fan can now be started and brought up to speed.

   F. Start the dust laden air through the collector. The collector should be started under partial load to allow the bags to become slowly and evenly coated with dust particles.

      On pneumatic conveying systems, watch the differential pressure gauge closely for the first hour or so. If unstable, the collector discharge system may be too small for the volume it is seeing. A quick fix is to reduce the material feed until the discharge rate can be increased.

G. Observe the manometer or magnahelic differential pressure gauge reading. As the new filter bags become coated with dust, the efficiency of the filtering action increases, and the differential pressure across the filter bags will also increase. Slowly bring the collector to full load and note the final pressure drop across the filter bags. Never allow the pressure drop across the filter bags to exceed 17" w.g. maximum or filter bags may collapse.

Note: If the pressure drop continues to increase over 5" w.g. and does not stabilize, decrease the timer "off time" to fifteen seconds. Should adjustment of the timer "off time" fail to cause the pressure drop to stabilize below 5" w.g., shut down the collector and refer to "Troubleshooting the Collector", or call your CAMCO representative.

H. When the collector has stabilized, the timer "off time" interval may be slowly increased for the most economical use of compressed air. As the "off time" is increased, the differential pressure will also increase. Readings up to 6" w.g. are acceptable; however, we recommend operating at 3"-4" w.g. for maximum filter bag life. The timer "off time" may be decreased when lower differential pressure readings are desired. When adjusting the "off time" interval, proceed in small steps, allowing the differential pressure to stabilize for several hours between increments.

I. Check the main air flow with a pitot tube, or equivalent measuring device, to establish initial conditions. If the main air flow must be adjusted up or down to suit the process, repeat step 2-H above.

CAMCO
CLEAN AIR MANAGEMENT CO., INC.

10200 W. 75TH ST., SUITE 100 • SHAWNEE MISSION, KS 66204
PHONE: 913-831-0740 • FAX: 913-831-9271

SHUT-DOWN PROCEDURES

1. Dust control systems

   Reverse start-up procedure, shut down fan, then after 5 or 10 minute delay, shut down the timer and discharge system.

2. Pneumatic systems

   Reverse start-up procedure, shut down fan, then after 5 or 10 minutes delay, shut down the timer and discharge system.

CAMCO
CLEAN AIR MANAGEMENT CO., INC.

10200 W. 75TH ST., SUITE 100 • SHAWNEE MISSION, KS 66204
PHONE: 913-831-0740 • FAX: 913-831-9271

TROUBLESHOOTING THE DUST COLLECTOR

I. Excessive pressure drop across filter bags

The differential pressure gauge or manometer on your dust collector should read 6" w.g. or less. Higher readings and/or steadily increasing readings are an indication that the main air flow through the dust collector may be restricted, and a potential process problem such as poor suction at duct pickup points may exist. In extreme cases (over 17" w.g.) filter bags will be damaged. Check the following:

A. Pressure Gauge

Check the differential pressure gauge or manometer and the tubing leading to the dust collector for proper operation. Disconnect the lines at the gauge or manometer and clear with compressed air. Look for loose fittings, cracked, broken, or pinched tubing. Make sure the gauge is zeroed or that the manometer is level, zeroed, and contains the correct fluid.

B. Compressed Air System

Inspect the compressed air system as follows to make sure that all of the filter bags are being cleaned:

1. If none of the solenoid valves are operating, check the timer using the "Troubleshooting the Timer" section.

2. Check the air pressure at the header. It should recover to 60-100 psig before each pulse. If not, check to make sure that the compressed air supply system is in good operating condition, correctly sized, and supply lines are not too small or restricted. Listen for the sound of compressed air flowing continuously through one or more rows of filter bags, an indication of a valve or valves "stuck" in the pulsing position. The usual causes for this condition is either a leak in the tubing to the solenoid pilot valve or dirt in the solenoid and/or diaphragm valves.

3. Check that all solenoid pilot valves are firing in sequence by holding a finger over each solenoid exhaust port as described in item 6A-6H in the "Start up checklist" section.

C. Bags Loaded with Dust

A condition known as blinding. If the dust is dry, see paragraph 1-4; if the dust is wet, see paragraphs 5 and 6.

1. Dust not discharging from the hopper

   Check hopper for over-loading or bridging across the dust discharge. Correct by repairing dust discharge equipment, replacing with higher capacity equipment, or installing hopper vibrators, etc. as required to keep the hopper clear.

2. Air flow too high

   If the main air flow is too high to allow dust to drop off of the filter bags, an excessive pressure drop across the dust collector will result and dust will build up in the system. In many cases this high pressure drop in turn leads to a reduction in the main air flow so that it is necessary to remove the dust accumulation from the filter bags (and the rest of the system) before measuring the main air flow volume.

   Visually inspect the bags for heavy caking; if caking is evident, see the note below and take the necessary action to clean the bags. Next, measure the main air flow with a pitot tube or equivalent devise and compare with the original volume for which the unit was designed. If the flow is too high, cut back the main fan to prevent a recurrence of the problem.

3. Particle size and dust load

   If possible, compare the dust particle size and loading with the original design specifications. Finer dust may cause a higher pressure drop. Do not hesitate to call the factory; we have experience with many kinds of dusts.

4. Bags too tight

   Bags that have shrunk on their cages may not flex sufficiently during the compressed air pulse to loosen caked dust. If the bags were cleaned or laundered, pull a bag tight around its cage; you should be able to "gather" a small fold of material between your fingers.

4. Water leaks

   Inspect the dust collector housing and ductwork for holes, cracks, or loose gasketing where water could enter the collector.

5. Condensation

If moisture has been condensing inside the collector, check the dew point temperature of the incoming air stream. It may be necessary to insulate the collector and/or the ductwork leading to the collector to keep surface temperatures above the dew point and prevent condensation of the filter bags.

NOTE: Collectors that have had blinded or caked bags can possibly be put into service by running the pulsing air system for 15 to 30 minutes with a 10 second timer "off time" and without the main fan or blower. If the pressure drop is not lower when the main fan is started again, take the bags out of the collector and remove the caked dust by special dry-cleaning. Make sure the timer "off time" has been reset to specifications prior to re-start. Information pertaining to filter bag cleaning may be obtained by calling your CAMCO sales representative.

II. Extremely low pressure drop

A. Pressure Gauge

Check the differential pressure gauge or manometer and the tubing leading to the dust collector as in I-A of this section.

B. Holes in filter bags or bags incorrectly installed.

Inspect the filter bags for holes, rips, tears, or excessive wear. Make sure that the filter bags were installed correctly according to the "Bag & Cage Installation" section.

C. Ductwork and Dampers

Inspect the ductwork to and from the dust collector for air leaks or blockage. Make sure that any dampers in the system are correctly positioned to allow air to flow through the dust collector.

D. Leaks in the Housing

Check the tube sheets (flat steel sheets from which the filter bags are suspended) and the dust collector housing for holes, cracks or loose gasketing that would permit air to bypass the dust collector or filter bags.

III. Continuous flow of dust in the clean air exhaust (primary dusting)

A. Holes in the filter bags or bags incorrectly installed.

Inspect the filter bags as in II-B this section.

TROUBLESHOOTING THE DUST COLLECTOR (continued)

B. Holes in the tube sheets

Check the tube sheets for holes, cracks or loose bolts that would permit dusty air to bypass the filter bags.

IV. Puff of dust in the clean air exhaust after each pulse (secondary dusting)

A. Air header pressure too high

Check air header pressure gauge. If the pulsing air pressure is over 80 psig, filter bags may flex excessively and allow fine dust to pass through the bag material.

B. Worn filter bags

Inspect the filter bags for wear. Thin bags may not stop fine dust when flexed by a compressed air pulse.

C. Residual dust

If dust has gotten into the clean air plenum because of a dropped or torn bag, hole in tube sheet, etc., the pulsing air may stir up the dust and allow it to escape into the clean air exhaust after each pulse. Residual dust may also be driven down inside the filter bags by the pulsing air; if the filter bags are filled with several inches of dust, clean both the clean air plenum and the filter bags to avoid further problems.

V. Short filter bag life

This is often a complicated problem to diagnose and we recommend calling the factory for advice. The following list may be helpful in performing some preliminary checks:

A. Temperature

operating temperature above the recommended limit of the filter bag material (220 degrees F max.)

B. Chemical attack

Bag material degrades due to attack from certain chemicals in the dust or gasses in the air stream.

C. High Moisture

High moisture content in the collector may cause certain filter bag material to shrink or degrade (more rapidly at elevated temperatures).

D. Localized abrasion

Abrasion of the bags at the dusty air inlet; a dust impingement baffle may be required.

E. Internal bag supports gone bad

Corroded, rusted or broken filter cages can cause excessive bag wear. Stainless steel or coated cages are available.

CLEAN AIR MANAGEMENT CO., INC.

10200 W. 75TH ST., SUITE 100 • SHAWNEE MISSION, KS 66204
PHONE: 913-831-0740 • FAX: 913-831-9271

TROUBLESHOOTING THE TIMER

1. Check for mechanical damage.

2. If the "Power On" indicator is not on, check for 120 VAC power input. The "hot" line connection must be connected to terminal "L1", as this is the fused terminal.

3. Check for a blown fuse; if replacement is necessary, use only 2 AMP standard 3AG fuse (1-1/4" long). **Do not use a slow-blow type fuse.**

4. Check the wiring from the timer to the solenoids for open or short circuits.

5. After performing steps 1-4, if the timer is still not functioning properly (no output voltage, sequencing problems, etc.) please contact your CAMCO representative.

National Controls Corporation
Subsidiary of Tokheim Corp.
1725 Western Drive
West Chicago, IL 60185

Models DNC-T2003 thru DNC-T2032

Operating Logic:

Input power is applied to the control at all times. For "On Demand" cleaning, closure of isolated control contacts (pressure switch) initiates the "Off" time. At the end of the off time the control energizes solenoid no. 1 to provide a cleaning pulse; it then transfers to the next compartment initiating the off time again. This cycle continues until the control contacts open. The control remembers the last output activated and will activate the next one in line when the control contacts reclose. For "continuous" cleaning the pressure switch terminals should be shorted together. A program wire allows for field selection of number of outputs required.

Specifications:

Time Delay:

On Time: Adjustable from 50 to 500 milliseconds
Off Time: Range A—adjustable from 1.5 to 30 seconds
Range B—adjustable from 8.5 to 180 seconds
Repeatability: ± 3% over temperature and voltage ranges

Input:

Operating Voltage: 105 to 135 volts A.C. 50/60 Hz

Output:

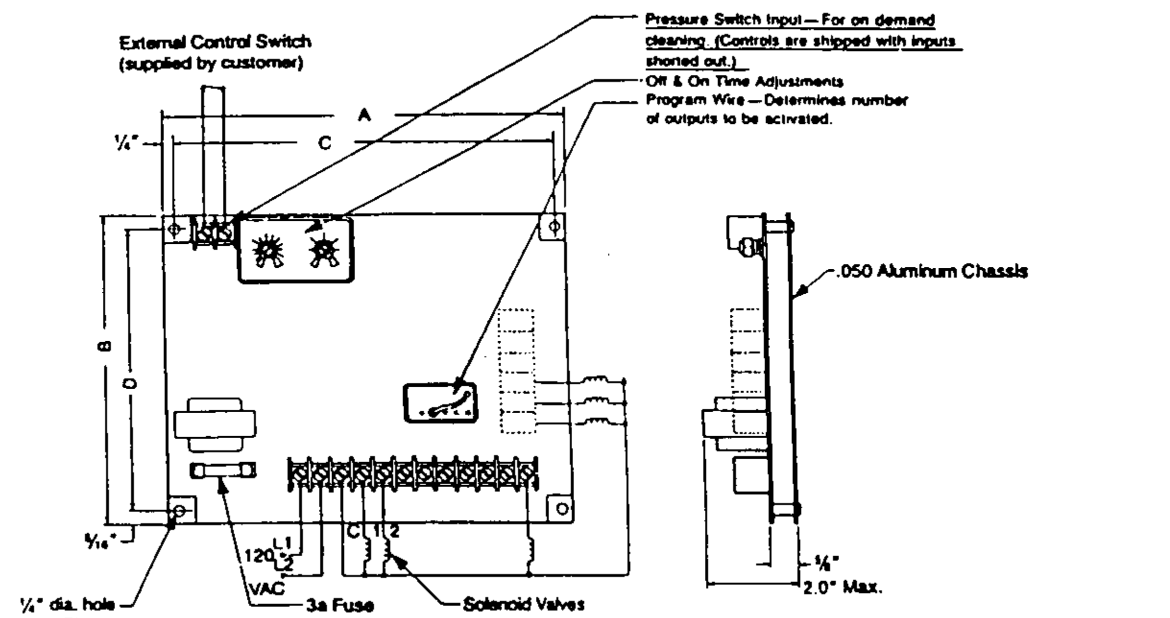
Type: Solid-state switch rated at 200 VA max. per output. Number of outputs to be activated is determined by position of program wire.

Protection:

Transient Voltage: 30 joule varistor
Short Circuit Protection: 3 amp. fuse

Environmental:

Operating Temperature: − 40° to 150°F (− 40°C to 66°C)



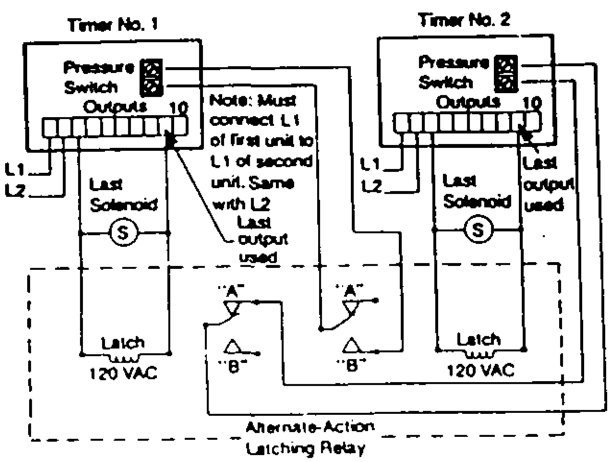
Size And Hook-up Diagram of Dust Collector Controls,
(Exact location of components varies from model to model)

Model	Off Time Sec.	Max. No. of Outputs	Dimensions-In. A	B	C	D	Size of NEMA 4 Enclosure Reqd	Programmable No. of Outputs
DNC-T2003-A10	1.5-30	3	6¾"	4⅞"	6¼"	4¼"	8" x 6" x 3½"	1-3
DNC-T2003-B10	8-180							
DNC-T2006-A10	1.5-30	6	8¾"	6⅞"	8¼"	6¼"	10" x 8" x 4"	2-6
DNC-T2006-B10	8-180							
DNC-T2010-A10	1.5-30	10	8¾"	6⅞"	8¼"	6¼"	10" x 8" x 4"	3-10
DNC-T2010-B10	8-180							
DNC-T2020-A10	1.5-30	20	10¾"	8⅞"	10¼"	8¼"	12" x 10" x 5"	11-20
DNC-T2020-B10	8-180							
DNC-T2032-A10	1.5-30	32	12¾"	10⅞"	12¼"	10¼"	14" x 12" x 6"	17-32
DNC-T2032-B10	8-180							

UL Recognized Component: File #E65038 **CSA Certified** File #LR33434

Accessories:

	Description	Part Number
Enclosure.........	National Controls offers NEMA-4 type enclosures for mounting our controls. These enclosures are made of heavy gauge steel and have a continuous hinge type cover. All seams are continuously welded. The finish is gray hammer-tone enamel inside and out over phosphatized surfaces.	
for T2003........	8" x 6" x 3½"	BOX-A0806-CHNF
for T2006........	10" x 8" x 4"	BOX-A1008-CHNF
for T2010........	10" x 8" x 4"	BOX-A1008-CHNF
for T2020........	12" x 10" x 5"	BOX-A1210-CHNF
for T2032........	14" x 12" x 6"	BOX-A1412-CHNF
Pilot Lamp........	NEMA-4 rated red light	ASL-OORED-NEMA4
On/Off Switch...	NEMA-4 rated switch with legend plate	MSW-ODPST-011



To expand the number of outputs to 64 or less, any two timers can be connected via a dual coil alternate action latch relay as shown.

The output pulse from the last compartment used in timer 1 causes the latching relay to transfer to the "A" position shown, thus stopping timer 1 and starting timer 2. When the last compartment used in timer 2 pulses, the reverse happens as the latching relay transfers to position "B".

Important Notice to Users

Our timers are capable of use in a wide array of devices and in various applications.

Any device or system incorporating a timer should be so designed that, in the event of failure, malfunction or normal wear-out of the timer, the device or system will become inoperative in a manner which will prevent property damage or bodily injury.

CAUTION SENSITIVE CIRCUITRY: Testing and trouble shooting this circuit board with a grounded test instrument or applying any external voltage to pressure switch terminals will cause serious damage to circuit boards components. Failure to comply will void any warranty.

National Controls Corporation

1725 Western Drive
West Chicago, IL 60185
Toll-free 800-323-2593
or in IL 708-231-5900

Some Don'ts:

1. Do not mount controls in high vibration areas without shock mounts.
2. Do not mount controls in areas of high dust or corrosive atmospheres without a protective enclosure.
3. Do not use a converter or inverter for the power source.
4. Do not mount control in high transient voltage are as without an isolation transformer.
5. Do not leave control box door open.
6. Do not allow a local repair shop to repair the controls as we employ some very sophisticated components that could be further damaged. For service call us directly. Toll-free 800/323-2593. In IL 312/932-6900

CAMCO
CLEAN AIR MANAGEMENT CO., INC.

10200 W. 75TH ST., SUITE 100 • SHAWNEE MISSION, KS 66204
PHONE: 913-831-0740 • FAX: 913-831-9271

SAFETY RECOMMENDATIONS

Because this unit may be under pressure, do not attempt to open any device doors or panels while fans or blowers are running. The unit has air hoses and valves with a maximum recommended operating pressure of 100 psig. To eliminate the danger of bursting, care must be taken to insure maximum desired pressure is not exceeded.

Before servicing any portion of the compressed air system, the air supply must be shut off and any pressure relieved.

If your unit is equipped with a discharge auger or an airlock, be sure chain guards are installed before start-up and servicing is attempted only after electrical power is locked out.

While servicing the filter, it is very important that there are no open flames, welding or grinding sparks. Dust laden air could be highly explosive and extreme care must be taken.

Before entering any dust collector:

1. Run cleaning mechanism 20 minutes with the fan off to clean filter bags.
2. Discharge solids from hopper.
3. Shut off compressed air supply and relieve pressure in the header.
4. Lock out electrical power on all rotating equipment.
5. On toxic operation, purge collector housing and install a blank in the inlet duct.
6. Install catwalks and safety cables.
7. Secure access doors in an open position or remove doors
8. Use Buddy system.
9. Wear a respirator.
10. Use common sense.

10200 W. 75TH ST., SUITE 100 • SHAWNEE MISSION, KS 66204
PHONE: 913-831-0740 • FAX: 913-831-9271

ROUTINE MAINTENANCE

A. Inspection

Frequency will vary as widely as there are operating conditions. In general proceed as follows:

1. Daily - Check unit differential pressure.

2. Weekly - Check timer and solenoid valves for function. This usually is only listening to check uniform time in interval between blasts.

3. Monthly - Lubricate fan, rotary valve and screw conveyor. Check seals on latter two for dust loss.

4. Quarterly - On Top Access Units, check for dust accumulation in clean air plenum.

B Repairs

1. Filter bags - Generally replacement, although some applications can be laundered.

2. Solenoid Valves - Repair kits are available if the valve is stuck open or fails to operate.

3. Diaphragm Valves - Repair kits are available if the valve is stuck open or fails to operate due to a ruptured diaphragm.

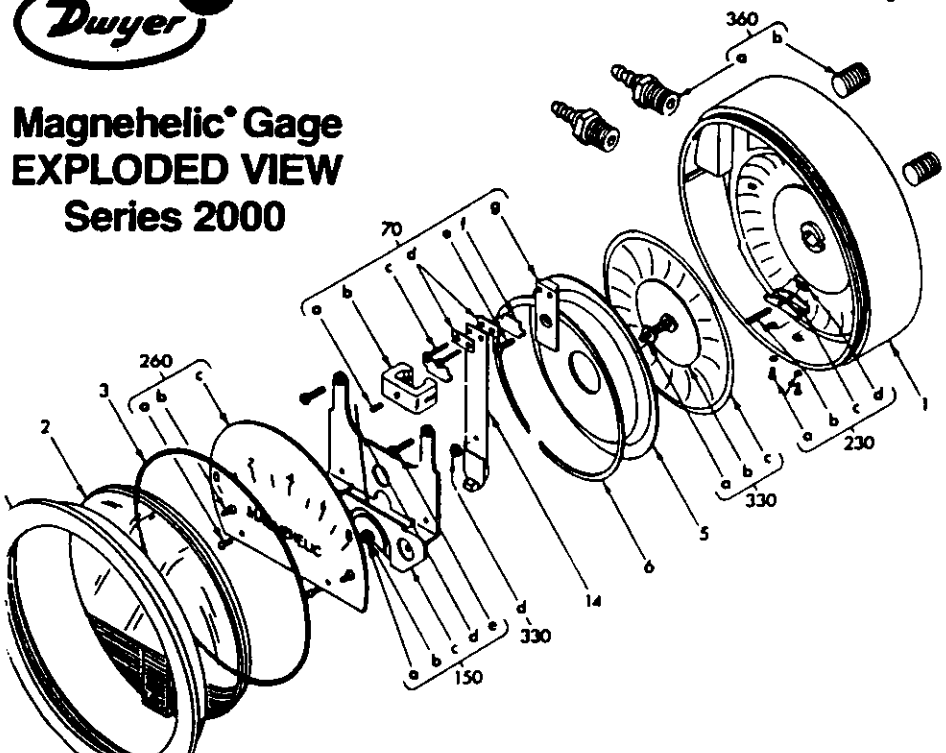
4. Rotary Valves - Usually a matter of periodic seal and blade replacement. More detailed information is supplied with the valve.

5. Screw Conveyors - Periodic replacement of "V" belts and shaft seals. Inspect hanger bearings during filter bag change. Failure will be detected by the squeal.

6. Fans - "v" belt tension and replacement of bearings if running rough. Make sure rotor balance is maintained.

Dwyer

Magnehelic® Gage EXPLODED VIEW Series 2000



1. Case
2. Cover with zero adjust assy.
3. "O" ring seal
4. Bezel
5. Diaphragm sealing plate
6. Retaining ring

70. Range Spring assembly
   a. Clamp set screw
   b. Clamp
   c. Mounting screws (2 req'd)
   d. Clamping shoe (2 req'd)
   e. Clamp plate screw
   f. Spacer (2 req'd)
   g. Clamp plate

14. Range Spring with magnet

150. Wishbone Assembly – consists of:
   a. Front jewel
   b. Locking nut
   c. Wishbone
   d. Pointer
   e. Mounting screws (2 req'd)
   f. Helix assembly (not shown)
   g. Pivots (2 req'd) (not shown)
   h. Rear jewel (not shown)

230. Zero adjust assembly – consists of:
   a. Foot screws with washers (2 req'd)
   b. Adjust screw
   c. Foot
   d. Finger

260. Scale Assembly – consists of:
   a. Mounting screws (2 req'd)
   b. Bumper pointer stop (2 req'd)
   c. Scale

330. Diaphragm Assembly – consists of: (Arbor press needed to install)
   a. Linkage assy., complete
   b. Front plate
   c. Diaphragm
   d. Rear plate (not shown)
   e. Plate washer (not shown)

360. Mounting Hardware Kit
   a. Adapter – pipe plug 1/8" NPT to rubber tubing – (2 req'd)
   b. Pipe plug 1/8" NPT – (2 req'd)
   c. Mounting lug (3 req'd)
   d. Long screw (3 req'd)
   e. Short screw (3 req'd)

Ordering Instructions:

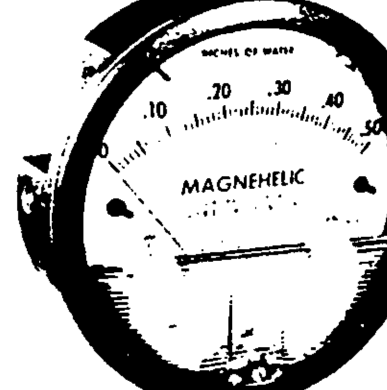
When corresponding with the factory regarding Magnehelic® gage problems, refer to the call-out numbers in this view. Be sure to include model number, pressure range, and any special options. Field repair is not recommended; contact the factory for repair service information.

Litho in U.S.A. 7/88 12-440212-00

OPERATING INSTRUCTIONS and PARTS LIST

Dwyer

Magnehelic® Differential Pressure Gage



SPECIFICATIONS

Dimensions: 4-3/4" dia. X 2-3/16" deep.

Weight: 1 lb. 2 oz.

Finish: Baked dark gray enamel.

Connections: 1/8 N.P.T. high and low pressure taps, duplicated, one pair side and one pair back.

Accuracy: Plus or minus 2% of full scale, at 70°F. (Model 2000-0, 3%; 2000-00, 4%).

Pressure Rating: 15 PSI.

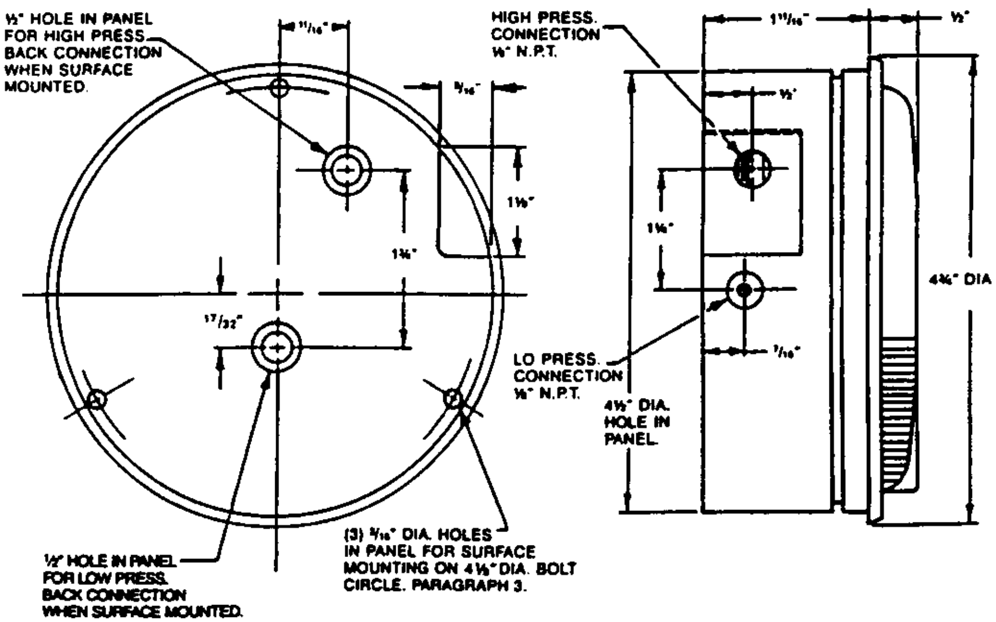
Ambient Temperature Range: 20° to 140°F.

Standard gage accessories include two 1/8" N.P.T. plugs for duplicate pressure taps, two 1/8" pipe thread to rubber tubing adapters, and three flush mounting adapters with screws.

Caution: For use with air or compatible gases only.

For repeated over-ranging or high cycle rates, contact factory.

Hydrogen Gas Precautionary Note: The rectangular rare earth magnet used in the standard gage may not be suitable for use with hydrogen gas since a toxic and explosive gas may form. For hydrogen service, consult the factory for an alternate gage construction.

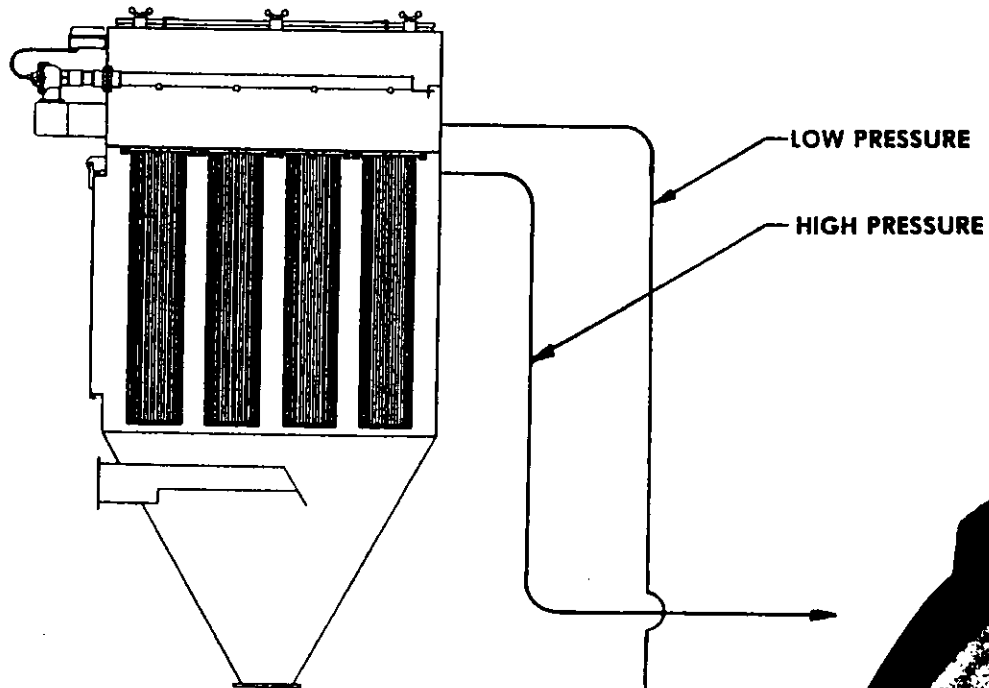


BULLETIN NO. 27

OPERATING INSTRUCTIONS and PARTS LIST

Magnehelic® Differential Pressure Gage

Dwyer



SPECIFICATIONS

Dimensions: 4-3/4" dia. × 2-3/16" deep.
Weight: 1 lb. 2 oz.
Finish: Baked dark gray enamel.
Connections: 1/8 N.P.T. high and low pressure taps, duplicated, one pair side and one pair back.
Accuracy: Plus or minus 2% of full scale, at 70°F. (Model 2000-0, 3%; 2000-00, 4%).
Pressure Rating: 15 PSI.
Ambient Temperature Range: 30° to 140° F.
Standard gage accessories include two 1/8" N.P.T. plugs for duplicate pressure taps, two 1/8" pipe thread to rubber tubing adapters, back mounting stud with two washers and jam nut and three flush mounting adapters with screws.

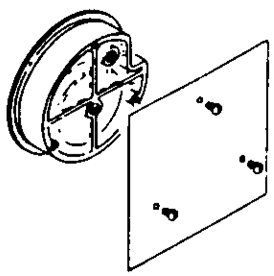
Caution: For use with air or compatible gases only.

MAGNEHELIC® INSTALLATION

1. Select a location free from excessive vibration and where the ambient temperature will not exceed 140°F. Also, avoid direct sunlight which accelerates discoloration of the clear plastic cover. Sensing lines may be run any necessary distance. Long tubing lengths will not affect accuracy but will increase response time slightly. Do not restrict lines. If pulsating pressures or vibration cause excessive pointer oscillation, consult the factory for ways to provide additional damping.

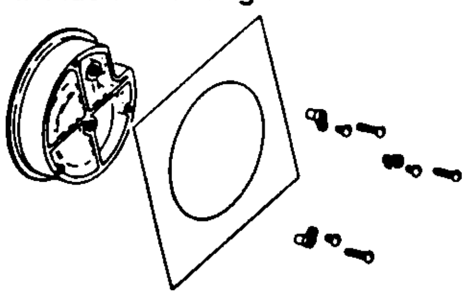
2. All standard Magnehelic gages are calibrated with the diaphragm vertical and should be used in that position for maximum accuracy. If gages are to be used in other than vertical position, this should be specified on the order. Many higher range gages will perform within tolerance in other positions with only rezeroing. Low range Model 2000-00 and metric equivalents must be used in the vertical position only.

3. Surface Mounting



Locate mounting holes, 120° apart on a 4-1/8" dia. circle. Use No. 6-32 machine screws of appropriate length.

4. Flush Mounting



Provide a 4½" dia. opening in panel. Insert gage and secure in place with No. 6-32 machine screws of appropriate length, with adaptors, Part No. 360c, firmly secured in place. To ·int gage on 1¼"-2" pipe, order optional ,) pipe mounting kit.

5. To zero the gage after installation

Set the indicating pointer exactly on the zero mark, using the external zero adjust screw on the cover at the bottom. Note that the zero check or adjustment can only be made with the high and low pressure taps both open to atmosphere.

Operation

Positive Pressure: Connect tubing from source of pressure to either of the two high pressure ports. Plug the port not used. Vent one or both low pressure ports to atmosphere.

Negative Pressure: Connect tubing from source of vacuum or negative pressure to either of the two low pressure ports. Plug the port not used. Vent one or both high pressure ports to atmosphere.

Differential Pressure: Connect tubing from the greater of two pressure sources to either high pressure port and the lower to either low pressure port. Plug both unused ports.

When one side of gage is vented in a dirty, dusty atmosphere, we suggest an A-331 Filter Vent Plug be installed in the open port to keep inside of gage clean.

a. For portable use or temporary installation, use 1/8" pipe thread to rubber tubing adapter and connect to source of pressure with rubber or Tygon tubing.

b. For permanent installation, 1/4" O.D., or larger, copper or aluminum tubing is recommended. See accessory bulletin S-101 for fittings.

MAINTENANCE

Maintenance: No lubrication or periodic servicing is required. Keep case exterior and cover clean. Occasionally disconnect pressure lines to vent both sides of gage to atmosphere and re-zero. Optional vent valves, (bulletin S-101), should be used in permanent installations.

Calibration Check: Select a second gage or manometer of known accuracy and in an appropriate range. Using short lengths of rubber or vinyl tubing, connect the high pressure side of the Magnehelic gage and the test gage to two legs of a tee. Very slowly apply pressure through the third leg. Allow a few seconds for pressure to equalize, fluid to drain, etc., and compare readings. If accuracy unacceptable, gage may be returned to factory for recalibration. To calibrate in the field, use the following procedure.

Calibration:

1. With gage case, P/N 1, held firmly, loosen bezel, P/N 4 by turning counterclockwise. To avoid damage, a canvas strap wrench or similar tool should be used.
2. Lift out plastic cover and "O" ring.
3. Remove scale screws and scale assembly. Be careful not to damage pointer.
4. The calibration is changed by moving the clamp, P/N. 70-b. Loosen the clamp screw(s) and move slightly toward the helix if gage is reading high, and away if reading low. Tighten clamp screw and install scale assembly.
5. Place cover and O-ring in position. Make sure the hex shaft on inside of cover is properly engaged in zero adjust screw, P/N 230-b.
6. Secure cover in place by screwing bezel down snug. Note that the area under the cover is pressurized in operation and therefore gage will leak if not properly tightened.
7. Zero gage and compare to test instrument. Make further adjustments as necessary.

Caution: If bezel binds when installing, lubricate threads sparingly with light oil or molybdenum disulphide compound.

Warning: Attempted field repair may void your warranty. Recalibration or repair by the user is not recommended. For best results, return gage to the factory. Ship prepaid to:

Dwyer Instruments, Inc.
Attn. Repair Dept.
55 Ward St.
Wakarusa, IN 46573

Trouble Shooting Tips:

• *Gage won't indicate or is sluggish.*

1. Duplicate pressure port not plugged.
2. Diaphragm ruptured due to overpressure.
3. Fittings or sensing lines blocked, pinched, or leaking.
4. Cover loose or "O" ring damaged, missing.
5. Pressure sensors, (static tips, Pitot tube, etc.) improperly located.
6. Ambient temperature too low. For operation below 20°F, order gage with low temperature, (LT) option.

• *Pointer stuck-gage can't be zeroed.*

1. Scale touching pointer.
2. Spring/magnet assembly shifted and touching helix.
3. Metallic particles clinging to magnet and interfering with helix movement.
4. Cover zero adjust shaft broken or not properly engaged in P/N 230-b adjusting screw.

We generally recommend that gages needing repair be returned to the factory. Parts used in various sub-assemblies vary from one range of gage to another, and use of incorrect components may cause improper operation or failure. Gages repaired at the factory are carefully calibrated and tested to assure "like-new" operation. After receipt and inspection, we will be happy to quote repair costs before proceeding.

Consult factory for assistance on unusual applications or conditions.

Use with air or compatible gases only.

National Controls
Corporation
Subsidiary of Tolrhelm Corp.
1725 Western Drive
West Chicago, IL 60185

Models DNC-T2003 thru DNC-T2032

Operating Logic:

Input power is applied to the control at all times. For "On Demand" cleaning, closure of isolated control contacts (pressure switch) initiates the "Off" time. At the end of the off time the control energizes solenoid no. 1 to provide a cleaning pulse; it then transfers to the next compartment initiating the off time again. This cycle continues until the control contacts open. The control remembers the last output activated and will activate the next one in line when the control contacts reclose. For "continuous" cleaning the pressure switch terminals should be shorted together. A program wire allows for field selection of number of outputs required.

Specifications:

Time Delay:

On Time: Adjustable from 50 to 500 milliseconds
Off Time: Range A—adjustable from 1.5 to 30 seconds
Range B—adjustable from 8.5 to 180 seconds
Repeatability: ± 3% over temperature and voltage ranges

Input:

Operating Voltage: 105 to 135 volts A.C. 50/60 Hz

Output:

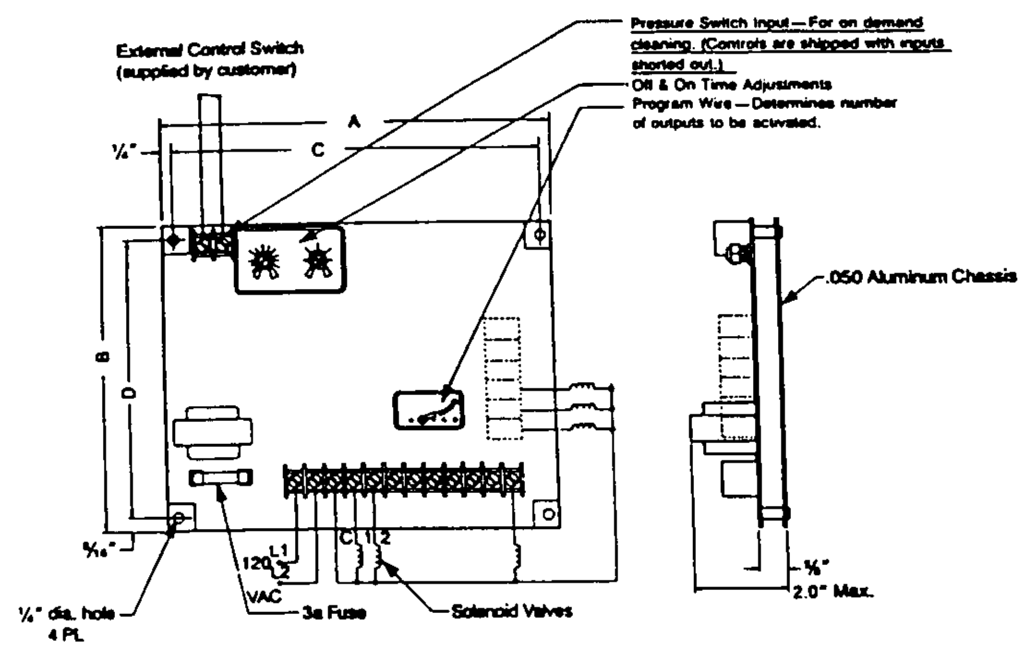
Type: Solid-state switch rated at 200 VA max. per output. Number of outputs to be activated is determined by position of program wire.

Protection:

Transient Voltage: 30 joule varistor
Short Circuit Protection: 3 amp. fuse

Environmental:

Operating Temperature: – 40° to 150°F (– 40°C to 66°C)



Size And Hook-up Diagram of Dust Collector Controls,
(Exact location of components varies from model to model)

Model	Off Time Sec.	Max. No. of Outputs	Dimensions-In. A	B	C	D	Size of NEMA 4 Enclosure Reqd	Programmable No. of Outputs
DNC-T2003-A10	1.5-30	3	6¾"	4⅞"	6¼"	4¼"	8" x 6" x 3½"	1-3
DNC-T2003-B10	8-180							
DNC-T2006-A10	1.5-30	6	8¾"	6⅞"	8¼"	6¼"	10" x 8" x 4"	2-6
DNC-T2006-B10	8-180							
DNC-T2010-A10	1.5-30	10	8¾"	6⅞"	8¼"	6¼"	10" x 8" x 4"	3-10
DNC-T2010-B10	8-180							
DNC-T2020-A10	1.5-30	20	10¾"	8⅞"	10¼"	8¼"	12" x 10" x 5"	11-20
DNC-T2020-B10	8-180							
DNC-T2032-A10	1.5-30	32	12¾"	10⅞"	12¼"	10¼"	14" x 12" x 6"	17-32
DNC-T2032-B10	8-180							

UL Recognized Component: File #E65038
CSA Certified File #LR33434

Installation & Maintenance Instructions

2-WAY DIRECT-ACTING SOLENOID VALVES
NORMALLY OPEN OR NORMALLY CLOSED OPERATION
BRASS OR STAINLESS STEEL CONSTRUCTION – 1/8", 1/4", OR 3/8" NPT

SERIES 8262 8263

Form No.V5256R8

IMPORTANT: See separate solenoid installation and maintenance instructions for information on: Wiring, Solenoid Temperature, Causes of Improper Operation, and Coil or Solenoid Replacement.

DESCRIPTION

Series 8262 and 8263 valves are 2-way direct-acting general service solenoid valves. Valves bodies are of rugged brass or stainless steel. Series 8262 or 8263 valves may be provided with a general purpose or explosionproof solenoid enclosure. Series 8262 and 8263 valves with suffix "P" in the catalog number are designed for dry inert gas and non-lubricated air service.

OPERATION

Normally Open: Valve is open when solenoid is de-energized; closed when is energized.

Normally Closed: Valve is closed when solenoid is de-energized; open when energized.

IMPORTANT: No minimum operating pressure required.

Manual Operation

Manual operator allows manual operation when desired or during an electrical power outage. Depending upon basic valve construction, three types of manual operators are available:

Push Type Manual Operator

To engage push type manual operator, push stem at base of valve body upward as far as possible. Valve will now be in the same position as when the solenoid is energized. To disengage manual operator, release stem. Manual operator will return to original position.

Screw Type Manual Operator

To engage screw type manual operator, rotate stem at base of the valve body clockwise until it hits a stop. Valve will now be in the same position as when the solenoid is energized. To disengage, rotate stem counterclockwise until it hits a stop.

⚠ CAUTION: **For valve to operate electrically, manual operator stem must be fully rotated counterclockwise.**

Stem/Lever Type Manual Operator

To engage manual operator, turn stem/lever clockwise until it hits a stop. Valve will now be in the same position as when the solenoid is energized. To disengage manual operator, turn stem/lever counterclockwise until it hits a stop.

⚠ CAUTION: **For valve to operate electrically, manual operator stem/lever must be fully rotated counterclockwise.**

Flow Metering Devices

Valves with suffix "M" in catalog number are provided with a metering device for flow control. Turn stem to right to reduce flow; left to increase flow.

INSTALLATION

Check nameplate for correct catalog number, pressure, voltage, frequency, and service. Never apply incompatible fluids or exceed pressure rating of the valve. Installation and valve maintenance to be performed by qualified personnel.

Note: Inlet port will either be marked "I" or "IN". Outlet port will be marked "2" or "OUT".

Future Service Considerations.

Provision should be made for performing seat leakage, external leakage, and operational tests on the valve with a nonhazardous, noncombustible fluid after disassembly and reassembly.

Temperature Limitations

For maximum valve ambient and fluid temperatures, refer to charts below. Check catalog number, coil prefix, suffix, and watt rating on nameplate to determine the maximum temperatures.

Wattage	Catalog Number, Coil Prefix	Coil Class	Max. Ambient Temp. °F	Max. Fluid Temp. °F
6, 10.5, 12.4	none, DA or S	A	77	180
6,10.5 12.4	DF, FT or SF	F	125	180
6,10.5, 12.4	HT	H	140	180
9,10.7	none, DP or SP	F	77	180
9.7	none, FT or HT	A, F or H	77	120
11.2	none, FT or HT	A, F or H	77	150
16.7	none, DP or SP	F	77	200
17.1	none, KP SP or SD	F	125	180
17.1	HB, KB SS or SV	H	140	180

Catalog Nos.8262B200 and 8262 C200 AC construction only and Catalog Nos.8262B214 and 8262 D200 AC and DC construction are limited to 140°F fluid temperature.

Valves with Suffix V or W that are designed for AC service and normally closed operation are for use with No. 2 and 4 fuel oil service. These valves have the same maximum temperatures per the above table except Suffix W valves are limited to a maximum fluid temperature of 140°F.

Listed below are valves with Suffix V in the catalog number that are acceptable for higher temperatures.

Catalog Number Coil Prefix	Max. Ambient Temp.°F	Max. Fluid Temp.°F
FT8262, HB8262 FT8263, HB8263 8262G, 8263G	125	250*
HT or HB 8262G HT or HB 8263G	140	250

*The only exception is the 8262G and 8263G series (Class F coil) at 50 Hertz rated 11.1 and 17.1 watts are limited to 210°F fluid temperature.

Positioning

This valve is designed to perform properly when mounted in any position. However, for optimum life and performance, the solenoid should be mounted vertically and upright to reduce the possibility of foreign matter accumulating in the solenoid base sub-assembly area.

ASCO Valves Automatic Switch Co. 50-60 Hanover Road, Florham Park, New Jersey 07932

OPERATING INSTRUCTIONS AND PARTS LIST

Dwyer

PHOTOHELIC® PRESSURE SWITCH/GAGE*

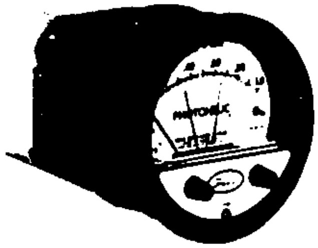
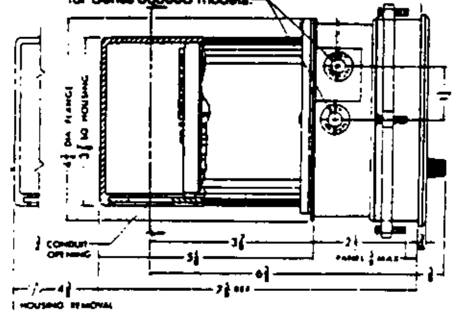
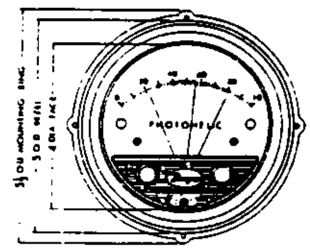


Figure 1 Series 3000 Photohelic® Switch/Gage.

1/8" NPTM pressure connections. Single high pressure connection for Series 36000S models.





4-13/16" (122 mm) dia. hole required for panel mounting.

NOTE: Detailed dimension drawings are available from our Customer Service Dept. for PHOTOHELIC® switch/gages as installed in two optional enclosures. For weatherproof housing, request no. 13-700132-00. For explosion-proof housing, request no. 13-700113-01.

The Photohelic® Switch/Gage is a very versatile, precise pressure switch combined with the time-proven Magnehelic® pressure gauge. Models are available with one or two phototransistor actuated relays. Gage reading is unaffected by switch operation. Easy to adjust set points have knob controls. Applied pressure and switch set points are fully visible at all times. Deadband is one pointer width — less than 1% of full scale. Double-pole double-throw relays can be easily interlocked to provide variable deadband control. For positive, negative or differential pressures; single positive pressure only on 36000S models. Full scale ranges available from 0-.25 in W.C. to 0-6000 psig.

PHOTOHELIC SENSING — HOW IT WORKS

In a typical control application, the Photohelic switch/gage controls between high and low pressure set points. When pressure changes, reaching either set point pressure, the beam from an LED to the limiting phototransistor will be cut off by the helix-driven light shield. The resulting signal change is electronically amplified to actuate its DPDT slave relay and switching occurs. Dead band between make and break is 1% of full scale or less — just enough to assure positive, chatter-free operation.

*Patent No. 3,862,416

SPECIFICATIONS

1. Dimensions: 5" Diameter × 8¼" Length.
2. Weight: 4 Lbs. 12 oz.
3. Gage Bezel: 5" O.D. × 4" I.D. across gage face. Fits panels up to 5/8" thick. 4¹³/₁₆" diameter hole required. Optional, 122 mm.
4. Gage Connections: 1/8" N.P.T.
5. Finish: Baked Dark Gray Epoxy Enamel.
6. Pressure Rating: -20" Hg. to 25 psig (-.67 to 1.7 bar). MP option; 35 psig (2.4 bar), HP option; 80 psig (5.5 bar). 36003S-36010S; 150 psig (10.3 bar). 36020S and higher; 1.5 × full scale pressure.
7. Ambient Temperature Range: 20 Deg. to 120 Deg. F standard. Low temperature model available.
8. Standard Accessories: Two (2) brass 1/8" N.P.T. to rubber tubing adapters, two (2) 1/8" N.P.T. pipe plugs, mounting ring, snap ring and screws for flush panel mounting. Instructions.
9. Contact Rating: 10A @ 24 VDC / 120VAC; 6A @ 240VAC.
10. Power Required: 117 V., 50, 60 Hz. A.C., 5 watts average (220V. and 240V. units also available).
11. Conduit Opening: 3/4" Conduit.
12. Accuracy: 2 percent of full scale (3% on -0 and 4% on -00 Ranges) at 70 Deg. F.
13. Series 3000 models are for use with air or compatible gases. Series 36000S models are for use with compatible gases and liquids.

For repeated over-ranging or high cycle rates, refer to factory.

DWYER INSTRUMENTS, INC.
P. O. BOX 373 MICHIGAN CITY, INDIANA 46360, U.S.A.
Telephone 219/879-8000
Fax 219/872-9057

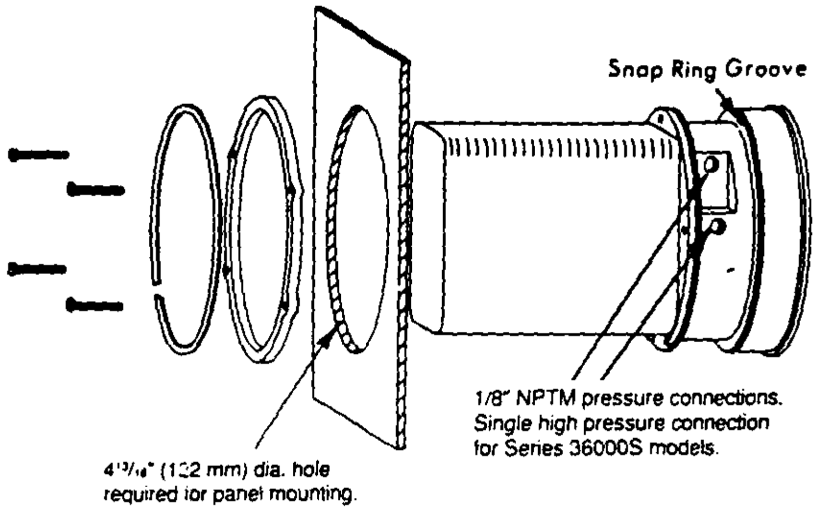


Figure 2
Through Panel Mounting

INSTALLATION

1. **Location:** All parts of the Dwyer PHOTOHELIC® pressure switch/gage are ruggedly constructed and will stand a moderate amount of vibration, physical shock, and handling. Normal care in handling and installation is all that is required. In cases where instrument panel vibration is severe, the panel should be spring mounted or the amplifier-relay unit mounted remotely on a more stable surface.

   Select a location where the ambient temperature will not exceed 120°F. Pneumatic pressure sensing lines may be run any necessary distance. For example, 250 foot sensing lines will not affect accuracy but will damp the reading slightly. Do not restrict lines. If pulsating pressure or vibration causes excessive pointer oscillation or relay chatter, consult factory for additional damping means. See accessory Bulletin S-101 for fittings.

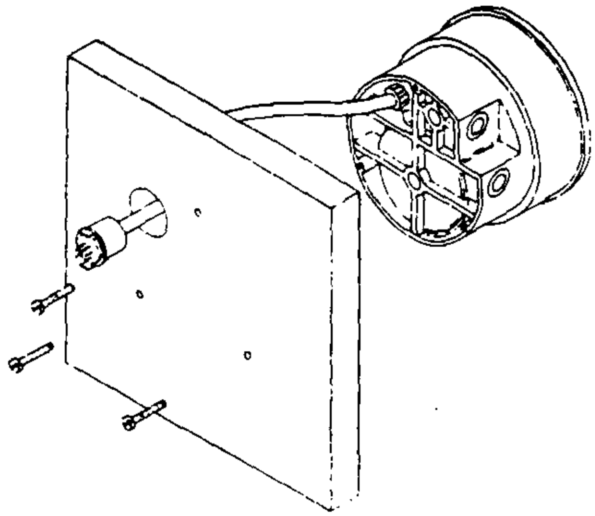
2. **Position:** The PHOTOHELIC® may be mounted as an integral package or the amplifier-load relay assembly and housing may be mounted remotely from the indicating gage-phototransistor unit. Extention cords with 7 pin plugs and receptacles are available from Dwyer for interconnection of the two units.

   The unit may be mounted in any desired position, scale vertical or horizontal, without affecting its accuracy, but must be rezeroed if position is changed from horizontal to vertical or vice versa. The -0 and -00 models must be mounted with the scale vertical.

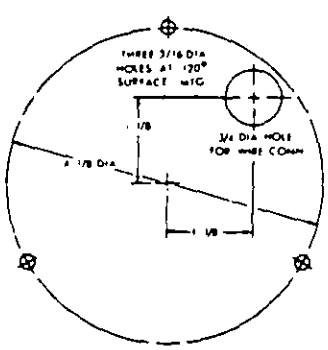
3. **Mounting:** The PHOTOHELIC® is normally mounted before making electrical connections, as the electrical enclosure is independent of the mounting means and may be removed at any time.

   A. **Panel Mounting:** Normal mounting is flush or through panel as shown in Fig. 2. Be sure to allow 4-3/8" extra space behind the unit for electrical enclosure removal. Make a single $4\frac{13}{16}$" diameter hole in the panel. Insert the entire PHOTOHELIC® unit from the front, then slip on the mounting ring and snap ring from the rear. Seat the snap ring in its groove, back up the mounting ring against snap ring and tighten the four (4) 2" No. 6-32 clamp screws provided. If behind panel space is critical, the amplifier-relay unit can be mounted remotely. See the Remote-Relay Mounting Instructions for details.

B. Gage Mountings with Relays Remote: Where it is desirable to mount the amplifier-relay unit separate from the gage-phototransistor unit, the gage may be mounted either as shown in Fig. 2 (except less amplifier-relay portion) or surface mounted as shown in Fig. 3A. Use the layout shown in Fig. 3B to locate holes. The complete package cannot be surface mounted.



A
Surface Mounting

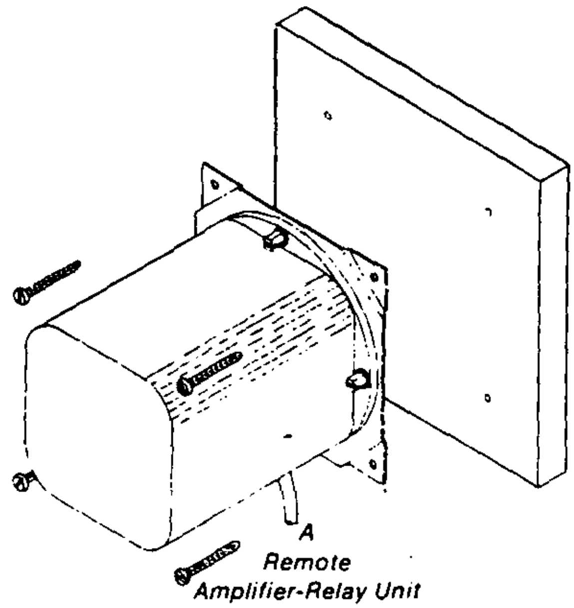


B
Hole Layout (Front)

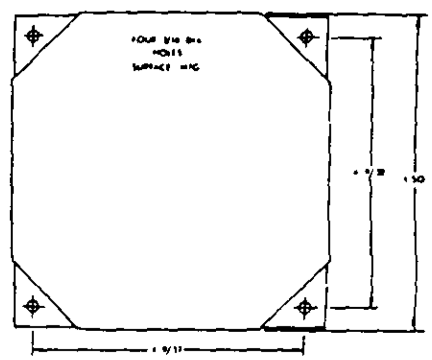
Figure 3

C. Remote Relays Mounting: The amplifier — relay unit may be mounted remotely as shown in Fig. 4A. Use the hole layout as shown in Fig. 4B for this option.

Additional mounting information for special requirements is available from the factory.



A
Remote
Amplifier-Relay Unit



B
Hole Layout

Figure 4

4. Pneumatic Connections & Zeroing: After installation but before making pressure connections, set the indicating pointer exactly on the zero mark, using the zero adjust screw located at the bottom of the front cover. Note that this adjustment can only be made with the high and low pressure taps both open to atmosphere.

Connect the high and low pressure taps to positive, negative, or differential pressure sensing points. Use ¼" diameter metal or other instrument tubing and ⅛" N.P.T. adaptors at the Dwyer PHOTOHELIC® pressure switch gage. Adaptors for rubber or soft plastic tubing are furnished with the instrument for use where this type of connection is preferred.

If the PHOTOHELIC® is not used to sense differential pressure, one of the pressure taps must be left open to atmosphere. This will allow the reference pressure to enter. In this case, installation of a Dwyer No. A-331 Filter Plug or similar fitting in the reference pressure tap is recommended to reduce the possibility of dust entering the instrument.

NOTE: If the Photohelic switch/gage is over pressured, pointer may "jump" from full scale back to zero and remain there until the excess pressure condition is relieved. Users should be aware of possible false zero pressure indications under this condition.

ELECTRICAL CONNECTIONS

1. **Cover:** The amplifier-relay unit has an easy to remove housing. Remove the three (3) screws as shown in Fig. 5 and slide the housing off. Make all the electrical connections before reinstalling and refastening the housing.

2. **Conduit:** Electrical access to the connection box portion of the relay housing is by bottom opening for ¾" conduit. Use of flexible conduit is recommended. It should be supported from the panel or other suitable surface to prevent the wiring system from exerting undue strain on the instrument. See Fig. 5.

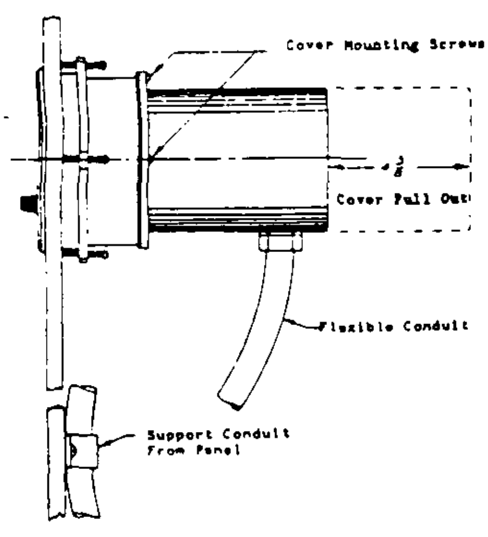
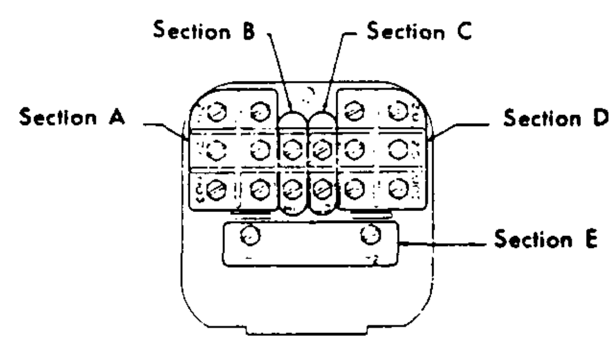


Figure 5
Mounting Details

3. **Terminal or Connection Board Layout:** In Fig. 6. "Terminal Board," **Section A** contains the connections for the load or slave relay actuated by the high or right set-point. This relay is a double pole, double throw type. The two top connections are normally closed, the two middle connections are normally open, and the bottom connections are the common pair. The relay is in its normal or De-Energized position when pressure is below the right hand set-point.

Section D is exactly the same as **Section A** except that its load or slave relay is controlled by the low or left set-point. The De-Energized position is below the left hand pointer set-point.

Section B contains the external connections to the holding coil circuit for the high or right set-point relay and **Section C** contains similiar connections for the low or left set-point relay. The function and use of these connections varies somewhat depending on the circuit style of the instrument. See paragraphs 5 and 6 for details



CAUTION: Do not apply electrical current to terminals in sections B and C.

Figure 6
Terminal Board

Section E contains the power connections for the control unit transformer primary. The transformer in turn supplies reduced voltage power for the LED, phototransistor, amplifier unit, and load relay pull in and holding coils. Connections must always be made to this section in order to put the unit in operation. Standard units are designed for 117 V.A.C. input to the transformer. Special units are also available for other voltages.

Separate Ground Wire attachment is provided for by a No. 6-32 screw on the mounting bracket near the conduit opening. An additional ground wire connection is located on the side of the gage body for use when the amplifier-relay unit is mounted remotely.

Single Set-Point instruments are furnished with the right or high set-point components and circuitry in place. These are connected to Sections A and B of the terminal board. The left or low set-point components are omitted.

4. **Circuit Style:** The PHOTOHELIC® is available with several factory installed optional internal circuits. They are identified as to style by a label shown in Fig. 7. This label is mounted prominently on the terminal board of each instrument. The letter H denotes a circuit in which the relay can be made to latch or remain energized after pressure increase to its set-point.

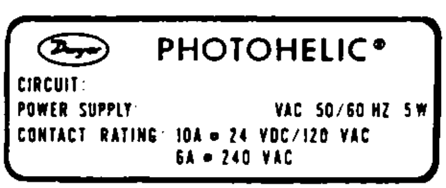


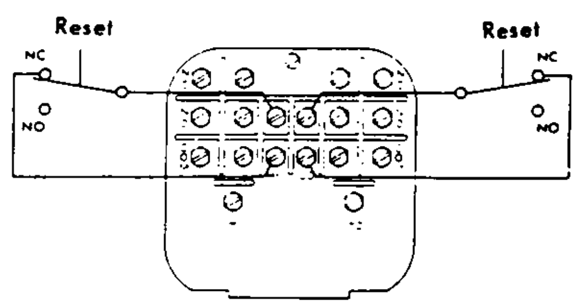
Figure 7
Circuit Label

The letter L denotes a circuit in which the relay can be made to latch or remain de-energized after pressure decrease to its set-point. Two letters are required to fully identify a dual set-point unit. Thus, circuit style HH, which is standard, is a dual set-point circuit which has provisions for latching on pressure increase to either set-point. Single relay units are identified by the letters SR followed by H for the standard unit or L for the special low latch unit. Units for use with other than standard 117 VAC will be so indicated on the label.

5. **Dual Set Point Automatic Reset:** Circuit Style HH is used for simple on-off switching applications. To place in service, connect load circuits to the appropriate terminals in Section A (Fig. 6) for the right set-point and Section D for the left set-point. Note that the N.O. contacts are open when the gage pressure pointer is to the left of the set-point pointers. No connections are necessary in Sections B and C. Make external ground connections as required and connect power to Section E for the control unit. To use circuit style LL for automatic reset, a jumper wire must be installed between the upper and lower terminals in sections B and/or C.

6. **Dual Set Point Manual Reset:** Circuit Style HH may also be used for manual reset applications where it is desired to have maintained contact on either relay following pressure increase above its set-point. Load or signal connections are made to the appropriate terminals in Sections A and D (as in paragraph 5 above). Connect terminals in Sections B and C through normally closed switches or push buttons as shown in Fig. 8. Use of "dry-circuit" type switches such as Dwyer Part No. A-601 with paladium, gold, etc. or rotary wiping action type contacts is recommended. Make external ground connections as required and connect power to Section E for the control unit.

Circuit style LL is used for manual reset applications which require that contact be maintained following pressure decrease below the set-point. Load connections are made to the appropriate terminals in Sections A and D. A normally open type manual reset switch such as Dwyer Part No. A-601 is connected to the terminals in sections B and C. The circuit must be "armed" by momentarily closing the switch while the black pointer is to the right of the set-point. From that point on, the circuit will latch on pressure decrease below the set-point and remain latched on pressure increase until manually reset with the optional switch.



CAUTION: Do not apply electrical current to terminals in sections B and C.

Figure 8
Manual Reset with Circuit HH

7. **Dual Set Point Automatic and Manual Reset Combinations:** Circuit style HH may be used with either set-point wired and operating as in paragraph 5 above and other set-point wired and operating as in paragraph 6.

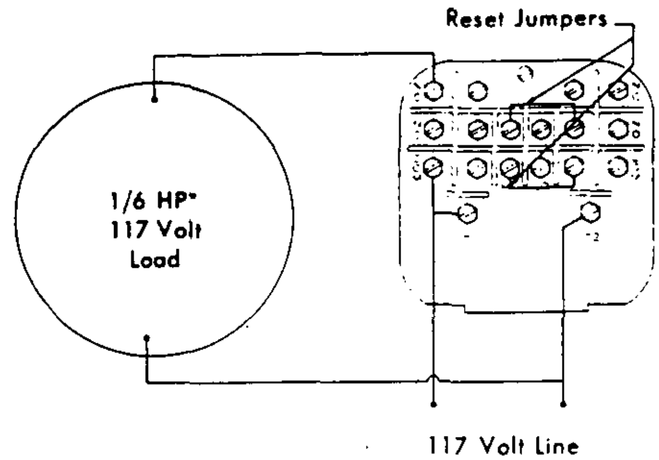
8. **High Low Limit Control — Dual Set-Point:** Circuit Style HH may be used to control fans, dampers, pumps, etc., between the set-points of a PHOTOHELIC.® To accomplish this, use one set-point relay to reset the other as shown in the wiring diagram Fig. 9. In this typical application, the load (for instance a fan) would be connected to the N.C. contacts of the right set-point relay, Section A (Fig. 6). On pressure rise to the right set-point, its relay would pull in and hold even though pressure might then fall below that set-point. If the pressure continued to fall to the left set-point, its relay would automatically be DE-ENERGIZED, return to its normal position and in so doing, open the holding coil circuit from Section B (Fig. 6). The right set-point relay would thus be reset and the cycle could repeat.

9. **Dual Set-Point Special Purpose Circuits:** Circuit Style LL may be used where manual reset following maintained contact on pressure decrease to either set-point is desired. Circuit Styles HL and LH are combination units. For special combinations of features, special units, and detailed instructions regarding their use, consult the factory.

10. **Single Set-Point PHOTOHELIC:®** The single set-point PHOTOHELIC® is furnished with the right set-point only. Terminals in Section A and B (Fig. 6) are connected to this relay. Circuit Style SRH is wired for automatic reset as in paragraph 5 above. Manual reset is accomplished by adding a normally closed reset switch or push button to the circuit as described in paragraph 6 above.

11. **Single Set-Point Special:** Manual reset after actuation on falling pressure can be obtained by using Circuit Style SRL. Consult the factory for special units and detailed instructions regarding their use.

12. **Placing in Service:** In normal operation each relay is de-energized when the pressure applied to the instrument is below its set-point. Special low-latching units will ordinarily have to be reset before placing on the line in normal operation.



**Note: For larger motors, use the Photohelic® in a maintained contact, 117 Volt Control or Push Button Circuit of the motor starter.*

Figure 9
High-Low Limit Control
(Circuit HH)

13. **Failure Mode:** The PHOTOHELIC® circuit design provides certain protection in the event of a loss of pressure or electrical power. In either case, both relays will de-energize, returning to their normal "zero pressure" state. The exceptions to this are models with center zero ranges. Because the relays on all standard models are always energized when the indicating (black) pointer is to the right of their respective set points, the relay action on loss of pressure will depend on set-point position, since either of them could be located to the left of zero. As an example: if the left pointer were set at -2 in. w.c. and negative pressure was -3 in. w.c., a loss of that pressure would allow the black pointer to return to the center and thus cause the low set-point relay to energize.

If the LED should burn out, only the left-low relay will de-energize. The right-high relay will react as if pressure were above its set-point and will remain energized even though pressure might be below that setting. In this situation, only termination of electrical power will allow the right-high relay to de-energize.

MAINTENANCE AND SERVICE

Dwyer PHOTOHELIC® Switch/Gages are precision instruments, expertly assembled and calibrated at the factory. They require no lubrication or periodic servicing. If the interior is protected from dust, dirt, corrosive gases and fluids, years of trouble-free service may be expected. Zero adjustment should be checked and reset occasionally to maintain accuracy. Any repairs necessary to either the Dwyer Magnehelic® pressure gage or the electronic components should be performed by a trained instrument mechanic. In most cases, this is best accomplished by returning the complete PHOTOHELIC® Switch/Gage to the Dwyer factory.

PHOTOHELIC® PRESSURE SWITCH/GAGE

MODELS AND RANGES

Model Number	Range, Inches of Water	Minor Div.
3000-00	0- 25	005
3000-0	0- 50	01
[illegible]	0-1 0	02
3002	0-2 0	05
[illegible]	0-3 0	10
3004	0-4 0	10
3005	0-5 0	10
3006	0-6 0	20
3008	0-8 0	20
3010	0-10	20
3015	0-15	50
3020	0-20	50
3025	0-25	50
3030	0-30	1 0
3040	0-40	1 0
3050	0-50	1 0
3060	0-60	2 0
3080	0-80	2 0
3100	0-100	2 0
3150	0-150	5 0

Model Number	Range, Zero Center Inches of Water	Minor Div.
3300-0	.25-0-.25	.01
3301	.5-0-.5	02
3302	1-0-1	.05
3304	2-0-2	.10
3310	5-0-5	20
3320	10-0-10	.50
3330	15-0-15	1 0

Model Number	Range PSIG	Minor Div. PSIG
3201	0-1	.02
3202	0-2	.05
3203	0-3	.10
3204	0-4	.10
3205	0-5	.10
3210	0-10	.20
3215	0-15	.50
3220	0-20	.50
3230	0-30	1.0
36003S	0-30	1 0
36006S	0-60	2.0
36010S	0-100	2.0
36020S	0-200	5.0
36030S	0-300	10
36060S	0-600	20
36100S	0-1000	20
36300S	0-3000	100
36600S	0-6000	200

Dual Scale Air Velocity Units*		
Model Number	Range, Inches of Water	Range, Air Velocity FPM
3000-00AV	0- 25	300- 2000
3000-0AV	0- 50	500- 2800
3001-AV	0-1 0	500- 4000
3002-AV	0-2 0	1000- 5600
3010-AV	0-10	2000-12500

*For use with pitot tube

Model Number	Range, MM of Water	Minor Div. MM
3000-6MM	0-6	20
3000-10MM	0-10	50
3000-25MM	0-25	.50
3000-50MM	0-50	1 0
3000-80MM	0-80	2.0
3000-100MM	0-100	2.0

Model Number	Range, Zero Center MM of Water	Minor Div. MM
3300-20MM	10-0-10	.50

Model Number	Range, CM of Water	Minor Div. CM
3000-15CM	0-15	.50
3000-20CM	0-20	50
3000-25CM	0-25	.50
3000-50CM	0-50	1.0
3000-80CM	0-80	2.0
3000-100CM	0-100	2 0
3000-150CM	0-150	5.0
3000-200CM	0-200	5.0
3000-250CM	0-250	5.0
3000-300CM	0-300	10.0

Model Number	Range, Zero Center CM of Water	Minor Div. CM
3300-4CM	2-0-2	.10
3300-10CM	5-0-5	.20
3300-30CM	15-0-15	1.0

Model Number	Range, Pascals	Minor Div. Pascals
3000-60Pa	0-60	2.0
3000-125Pa	0-125	5.0
3000-250Pa	0-250	5 0
3000-500Pa	0-500	10.0
3000-750Pa	0-750	25.0

Model Number	Range, Zero Center Pascals	Minor Div. Pascals
3300-250Pa	125-0-125	5.0
3300-500Pa	250-0-250	10.0

Model Number	Range Kilo-pascals	Minor Div. Kilo-pascals
3000-1kPa	0-1.0	02
3000-1.5kPa	0-1.5	05
3000-2kPa	0-2.0	05
3000-3kPa	0-3.0	10
3000-4kPa	0-4.0	10
3000-5kPa	0-5.0	.10
3000-8kPa	0-8 0	20
3000-10kPa	0-10	.20
3000-15kPa	0-15	.50
3000-20kPa	0-20	.50
3000-25kPa	0-25	.50
3000-30kPa	0-30	1.0

Model Number	Range, Zero Center Kilo-pascals	Minor Div. Kilo-pascals
3300-1kPa	.5-0-.5	02
3300-3kPa	1 5-0-1 5	10

Note: The Photohelic® pressure switch/gage may be used in an Underwriters Laboratories approved industrial control panel if the usage conforms to U/L specifications for the acceptance of unlisted components.

Control Technology Specifications
Emission Point 3
Separator Dust Collector Vent

Control Equipment:	**Pulse Jet Fabric Filter**
Manufacturer:	**Z&Z Conveying**
Model #:	**CF 49 39(32)-20**

Z-Z Conveying Technology Inc.

Separation Technologies
Needham, MA

Proposal 99-8-1723rev.1
August 23rd. 1999

PROPOSAL

Item #1 Separator Dust Collection

Top Access Dust Collector

Model No.	64 – 08(6)-20 TA
Application	Nuisance Venting
Gas Volume	4000 acfm
Gas Temperature	140 Deg. F max
Location	Outdoors
Product Handled	Fly Ash Dust
Inlet Loading	20 gr./acf.
System Design	Vacuum
Performance Guarantee	35 mg./cu. m. in the exhaust air

Equipment Specification

Drawing Number	To follow
Filter Area	784
Air/Cloth Ratio	5.1 : 1.0
Bag Type	16 oz. polyester composite 5 7/8" dia. x 8 Ft.
Bag Number	Sixty four (64)
Venturies & Cages	Carbon Steel
Plenum Access Door	4'-0" x 1'-6" hinged and clamped
Hopper Access	1' – 6" Sq.
Plenum Material	11 ga. hrs. all welded
Housing Material	11 ga. hrs.
Hopper Material	10 ga. hrs. all welded
Diaphragm Valves	1"
Solenoid Valve	NEMA 4
Solid State Timer	NEMA 4 encl. c/w Photohelic gauge/switch.
Service Platform	Included
Ladder	Included
Support Legs	Included
Painting	Prime & 1 coat of gray enamel

Tropical

Z-Z Conveying Technology Inc.

Separation Technologies
Needham, MA

Proposal 99-8-1723rev.1
August 23rd. 1999

Item # 2

Exhaust Fans Model No. IE13 arrg't 9 c/w:

- Heavy Duty bearings
- V-Belt Drive
- OSHA Belt Guard
- 15 Hp. motor TEFC hi. eff 460/3/60 1,800 rpm.
- Inlet flange c/w flex conn.
- Outlet flange
- Outlet volume control damper c/w quadrant

Rating Present : 4000 acfm. @ 9" sp. @ 140 deg. F max.
2014 rpm. 9.79 bhp. at cond.

Item # 3

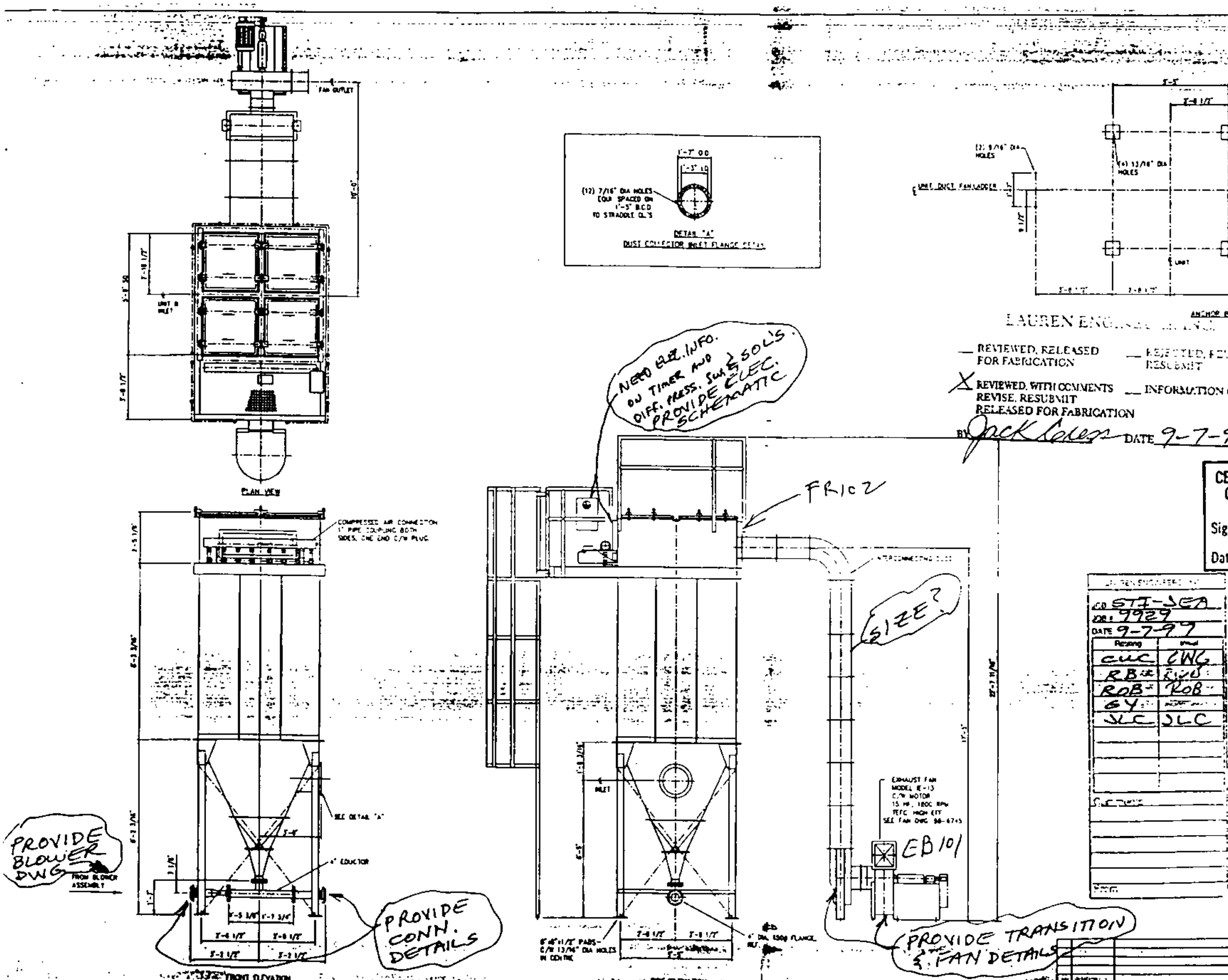
One (1) only – Blower packages size for 320 cfm. at 8 psig. cons. of:

- Inlet filter silencer
- Inlet silencer
- Blower (1,850 rpm. 15 bhp.)
- 20 hp. motor TEFC hi. eff. 460/3/60 1,800 rpm.
- V-Belt drive
- OSHA belt guard
- Elevated support frame
- Exhaust silencer
- Pressure relief valve
- Pressure gauge
- Check valve
- Flex conn.

Blower supplied in one complete ass'y.

Item # 4

4 " dia. eductors c/w flanges and venturi tail and nozzle made of Ni-Hard



LAUREN ENGINEERS, INC.

— REVIEWED, RELEASED FOR FABRICATION
— REJECTED, REVISE, RESUBMIT
X REVIEWED, WITH COMMENTS REVISE, RESUBMIT RELEASED FOR FABRICATION
— INFORMATION ONLY

BY Jack Coles DATE 9-7-99

RECEIVED
SEP 07 1999
LAUREN ENGINEERS, INC.

CERTIFIED FOR INSTALLATIONS AND CONSTRUCTION PURPOSES ONLY

Signed Jozy Jlet
Date Aug 30/99

CO	STI-SEA
ORD	7929
DATE	9-7-99
Reviewing	Issued
CWC	CWG
RB	RJD
ROB	ROB
GY	
JLC	JLC

FR102
EB101

NOTES:
1. ELECTRICAL TOTALLY ENCLOSED NEMA 4
2. POWER REQ'D - SOLENOIDS & TIMER 120-1-60 - FAN MOTOR 460-3-60
3. COMPRESSED AIR REQ'D 6 SCFM AT 80 PSIG
4. COMPRESSED AIR SUPPLY TO BE CLEANED AND FREE OF OIL AND WATER AT ALL TIMES.
5. PAINT ONE COAT OF PRIMER INTERIOR & EXTERIOR EXTERIOR ONLY ONE COAT OF MACHINERY GREY ENAMEL
6. TOTAL WEIGHT 3200 LBS
7. UNIT SHIPPED IN ONE COMPLETE ASSEMBLY EXCEPT FILTER ELEMENTS AND LADDER SHIPPED LOOSE FOR FIELD INSTALLATION BY OTHERS.

IS THIS PAINT ADEQUATE FOR SALT AIR ENVIRON.?

Z-Z CONVEYING TECHNOLOGY INC.
CONCORD, ONTARIO

GENERAL ARRANGEMENT OF DUST-COLLECTOR
MODEL 64-08(6)-20 TRD. C/W EDUCTOR & EXHAUST FAN
SEPERATION TECHNOLOGIES INC. P.O. # 30848
C/O ST. JOHNS RIVER POWER PARK

N.T.S.	DRD	
AUG 26/99	JJ	PD-3378

Z-Z Conveying Technology Inc.

OWNER'S MANUAL

PULSE - JET
DRY DUST COLLECTOR
SIDE BAG REMOVAL

TABLE OF CONTENTS

GENERAL DESCRIPTION 1

ASSEMBLY INSTRUCTIONS 2

TREORY OF OPERATION 3

START-UP PROCEDURES 7

TROUBLE SHOOTING 8

MAINTENANCE 12

GENERAL DESCRIPTION

A. Introduction

This manual provides operation and maintenance instructions for the Pulse Jet Dry Dust Collector Units.

B. Description

The Pulse Jet unit is a continuous self-cleaning dust filter capable of removing dust particles as small as sub-micron size from gaseous streams. High dust collecting efficiency is maintained under continuous operating conditions without the use of internal moving parts or rapping mechanisms. Versatile application and simplicity of operation are inherent design features.

The collector (Figure 4) is divided into two dust tight compartments by the tube sheet, (D). The lower compartment is called the housing, (M). The housing contains the filter bags, (A). The filter bags fit around and are supported by wire retainers, (B). The filter bags and wire retainers, as units, are clamped to special "venturi" shaped nozzles, (E), which are fastened to the tube sheet and which extend into the bag/retainer assemblies.

The filter bags are fabricated from material suitable for the temperature, moisture and resistance characteristics of the gas stream. Special coating treatments are available to increase collection efficiency. Untreated bags are preferred when the treatment is harmful to the product.

The upper compartment is called the Plenum, (Q). The plenum houses the blowtubes, (F), supports the solenoid valves, (J), diaphragm valves, (K), and compressed air manifold, (L), and provides an exhaust outlet, (R), for the filtered gas. The blowtubes, with orifice nozzles, (G), are located above each row of filter bags such that the orifice nozzles are directly above the throat of each venturi in that row.

The collector housing is designed to accept a hopper, (O). The hopper usually provides and inlet for the dust-laded gases and an outlet for the collected dust. The hopper outlet is adaptable to airlock, slide gate or screw conveyor.

A diffuser (T) (if supplied) absorbs the impact of high velocity dust particles and distributes the flow of the incoming air.

Each collector has a manometer (S), or magnehelic gauge supplied with it. The field installed manometer or magnehelic gauge registers the pressure differential cross the collector making it a useful tool for monitoring the efficiency of the pulse jet cleaning of the bags.

ASSEMBLY INSTRUCTION

A. General

Due to the construction of some Pulse Jet components, field assembly and installation is a necessity. This Section provides instructions covering installation and assembly required at the job site.

B. Unpacking

Remove all components from the packing and check against the shipping ticket. Report shortages to the carrier at once. Inspect all components for evidence of shipping damage. If damage exists it should be reported to the carrier at once and a damage claim filed.

C. Assembly of Parts

1a. Manometer

Connect the manometer to the couplings provided on the clean air plenum and the collector housing (Figure 4). Fill the manometer with the fluid supplied. Use of any other fluid is not recommended, since any change id fluid density will affect the accuracy.

b. Magnehelic

Connect the high pressure tap of the magnehelic gauge to the collector housing pressure tap. Connect the low pressure tap of the magnehelic gauge to the collector plenum pressure tap.

NOTE: The manometer or magnehelic gauge should be located where it can be easily read.

2 Timer

Connect electrically to the power source and the solenoid valves. See timer instruction manual.

CAUTION: The timer is a rugged mechanism. However, timer failure will be minimized if the timer is mounted in a vibration-free environment remote from the collector. In addition, installation indoors is recommended to eliminate potential problems caused by temperature fluctuations.

3 Compressed Air

The compressed air supply (90-110 PSIG) shall be connected to the header supplied with the collector. Observe the following precautions:

a. Use a minimum size pipe of 1" inside diameter for the main air line. Large systems will require an appropriately sized airline.

b. Before connecting to the collector, purge airline thoroughly to remove dirt, oil moisture, and/or loose rust scale.

c. Air must be kept clean and dry to insure trouble-free operation of the solenoid and diaphragm valves. An adequately sized filter must be installed in the line to remove moisture and oil. Air filter should be sized for 50 micron particle removal.Oil content should not exceed 10 ppm/wt. More elaborate instrument air dryers are required only when sensitive process conditions or severe freezing situations are encountered.

4. Filter Bags

a. Slip the filter bag over a wire retainer with the bag seam 180° from the slot in the top of the retainer (Figure 1). Pull the bag over the retainer until bottom of bag is against the bottom of the retainer.

b. Fold the top of the filter bag inside the retainer (Figure 2) and loosely install a bag clamp around the top of the bag/retainer assembly, with the clamp screw located approximately 90° off the bag seam.

c. Slip the bag/retainer assembly over a venturi collar of the tube sheet (Figure 3). making sure that the retainer groove is aligned with the venturi collar groove.

d. Using a 5/16 inch socket wrench tighten the clamp securely. It is important to use a greater than usual torque on the clamp for this application (50-60 in-lbs.).

CAUTION: Relaxation of felt fibers, caused by physical or chemical condition, could result in leakage or the filter bag slipping off the collar if the bag clamp is not tight and grooves engaged.

e. Inspect collector to insure that bags are not touching the collector walls.

NOTE: When installing fiberglass felt filter bags, extreme care is required during handling, assembling and installation.

The following recommendations and precautions will insure that you derive the maximum service from the fiberglass felt bags. As a general rule or thumb, handle the bags as if they are fragile glass tubes. Anything that would damage a glass tube will similarily affect the fiberglass felt. Every effort should be made to prevent creasing the bags. When received, the shipping carton should be handled so that it is not crushed or allowed to get wet. It should be stored in a horizontal position with the top up. When it is time to install the bags, a table should be set up to assemble the bag and retainer. The table should be somewhat longer than the bag and should be covered with heavy paper or other material to provide a smooth clean surface. The bags should be handled by at least two people at all times to avoid excessive bending. Work should be done in an area that is at least 70°F.

Bag /Retainer
Installation Technique

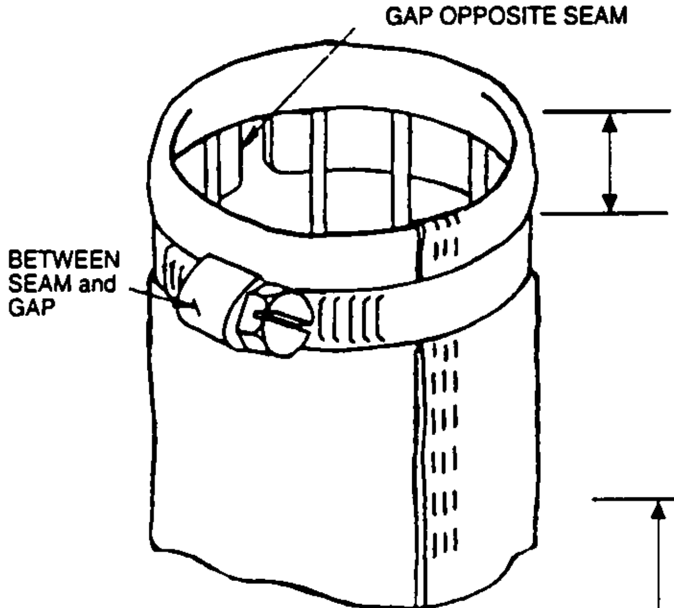


Fig. 1

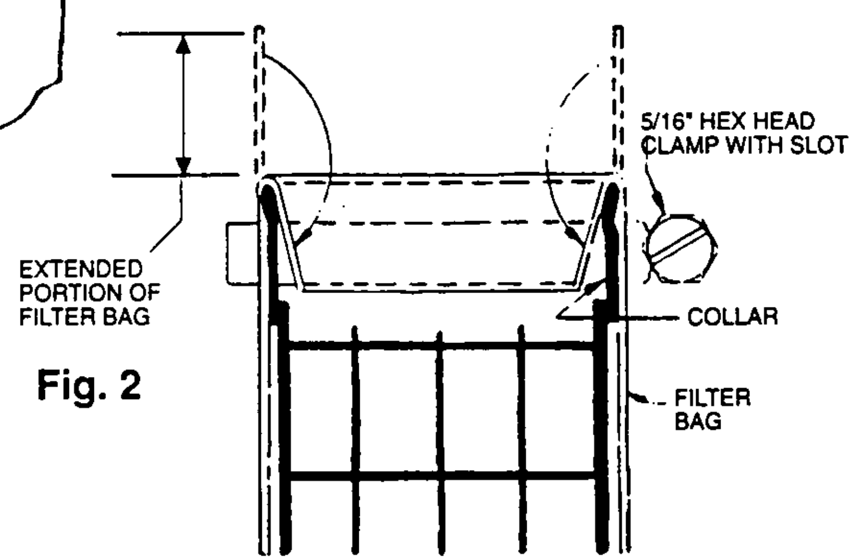


Fig. 2

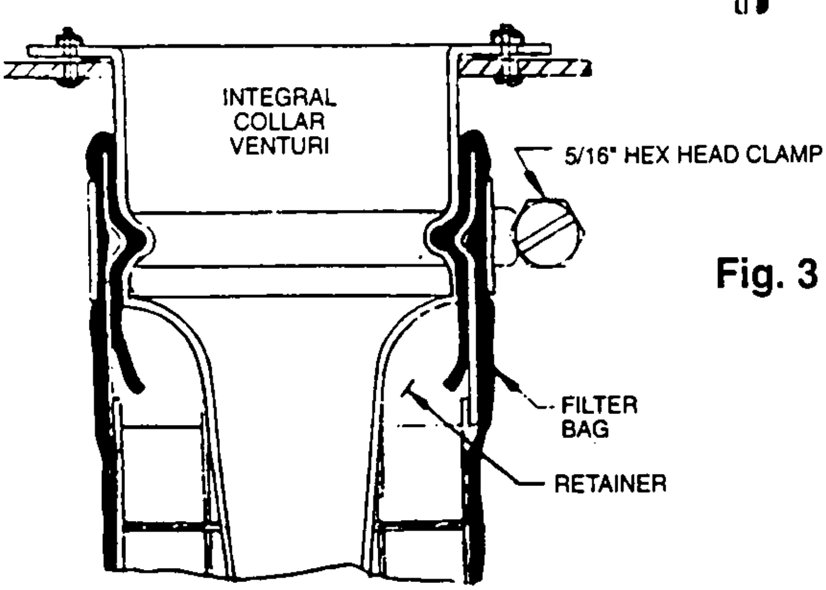
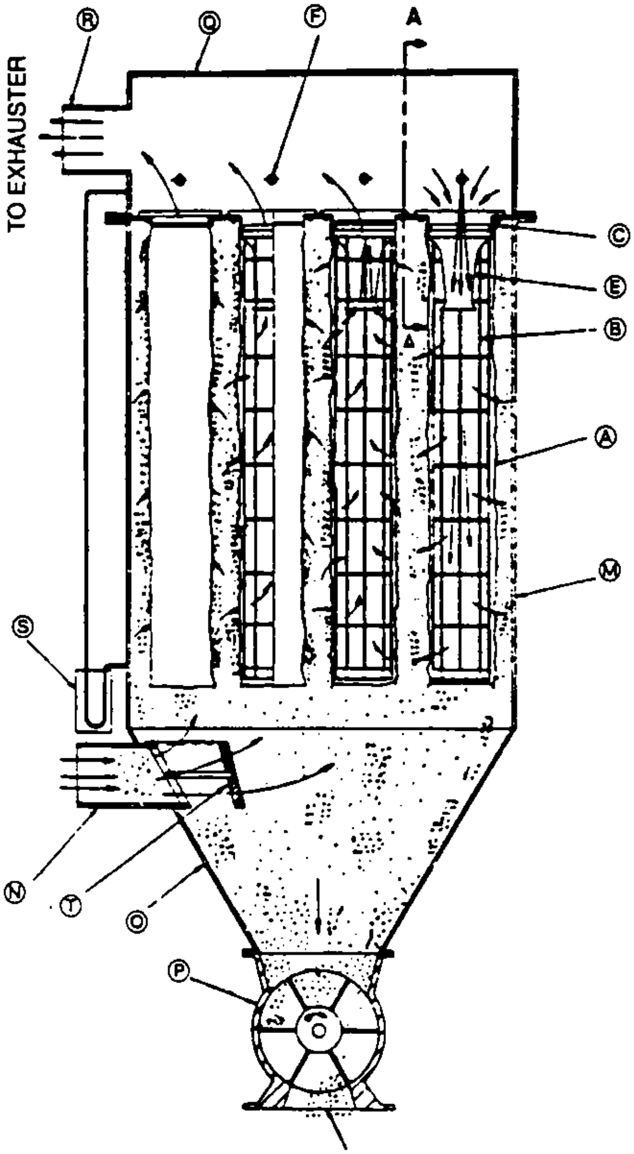
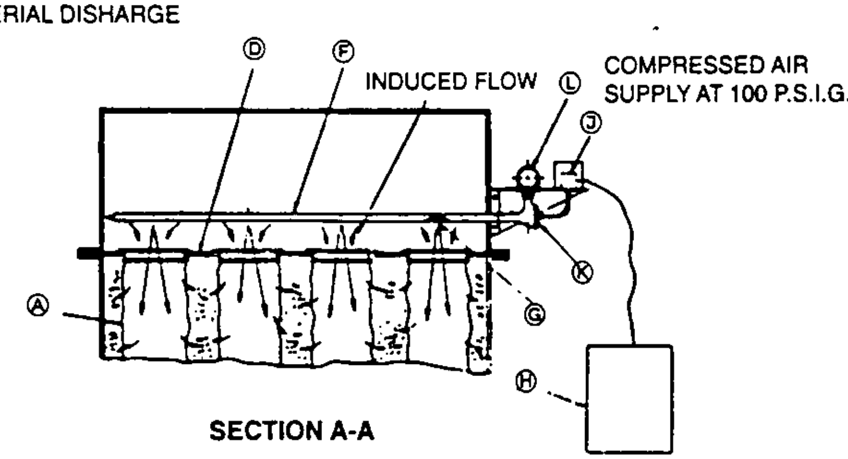


Fig. 3

Figure 4. Operational Components



A FILTER BSG
B RETAINER
C BAG CLAMP
D TUBE SHEET
E VENTURI
F BLOWTUBE
G ORIFICE
H TIMER, REMOTELY LOCATED
J SOLENOID VALVE IN WIRING TROUGH
K DIAPHRAGM VALVE
L COMPRESSED AIR MANIFOLD
M COLLECTOR HOUSING
N INLET
O HOPPER
P AIRLOCK
Q UPPER PLENUM
R EXHAUST
S MANOMETER
T DIFFUSER



SECTION A-A

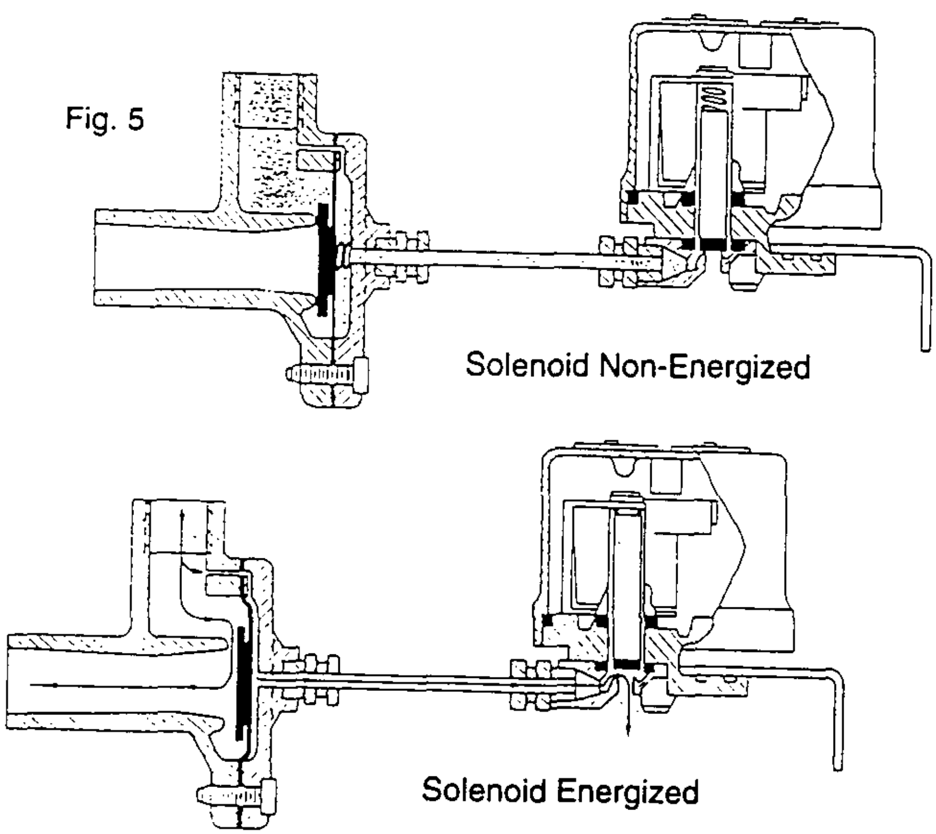
THEORY OF OPERATION

Dust Laden air under suction or pressure enters the lower section of the collector (Figure 4). The air travels through the filter bags, which retain the dust particles, on up through the venturis, into the clean air plenum and out the collector exhaust.

Dust collection on the outside of the filter bags causes a reduction in the porosity of the bags. The result as a pressure differential between the dirty and clean air sides of the collector. The control the pressure differential across the collector, a cyclic timer actuates a series of normally closed solenoid valves at present intervals causing them to open, The diaphragm valve opens as a result of the decrease in pressure from the opening of the solenoid (for detailed operation of the solenoid and diaphragm valves, see Figure 5). A momentary in-rush of high pressure air (90-110 PSIG) flows from the compressed air manifold to the blowtube and is expelled from the blowtube through orifices at a high velocity. Air from each orifice induces a secondary airflow several times the volume of surge air as it passes through the venturi throat. The combined effect of the primary and induced secondary air causes an instantaneous pressure rise on the clean side of the filter bags, causing a reverse flow of air through the filter bags sufficient for cleaning. Through this mechanism, the collected dust is released from the bags and falls into the hopper. As dust falls into the hopper, it is discharged into a collection system which may be a bin under the hopper or a corveying system which carried the dust to a remote disposal area.

Since only a fraction of the total filter area of the collector is cleaned at any one instant, continuous flow through the collector at rated capacities is assured.

Fig. 5



Solenoid Non-Energized

Solenoid Energized

START-UP PROCEDURES

Spray Dryer or Process Equipment

Initial adjustment must be made on the system before installing bags in the collector. An incorrectly functioning dryer or other process equipment may result in destruction of the bags if temperature or moisture is not in control. When used with drying equipment, preheat the collector for 30 min. to 1 hr. before start-up with material to eliminate the danger of condensation in the collector.

Start-Up with New Filter Bags

Close inlet or exhaust dampers approximately 50% before attempting to start up with new filter bags. High speed impingement, due to low resistance to air flow, can cause dust penetration of the filter bags. This will be particularly true when the air stream carried materials which tend to "blind" the bags. Open the inlet damper fully only after the filter bags have built up resistance (3 to 4 inches W.G. on the manometer). The timer controlling the compressed air pulsing should not be turned on until the differential pressure has reached 4 to 5 in. w.g., unless unattainable or if operating conditions will not permit this pressure drop.

Normal Start-Up (with seasoned bags)

Apply power to all auxiliary equipment (except fan). Energize timer and turn on compressed air. Introduce gases to the collector by opening dampers and starting fans.

CAUTION: Low collector resistance may overload the fan.

Differential Pressure Control

The expected differential pressure operating range is 1 to 6 inches W.G. If this tolerance cannot be maintained, adjust the cleaning cycle on the timer.

a. To reduce differential pressure, adjust time delay so that cleaning pulses occur at a more frequent rate (shorter OFF time).

b. To increase differential pressure that is on the low side, adjust time delay so that cleaning pulses occur at a less frequent rate (longer OFF time).

Shutdown

De-energize the fan and close inlet and exhaust dampers. Wait a period of 15 to 30 minutes, turn off compressed air and timer. Turn off all auxiliary equipment. The hopper(s) should be emptied of material before the airlock and/or screw conveyor is turned off.

TROUBLESHOOTING

When a Pulse Jet collector or any other collector is applied to a process stream, it should be considered as a piece of process equipment: the same level of engineering practice must be applied to its selection and operation. For example: Gas streams containing condensible vapors must be controlled so that no condensation takes place until the gas stream has passed through the dust collector Also, streams that contain a sublimed product are best handled by condensing out all sublimed vapor before it reaches the dust filter. Failure to control such conditions will result in a gradual, progressive blinding of the filter media.

There are some resins that will polymerize with time and operating temperatures. Some particles are reained in the interstices of the filter fabric longer than others, and if polymerization or crystal growth takes plaxe in this timeperiod, the particle is likely to become permanently locked in the fabric. The result is again progressive blinding of the filter media. The same condition may result with chemicals exhibiting crystal growth.

These comditions will not normally be observed in a short run test program, and thus, undersizing of the folter is likely. In general, increasing the total filter fabric area is the most effecive way of coping with these conditions by:

1. Providing for addition of tempering atmosphere.
2. Reducing the velocity through the filter media.
3. Spreading the product over a greater filter area.

Many cases of filter media blinding have been overcome by other methods: most notable are the following:

1. A change in filter media fabric.
2. Insulation of filter housing and ducts to reduce condensation tendencies.
   Most outdoor units should be insulate.
3. Raising temperatures of gas stream to reduce condensation tendencies.
4. Addition of humid atmospheres to reduce static electric charges in conveying and filtering equipment.

Condition	**Point to check and remedy:**
High differential pressure NOTE: Most installations are designed for differential pressure of 3 to 4 inches. A differential pressure of 1" to 6" can be considered normal.	1. Collector overloaded by too much air. Check fans speed, damper adjustment, system design. 2. Improper compressed air supply. 90 to 100 psig is required. More effective cleaning is possible with pressure up to 125 psig.

TROUBLESHOOTING

	3. Improper solenoid valve operation. A leaking diaphragm will reduce cleaning energy by slowing or preventing valve opening.
	4. Improper timer operation. Make sure that all valves are being activated. Check timer operation.
	5. Leaky airlocks or dust discharge will overload collector by preventing dust discharge.
	6. Moisture -Blinded bags: Recovery is often possible by running the cleaning mechanism without moving air through the collector.
	7. Considerable dust in the clean air (from a previously leaking bag, etc) can reduce cleaning effectiveness by impregnating the bags in the reverse direction.
	8. Statistic electricity can cause a high differential pressure. Increase humidity if possible.
	9. Make sure blowtubes are installed correctly (field assembled units).
Seepage-visible discharge	1. Improperly installed bags.
	2. Loose bag clamps.
	3. Torn bags or holes in bags.
	4. Improper sealing of tubesheet joints. (Field assembled units).
	5. Missing or loose venturi rivets.
Insufficient Suction on Exhaust hood or System	1. Fan direction or rotation incorrect. Fan will pump air inefficiently if wrong direction.
	2. Check for high differential pressure. (see above)
	3. Slippage on fan belts.
	4. Leakage duct work? Access Doors? Explosion doors? Discharge valve or airlock?
	5. Clogged duct, or closed gate or damper.
	6. Duct size or rum other than original design.
	7. Poor system design. Check against manual.

Unable to maintain compressed air pressure	1. Dirty solenoid valve sticking open. Clean and check pilot plunger. On CEMA 4 valve boxes, a manual override is provided by inserting 1/4", rod through hole in lower valve body. If the plunger is stuck open, rod will not be able to raise plunger. 2. Short circuit in wiring keeping one or more valves open. 3. Sticking timer relay, or pulse longer o.1 seconds. 4. Faulty, or too small a compressor and/ or pipe leaks. 5. Solenoid valves require a minimum or 5 psig to close. A long compressed air run after the shut-off valve can prevent the required 5 psig from developing. SOLUTION: Reservoir and shut-off valve near the collector.
Filter bag problems: (blinding, poor life etc.)	1. Check operating temperature against filter material rating. 2. Check operating humidity, free moisture etc. Too low Rh if static electricity is present. 3. Check for shrinkage, free moisture etc. 4. Review physical & chemical characteristics of material and gas stream. Particularly: status of vapors, sublimation, crystallization, polymerization etc. 5. Check for hopper bridging, material build up into the bag area can damage the bags. 6. Incorrect bag retainer installation can cause bag wear by allowing friction between adjacent elements or between outside elements & housing. Make sure tubes are installed vertically. 7. Abrasion caused by impingement of high velocity particles will shorten life. Check or install diffuser at inlet.

TROUBLESHOOTING

Solenoid Pilot Valve Trobleshootong

Valve will not open

1. Confirm adequate electrical service.
2. De-pressurize the system by either shutting down compressed air supply (Use isolation valve if provided). Disconnect the electrical signal source.
3. Remove cover.
4. Coil-check continuity or if metallic click is heard when coil is energized the coil is not the source of the problem.
5. Remove coil, then ferrule assembly for access to plunger, spring and orifice. Check hole in outlet to be sure it is not blocked, or for other foreign objects that may prohibit operation.

Valve will not close

1. De-pressurize system by either shutting down compressed air supply (Use isolation valves if provided). Disconnect the electrical signal source.
2. Remove cover.
3. Remove coil, then ferrule assembly for access to plunger, spring and orifice, check for dirt in valve preventing disc from sealing on seat.
4. If plunged in the ferrule assembly, rebuild valve with new ferrule, plunger, spring and seal.

   Note: It is recommended that the complete kit be used when wear is a problem.

MAINTENANCE

The Pulse Jet requires an absolute minimum of maintenance. The total lack of internal moving parts means that lubrication requirements are zero, except for accessory items such as fans, conveyors and airlocks.

HOUSING

The external housing surfaces should be treated as any other metal equipment, ie. periodic painting to prevent corrosion.

The Internal housing, particularly the top plenum (clean air chamber) should be thoroughly cleaned whenever bags are replaced. Good Housekeeping in the clean air plenum is essential to avoid impregnating the filters from the clean side, should bag tears or other failure, deposit considerable dust in the clean plenum.

BAGS

See bags installation instructions on Page 3. It is important to handle the bags with care at all times. Blinded bags can sometimes be rejuvenated without removal from the DUST COLLECTOR. Simply allow the cleaning mechanism to operate without the main air moving fan or blower running. This no-load cleaning can be more effective than washing. (From 1 to 30 hours is required for best cleaning).

Door gaskets may require occasional replacement. Sponge rubber is supplied as standard, although chemical considerations often require alternate materials. Replacement is a matter of cementing new material in place.

RIGHT ANGLE DIAPHRAGM VALVE

The right angle diaphragm valves controlling the reverse jet cleaning system are maintenance free providing the compressed air is clean and dry. In some cases, isolation valves have been incorporated to enable servicing the right angle diaphragm valves while the collector is on steam.

TIMER

Z. Z. Conveying does not recommend timer maintenance in the field. The entire timer assembly should be removed and returned to the factory for repair. We offer instant replacement. Experimentation, or attempted repairs by those not sufficiently familiar with timer operations and components almost invariably results in the destruction of one or more components and needlessly high repair changes.

SOLENOID VALVES

Solenoid Valves for Pulse Jet dust collectors are shown in Figure 5 and illustrate the standard arrangements which will be supplied with all units unless otherwise specified, In all cases the aluminum enclosure and integral solenoid pilot valve are suitable for outdoor application.

Z-Z CONVEYING TECHNOLOGY INC.

75 HYDE PARK DRIVE • RICHMOND HILL, ONT. • L4B 1X2

MODEL 22 SEQUENCER
OPERATING INSTRUCTIONS

OPERATION

The control logic selects an output circuit during the PULSE OFF period and lights a solid-state lamp. At the end of the off period a pulse is generated and fed to the output circuit. This operates a triac switch which applies power to the load, for the duration of the pulse period.

Output circuits are selected in sequence when all the bypass switches are in "ACTIVE" position. When the bypass switch for a given output is in "BYPASS" the logic will skip this output during the sequence. This bypass takes place during the pulse off period therefore no sequence time is lost.

Timers in the control logic determine PULSE ON and PULSE OFF times (see adjustments).

TROUBLE SHOOTING

TROUBLE	A	B	C	D	E	F	G	H	I	J	K	L
1. NO OUTPUT ON ANY CHANNEL	X	X	X	X							X	X
2. NO OUTPUT ON ONE CHANNEL				X	X	X		X		X	X	
3. RANDOM OUTPUT SEQUENCE							X				X	
4. SOLENOID ON CONTINUOUSLY									X	X		
5. SOLENOID CHATTERS										X		
6. NO CHANNEL INDICATION											X	X

POSSIBLE CAUSE

A. NO 115V,60Hz AT L1 & L2 TERMINALS

B. BLOWN OR MISSING 3AGC-2AMP FUSE

C. COMMON LINE OF SOLENOIDS OPEN TO SC

D. OPEN CONNECTION AT TERMINAL STRIP

E. OPEN WIRE TO SOLENOID

F. FAULTY SOLENOID VALVE

G. ALL BYPASS SWITCHES "ON"

H. ONE BYPASS SWITCH "ON"

I. LINE TO SOLENOID GROUNDED

J. TRIAC FAILURE

K. INTEGRATED CIRCUIT FAILURE

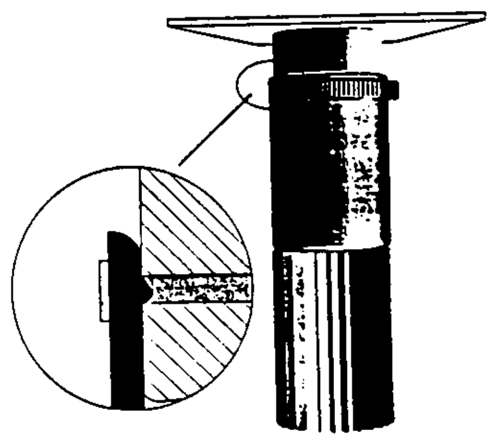
L. REGULATED POWER SUPPLY FAILURE

Z-Z Conveying Technology Inc.

INSTALLATION PROCEDURE FOR BOTTOM LOAD, CUP STYLE, CARTRIDGE FILTER ELEMENTS

Inspect each filter element for damage from shipping, storage and handling. Do not use damaged elements that may leak or fail prematurely.

Slowly push the filter element onto the venturi bag cup until the flexible boot snaps into place on the venturi cup grove. Pull the element down slightly to ensure the internal lip is fixed securely (see insert below).



Using a 5/16" socket wrench, tighten the clamp securely, ensuring it stays in place between the outer grove markings. While tightening, rock the filter element slightly to ensure the flexible boot is meeting properly with the grove.

After tightening, you should not be able to rotate the filter element by hand. Make sure the filter elements hang plumb and are not touching each other or the wall.

Operating Procedure

Close inlet damper approximately 50% before attempting to start up the new cartridge filters. Compressed air should not be turned on until the differential has reached 3" w.c.

Once pressure drops 3" wc has been reached, turn on the compressed air. (compressed air should be regulated between 50 and 60 psig.).

DALTEC INDUSTRIES LTD.

INSTALLATION, OPERATION, and MAINTENANCE INSTRUCTIONS

INTRODUCTION

Daltec Industries Ltd. designs and manufactures equipment for specific purpose specified. The receipt, handling, installation and maintenance of such equipment is the responsibility of the purchaser. It is recommended that the installation and start-up of the equipment be supervised or checked by personnel experienced in such work and equipment. Personnel trained in erection and field service are available, and arrangements for such service can be made through your local representative or at the company's office. Much of the equipment is manufactured to meet specific applications, and is necessarily of special design. These instructions are intended to supplement good erection techniques and are not to be considered as covering all possible conditions, because, of necessity, these instructions are general in nature. Pertinent data and information for the equipment purchased is shown on the drawing which is furnished. Special features of construction are covered by special instructions. Before starting to assemble or install the equipment, this drawing should be studied carefully.

SHIPMENT & RECEIVING

Daltec Industries Ltd. has inspected the equipment at its factory and prepared same for shipment. It should be in perfect condition when received, unless damaged in transit. Upon acceptance by the Carrier, the Carrier accepts responsibility for all damage or shortages, whether concealed or evident. Claims covering shortages or damage must be made to the Carrier by the Purchaser. Any shortage or damage should be noted on the delivery receipt, and inspection should be requested by the Carrier for all damage, whether evident or concealed.

HANDLING

During unloading and handling, care must be exercised to prevent damage or distortion which may make installation difficult or affect operation of the unit. The various parts are designed with sufficient strength for operating conditions, but when not unitized, may be damaged by rough handling. The rotor assembly has been designed to be supported by the shaft, and should be lifted by slings around the shaft, as close as possible to the hub on each side of the wheel. Slings should not press against the side plates of the wheel, as this may damage and distort the wheel. A spreader bar should be used. The rotor should never rest on the side plates or blades, nor should the rotor be lifted by any components of the fan wheel. To do so may damage the rotor assembly, and destroy the dynamic balance that is necessary for vibration free operation. If this balance is destroyed, rebalancing of the rotor assembly will be necessary. When handling the housing and other parts of this equipment, good rigging techniques should be applied. Avoid any concentrated stresses that will cause distortion and damage. Use of spreader bars is recommended.

If the fan is to be stored before erection, it should be stored in a dry location. Bearings, shaft, and any other machined surfaces should be protected against physical damage, moisture, dust and corrosion. If fan must be stored outside, care must be taken to protect the equipment from the elements, particularly the bearings and the bearing journals on the shaft. Frequent inspections should be made to ascertain that protection is adequate, and equipment is not being damaged by the elements.

ERECTION INSTRUCTIONS

The dimensions and details of the fan base are shown on the customer's drawing which has been supplied. These should be studied. The fan should be mounted on a rigid and substantial foundation.

DALTEC INDUSTRIES LTD.

The foundation should be at least five to six times the weight of the fan it supports. It is desirable that the bottom of the foundation be longer and wider than the top. If sides are vertical, substantial footings are desirable.
If fans are to be installed above the ground, the same 5 to 1 ratio applies. A rigid support should be supplied sufficient to support the equipment and absorb any vibration that might develop. If possible, installation should be on or near walls, beams, or supporting columns.

SETTING THE FAN

The fan should he installed on the foundation in the proper position and bearing pedestals should have steel shims of sufficient size and be used between the sole plate and foundation, close to the foundation bolts and also through the center of the sole plate. Be sure to allow sufficient room for grout.

BEARINGS

Bearings should be installed following the instructions of the manufacturer. As a caution, when disassembling bearings, do not mix parts from different bearings; they are not normally interchangeable. Do not work on bearings in a dirty or dusty atmosphere. All bearing parts should he thoroughly cleaned before installation. Locate position of fixed and floating bearings from drawing. The following instructions are peculiar to each type of bearing.

Ring oiled sleeve bearings:

Install base of pillow block in position on bearing pedestal. Align and level. Position bottom half of bearing in pillow block. Align with pillow block base. Oil bearing surfaces to avoid damage to the bearing when shaft is rotated. Protect the bearing surfaces from damage and cover to prevent foreign matter marring the surfaces.

Split pillow block-anti friction bearings:

Install bottom half of pillow block on the pedestal. Align and level. Bolt down temporarily. Remember to install bearing inserts on shaft before installing rotor assembly.

Solid pillow block-anti friction bearings:

Install solid pillow block bearings on the shaft and install with rotor assembly.

ROTOR ASSEMBLY

If wheel and shaft are not assembled, using care not to damage wheel, set it on the floor and brace. If shaft and hub have a protective coating, remove with proper solvent. Check for nicks, damage,rust, or corrosion. Clean up with crocus cloth. Never use emery cloth on bearing surfaces or wheel machined surfaces. Coat wheel bore with oil, loosen all set screws, remove keys. Determine how shaft should be installed for proper rotation. Rotation is determined as when viewed from drive side. On unit with dual drive, it is from the fixed bearing end. Install inlet cones over shaft. If there are inlet volume controls with fan be sure to install in the correct rotation. Vanes should spin the air in the direction of the wheel rotation when properly installed.
If the bearings are of the solid pillow block type, they should now be located on the shaft. Be sure the fixed and floating bearings are on the proper location.
If sleeve bearings are used, be sure that bearings and shaft at bearing lands are well lubricated. Lower complete rotor assemply carefully into the bearings. Guide the rotor so that shaft will go into bearing sleeves about square with the base to prevent upsetting the babbitt.
If the rotor assembly is large and very heavy and controlling same is difficult, it can be lowered down to, but not into the bearings. The bearings can now be lifted into place around the shaft. The rotor assembly, complete with bearings, can now be gently lowered onto the pedestals in the proper place.

Daltec Industries... Guelph Ontario

Customer:	ZZ CONVEYING	**Project:**				
Customer Ref No.:		**Model:**	IE 15 OR	**Volume:**	3600	acfm
Daltec Ref No:	97-5761A	**Speed:**	1633 rpm	**SP:**	9.00	inches wg
Date:	03/27/97	**Arr.**	9	**Temp:**	140	degF
Curve No.:		**Whl Dia:**	26.13 inches	**Density:**	0.0663	lb/ft^3
		Tip Spd:	11173 ft/min	**Baro:**	29.92	in Hg.
		Class:	Std	**Power:**	7.98	bhp
		Tag No.:		**OV:**	2874	fpm
				Belt Loss:	0.52	hp

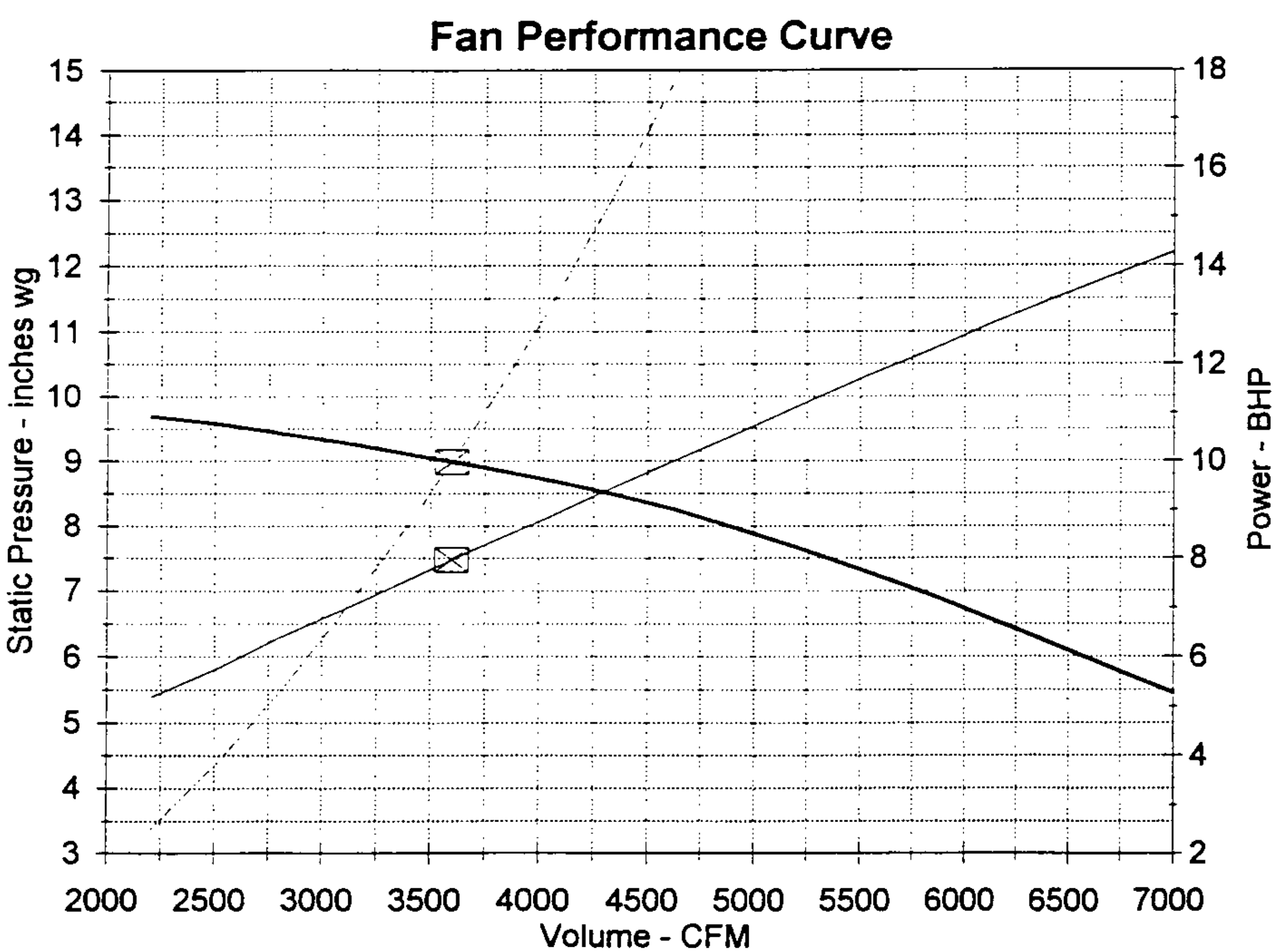
Total Sound Power Levels (Ref 10^-12 watts)

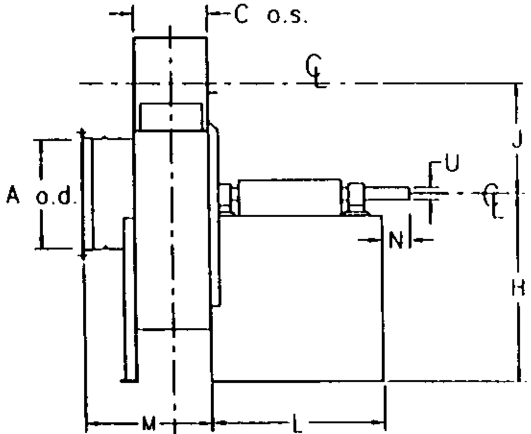
Octave Band	1	2	3	4	5	6	7	8
dB Level	97	98	95	92	88	85	80	77

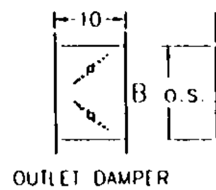
Single Value LwA= 94 Estimated Sound Pressure Level: 80 dBA

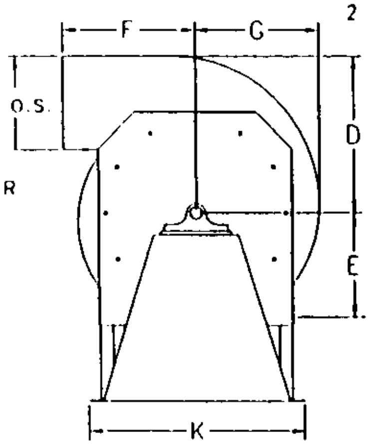
Sound Pressure Level @ 5 Feet from Sound Source in a Free Field (Ref 2^10-5 Pa, Q=2)

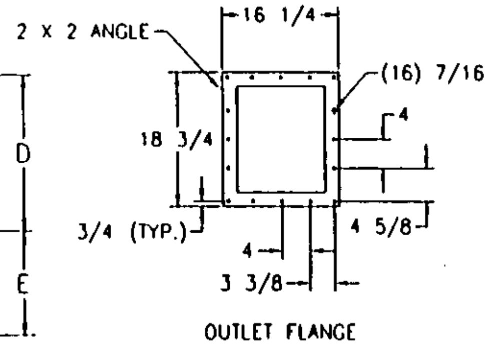
Includes appurtenances pressure drops. Drive losses not included.





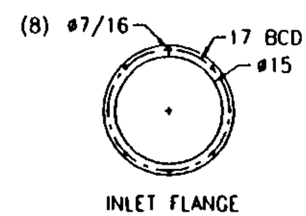


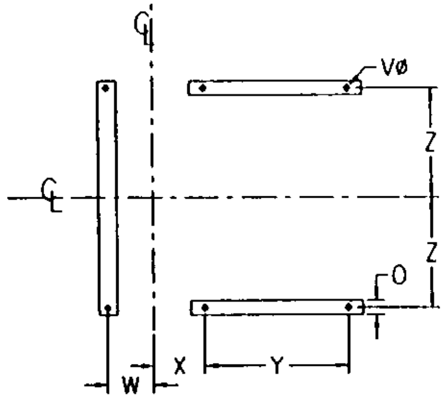




ACCESSORIES

- -INLET FLANGEC/W FLEX
- -OUTLET FLANGE
- -SKF SPLIT BLOCK BRGS.
- -BELT GUARD
- -MOTOR SUPPLIED BY:
  - -CUSTOMER
- -DRIVES SUPPLIED BY:
  - -DALTEC
- -DAMPER:
  - - OPPOSING BLADE
  - - MANUAL OPERATION





NOTES: DWG. SHOWS CCW ROTATION AND TH DISCHARGE.
AS BUILT ROT. AND DISCH. IS SHOWN BELOW.
* ADD 1/4" IF FLANGES ARE REQUIRED.

SIZE	A	B	C	D	E	F *	G	H 1	H 2	J	K
IE-15	15	14 3/4	12 1/4	22 1/8	18 5/8	19	20 3/8	26 1/4	-	14 3/4	30 1/4

L	M *	N	O	U 1	U 2	V	W	X	Y	Z
26	20	4	2 1/2	1 15/16	-	1/2	7 1/2	8 1/4	22	14 1/8

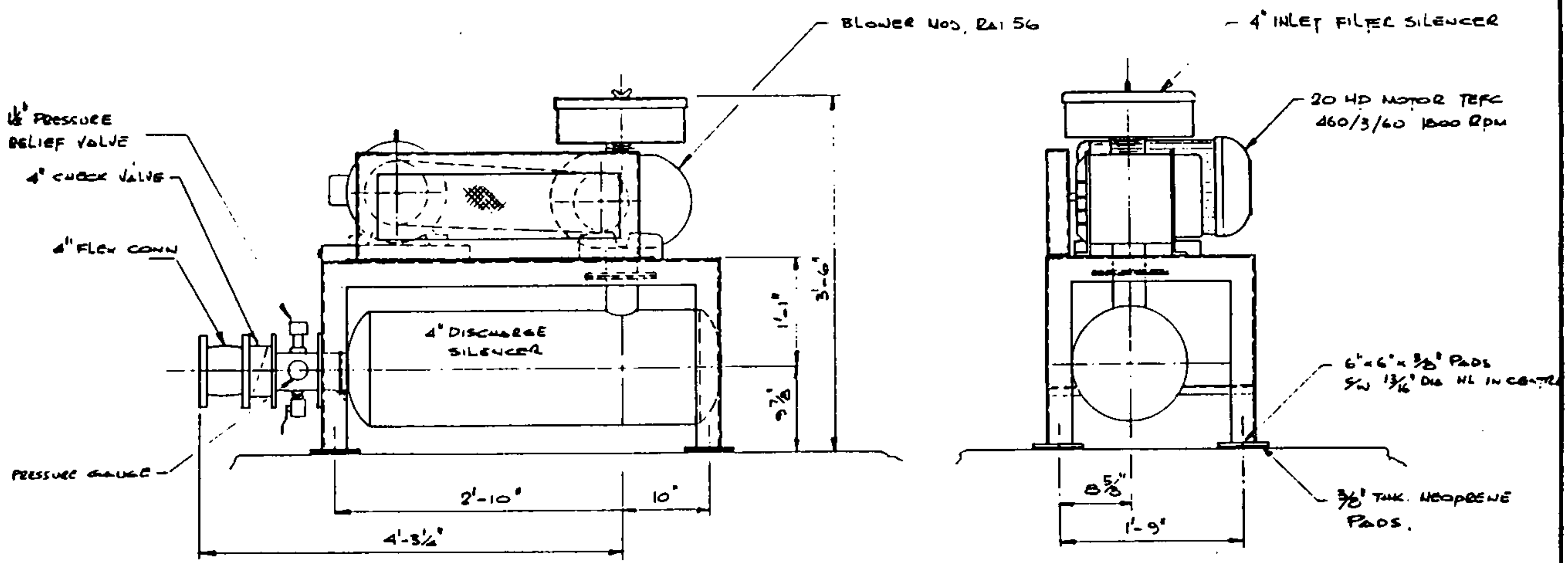
CUSTOMER	CFM	S.P	O.V.	RPM	BHP	TEMP	ALT.	DEN.
Z.Z. CONVEYING TECHNOLOGY INC.	3600 5000	9	2874 3993	1633 1718	7.98 11.94	140°F	-	.066

PURCH. ORDER	QTY.	DALTEC No.	HP	RPM	PH	HZ	VOLTAGE	ENCLOSURE	FRAME
A335-1022	2	97-5761	15	1750	3	60	460	TEFC	254T

MODEL	CLASS	ROT.	DISCH	ARRGM'T	MOTOR SHEAVE	BORE	FAN SHEAVE	BORE	BELT
IE-15	II	CCW	TH	9	3B5.4 3B6.6	1 5/8	3B5.8 3B6.8	1 15/16	(3) B56 (3) B58

Daltec Industries Ltd.
Guelph, Ontario, Canada

DATE: M/D/Y	TITLE	REVISION
04/15/97	IE 15 INDUSTRIAL EXHAUSTER	AS BUILT
SCALE N.T.S.		DRAWING No. 97-5761
DRAWN BY MG	REF. DWG. 7B010046	



RATING : 320 ICFM AT 8 PSIG

PRESSURE REL VALVE SET AT 10 PSIG

DRIVE DATA :

BLOWER : 5V 6.7 2GR.

MOTOR : 5V 7.1 2GR.

BELTS : 5VX 710

ROANOKE CEMENT CO.

ROXBORO NC.

BLOWER PACKAGE FOR ;

FLY ASH TRANSFER SYSTEM

Z.Z CONVEYING REF. A 335

Z-Z Conveying Technology inc.

SCALE: 1" = 1'-0"	APPROVED BY:	DRAWN BY Z.Z.
DATE: APR 8. 97		REVISED
GENERAL ARRG'T OF BLOWER PACKAGE MODEL RAI 56 WITH 20 HP MOTOR		
CUSTOMER : ROANOKE CEMENT CO. P.O.# M-1375		DRAWING NUMBER B-2963

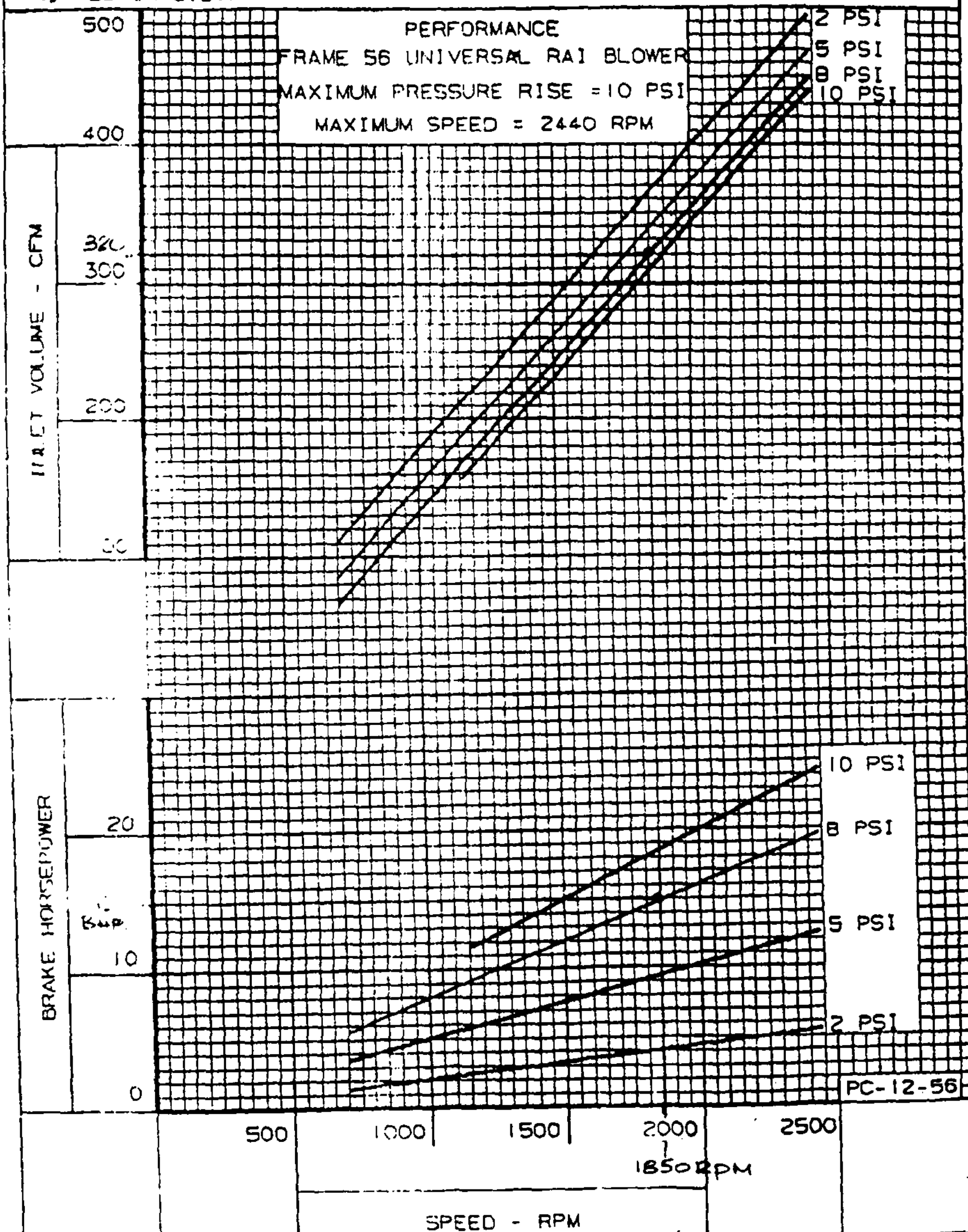
From : ZZ Conveying, Inc PHONE No. : 905 764 0532 Aug.14 1997 10:46AM P02

ROOTS DIVISION
DRESSER INDUSTRIES, INC.
CONNERSVILLE, IN. 47331

PRINTED IN U.S.A.

PERFORMANCE BASED ON INLET AIR AT 14.7 PSIA & 68°F

AUGUST 1986



ROOTS DRESSER

$2.00

Universal RAI BLOWER

INSTRUCTIONS
ROTARY LOBE BLOWERS

CONTENTS

NUMBERS IN ( ) ARE METRIC EQUIVALENTS

INFORMATION SUMMARY .... This page
Receiving. . .Installing. . .Operating

OPERATING CHARACTERISTICS 2
Description. . .Control. . .Protection

OPERATING LIMITATIONS 2
Pressure. . .Temperature. . .Speed

BLOWER ORIENTATION 3

INSTALLATION 5
Mounting. . .Aligning. . .Piping

LUBRICATION 7
Oil Fill. . .Servicing. . .Greasing

OPERATION 8
Starting. . .Checking. . .Running

TROUBLE SHOOTING 9
Capacity. . .Power. . .Heating

SAFETY PRECAUTIONS 10
Physical. . .Operating. . .General

MAINTENANCE/REPLACEMENTS 10
Servicing. . .Repairs. . .Clearances

PARTS DRAWINGS 14

DISTRIBUTORS 24

DO THESE THINGS To Get The Most From Your Roots Blower

1 Check shipment for damage. If found, file claim with carrier and notify Sales Office.

2 Unpack shipment carefully, and check contents against Packing List. Notify Sales Office if a shortage appears.

3 Store in a clean, dry location until ready for installation, if possible. Lift by methods discussed under INSTALLATION to avoid straining or distorting the equipment. Keep covers on all openings. Protect against weather and corrosion if outdoor storage is necessary.

4 Read LIMITATIONS and INSTALLATION sections in this manual and plan the complete installation.

5 Provide for adequate safeguards against accidents to persons working on or near the equipment during both installation and operation. See SAFETY PRECAUTIONS.

6 Install all equipment correctly. Foundation design must be adequate and piping carefully done. Use recommended accessories for operating protection.

7 Make sure both driving and driven equipment is correctly lubricated before start-up. See LUBRICATION.

8 Read starting check points under OPERATION. Run equipment briefly to check for installation errors and make corrections. Follow with a trial run under normal operating conditions.

9 In event of trouble during installation or operation, do not attempt repairs of Roots furnished equipment. Notify Sales Office or factory, giving all nameplate information plus an outline of operating conditions and a description of the trouble.

10 Unauthorized attempts at equipment repair may void Manufacturer's warranty. Units out of warranty may be repaired or adjusted by the owner. It is recommended that such work be limited to the operation described in this manual, using Factory Parts. Good inspection and maintenance practices should reduce the need for repairs. See Distributor List on last page for parts and service after warranty period.

OPERATING CHARACTERISTICS

Roots UNIVERSAL RAI® blowers, as covered in this manual, are designated as air blowers, and may be used for handling air in either pressure or vacuum service. They are unsuitable for handling gases because shaft seals are not designed to prevent leakage to atmosphere.

The Roots rotary lobe blower is a positive displacement type unit, whose pumping capacity is determined by size, operating speed and pressure conditions. It employes two double-lobe impellers mounted on parallel shafts and rotating in opposite directions within a cylinder closed at the ends by headplates. As the impellers rotate, air is drawn into one side of the cylinder and forced out the opposite side against the existing pressures. The differential pressure developed, therefore, depends on the resistance of the connected systems.

Effective sealing of the blower inlet area from the discharge area is accomplished by use of very small operating clearances. Resulting absence of moving contacts eliminates the need for any internal lubrication. Clearances between the impellers during rotation are maintained by a pair of accurately machined timing gears, mounted on the two shafts extending outside the air chamber.

Operation of the familiar basic rotary lobe blower is illustrated in FIGURE 1, where air flow is right to left from inlet to discharge with the bottom impeller rotating clockwise. In Position 1 it is delivering a known volume (A), to the discharge, while space (B) between the upper impeller and cylinder wall is being filled. Counterclockwise rotation of this impeller then traps equal volume (B) in Position 2, and further rotation delivers it to the discharge in Position 3. At the same time, another similar volume is forming under the lower impeller, and will be discharged when rotation reaches Position 1 again.

One complete revolution of the driving shaft alternately traps four equal and known volumes of air (two by each impeller) and pushes them through to the discharge. The pumping capacity of a lobe blower operating at a constant speed therefore remains relatively independent of reasonable inlet or discharge pressure variations. To change capacity, it is necessary either to change speed of rotation or vent some of the air.

No attempt should ever be made to control capacity by means of a throttle valve in the intake or discharge piping. This increases the power load on the driver, and may seriously damage the blower. Likewise, if a possibility exists that flow to the blower inlet may be cut off during normal operation of a process, then an adequate vacuum relief valve must be installed near the blower. A pressure type relief valve in the discharge line near the blower is also strongly recommended for protection against cut-off or blocking in this line.

When a belt drive is employed, blower speed can usually be adjusted to obtain desired capacity by changing the diameter of one or both sheaves. See pages 18 and 20 for minimum sheave diameter. In a direct coupled arrangement, a variable speed motor or transmission is required, or air may be vented through a manually controlled unloading valve and silencer. If discharge air is returned to the blower inlet, it must be cooled to 100° F (38° C) through a cooling by-pass arrangement.

Before making any change in blower capacity or operating conditions, contact the nearest Distributor for specific information applying to your particular blower. In all cases, operating conditions must be maintained within the approved range of pressures, temperatures and speeds as stated under LIMITATIONS. Also, the blower must not be used to handle air containing liquids or solids, or serious damage to the rotating parts will result.

OPERATING LIMITATIONS

To permit continued satisfactory performance, a Roots UNIVERSAL RAI® blower must be operated within certain approved limiting conditions. The Manufacturer's warranty is, of course, also contingent on such operation.

Maximum limits for pressure, temperature and speed are specified in Table 1 for various sizes of UNIVERSAL RAI® blowers. These limits apply to all blowers of normal construction, having operating clearances as listed in Table 5 when operated under standard atmospheric conditions. **Do not exceed any of these limits.**

Example: The listed maximum allowable temperature rise (increase in air temperature between inlet and discharge) for any particular blower may occur well before its maximum pressure or vacuum rating is reached. This can easily occur at high altitude or at very low speed.

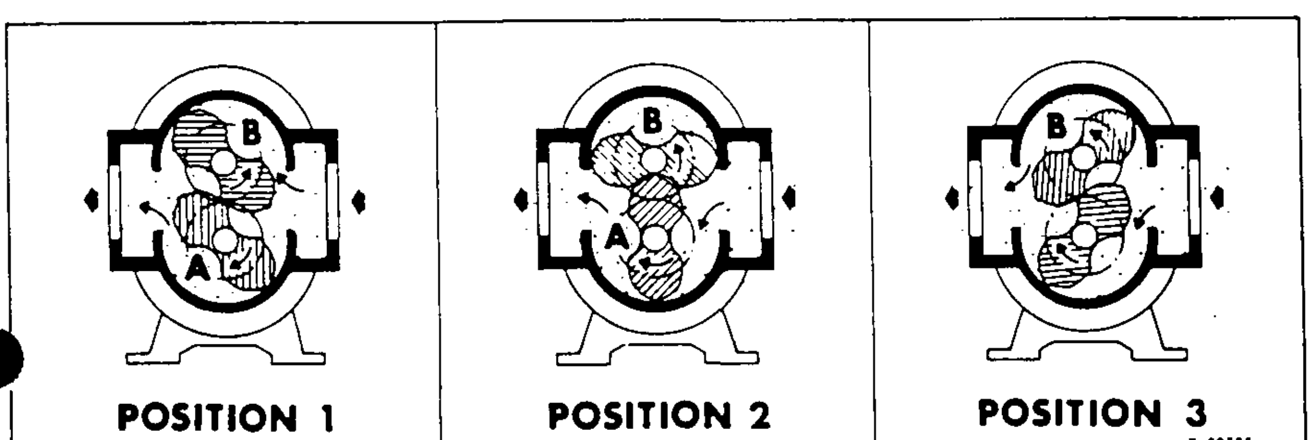


Figure 1 — Flow Through a Basic Type RAI Blower

Temperature rise then is the limiting condition. In other words, the operating limit is always determined by the maximum rating reached first. It can be any one of the three: pressure, temperature or speed.

Be sure to arrange connections or taps for thermometers and mercury type pressure or vacuum gauges at or near the inlet and discharge connections of the blowers. These, along with a good tachometer, will enable periodic checks of operating conditions to be made easily.

PRESSURE — On pressure service, the pressure rise in pounds per square inch (kPa) (between blower inlet and discharge) must not exceed the figure listed for the specific blower frame size concerned. Also, in any system where the blower inlet is at a positive pressure above atmosphere, the discharge pressure must never exceed 25 PSI (172 kPa) gauge regardless of blower size.

On vacuum service, with the discharge going to atmospheric pressure, the inlet suction or vacuum in inches of mercury (Hg.) (kPa) must not be greater than the values listed for the specific frame size.

TEMPERATURE — Various blower frame sizes are approved only for installations where the following temperature limitations can be maintained in service.

A. Measured temperature rise in Fahrenheit degrees (C°) must not exceed listed values when the inlet is at ambient temperature. Ambient is considered as the general temperature of the space around the blower. This is not outdoor temperature unless the blower is installed outdoors.
B. If inlet temperature is higher than ambient, the listed allowable temperature rise values must be reduced by ⅔ of the difference between the actual measured inlet temperature and the ambient temperature.
C. Average of inlet plus discharge temperature must not exceed 250°F (139°C).

SPEED RANGE — UNIVERSAL RAI® blowers may be operated at speeds up to the maximums listed for various frame sizes. They may be direct coupled to suitable constant speed drivers if pressure/temperature conditions are also within limits. At low speeds, excessive temperature rise may be the limiting factor as noted in the preceding example.

Table 1 — Maximum Allowable Operating Conditions

Frame Size	Speed RPM	Inlet Vac. Inches Hg. (kPa)	Temp. Rise Fahr. Deg. (C°)	Press. Rise PSI (kPa)
22	5275	15 (50)	225 (125)	12 (82)
24	5275	15 (50)	210 (117)	7 (47)
32	3600	15 (50)	225 (125)	15 (101)
33	3600	15 (50)	225 (125)	12 (82)
36	3600	15 (50)	225 (125)	7 (47)
42	3600	15 (50)	240 (133)	15 (101)
45	3600	15 (50)	225 (125)	10 (68)
47	3600	15 (50)	225 (125)	7 (47)
53	2850	15 (50)	225 (125)	15 (101)
56	2850	15 (50)	225 (125)	10 (68)
59	2850	15 (50)	225 (125)	7 (47)
65	2350	16 (53)	250 (139)	15 (101)
68	2350	16 (53)	240 (133)	12 (82)
615	2350	12 (40)	130 (72)	6 (40)
76	2050	16 (53)	250 (139)	15 (101)
711	2050	16 (53)	210 (117)	10 (68)
718	2050	12 (40)	130 (72)	6 (40)

BLOWER ORIENTATION

The unique removable feet feature of Roots UNIVERSAL RAI® blowers permit field modification of blower mounting by repositioning blower feet and gear box breather as shown in Fig. 3.

Four blower mounting positions are possible:
1. Horizontal mounting, vertical air flow, drive shaft on left.
2. Same as (1) except drive shaft on right.
3. Vertical mounting, horizontal air flow, drive shaft on bottom.
4. Same as (3) except drive shaft on top.

To change blower mounting:
1. Place blower on its feet.
2. Loosen feet capscrews (32).
3. Place blower on a solid base resting on the gear box end with drive shaft on top.
4. Remove feet. (Note - Feet capscrews (32) are longer than cylinder capscrews (26), only capscrews (32) are to be used for feet.)
5. Remove cylinder capscrews (32) where feet are to be re-installed. Install capscrews (26) in the location previously occupied by feet capscrews (32).
6. Install feet using capscrews (32).
7. Place blower on its feet on flat surface.
8. Loosen feet capscrews (32) and square up blower and re-tighten capscrews (32).
9. Gear box has four threaded holes, one with breather and three with pipe plugs. Remove pipe plug (21) from the top most hole. Remove breather (25) and install it in the top most hole. Install pipe plug that was removed from the top hole into the hole previously occupied by the breather. The breather and the pipe plug should be sealed with a thread sealer.

For convenience, the position of the grease fitting (37) and the relief fitting (38) could be interchanged, however each bearing must have one grease fitting (37) and one relief fitting (38).

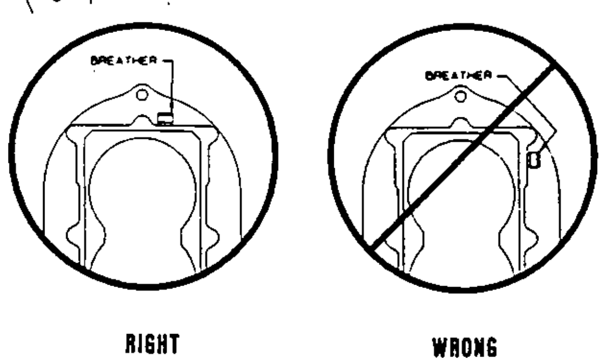


Figure 2 — Breather Installation

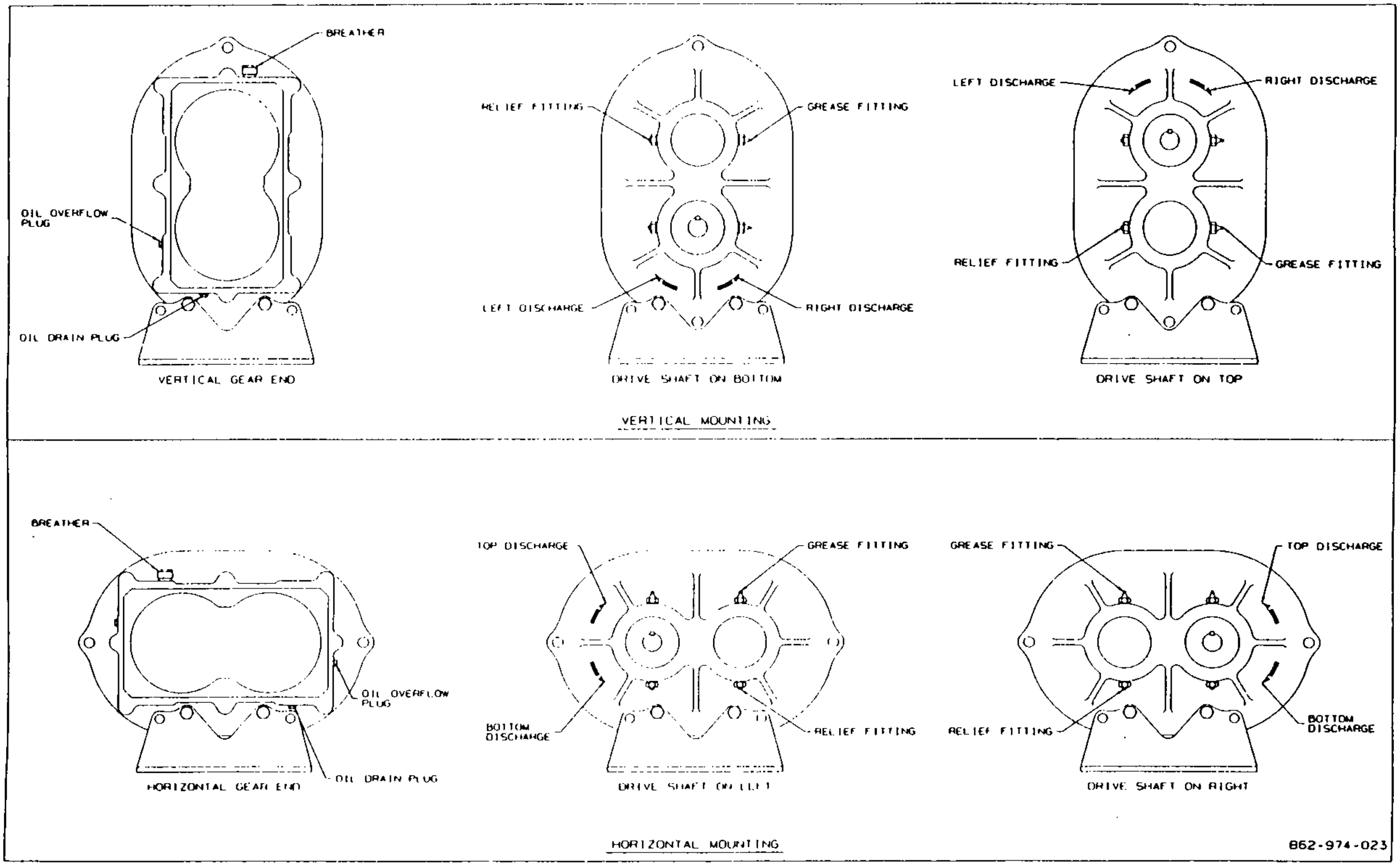


Figure 3 — Blower Orientation and Lubrication Points

INSTALLATION

Roots UNIVERSAL RAI® blowers are internally and externally treated after factory assembly to protect against normal atmospheric corrosion before installation. Maximum period of internal protection is considered to be one year under average conditions, if closing plugs or seals are not removed. Protection against chemical or salt water atmosphere is not provided. Avoid opening the blower until ready to start installation, as protection will be lost quickly by evaporation.

NOTE — If there is to be an extended period between delivery (and/or installation) and startup, the following steps should be taken to insure corrosion protection:

1. Coat internals of cylinder and gearbox with Nox-Rust No. VCI10 or equivalent. Repeat once a year or as conditions may require. Motorstor is oil soluble and does not have to be removed before lubricating. If desired, No. VCI10 may be removed from within the cylinder shortly before startup by spraying a fine mist of petroleum solvent through the blower while it is running at a slow speed with open inlet and discharge, or it can remain in the blower if it is not harmful to the operation of the connected system.
2. Fill drive end bearing cavities with grease as specified in Lubrication section.
3. Paint shaft extension, inlet and discharge flanges, and all other exposed surfaces with Nox-Rust X-110 or equivalent.
4. Seal inlet, discharge, and all vent openings with tape. It is not recommended that the unit be set in place, piped to the system, and allowed to remain idle for extended periods. If any part is left open to the atmosphere, the Motorstor vapor will escape and lose its effectiveness.
5. Units are not to be subjected to excessive vibration during storage. If stored outdoors, provide coverage such as a tarpaulin or lean-to.
6. Rotate drive shaft three or four revolutions every two weeks.
7. Prior to startup, remove flange covers on both inlet and discharge and inspect internals to insure absence of rust. Check all internal clearances. Also, at this time, remove gearbox and inspect gear teeth for rust.

Because of the completely enclosed blower design, location of the installation is generally not a critical matter. A clean, dry and protected indoor location is to be preferred. However, an outdoor or wet location will normally give satisfactory service. Important requirements are that the correct grade of lubricating oil be provided for expected temperatures, and that the blower be located so that routine checking and servicing can be handled conveniently after installation. Effect of the location on driver and accessory equipment must also be considered.

Supervision of the installation by a Factory Service Engineer is not usually required for these blowers. Workmen with experience in installing light-medium weight machinery should be able to produce satisfactory results. Handling of the equipment needs to be accomplished with care, and in compliance with safe practices. Blower mounting must be solid, without strain or twist, and air piping must be clean, accurately aligned and properly connected.

A bare blower without base should be lifted by a rope sling, with one loop passing under the gearhouse and the other loop under the cylinder.

When a blower is furnished mounted on a baseplate, with or without a driver, use of lifting slings passing under the base flanges is required. Arrange these slings so that no strains are placed on the blower casing or mounting feet, or on any mounted accessory equipment.

Before starting the installation, remove plugs, covers or seals from blower inlet and discharge connections and inspect the interior completely for dirt or foreign material. If cleaning is required, finish by washing the cylinder, headplates and impeller thoroughly with a petroleum solvent such as DuPont Triclene D. After this, turn the drive shaft by hand to make sure that the impellers turn freely at all points. Anti-rust compound on the drive shaft extension may also be removed at this time with the same solvent. Then plug the inlet and discharge connections to keep out dirt until ready to connect the air piping. Washing out is not required if the interior is found to be clean. The corrosion inhibitor used will vaporize and disappear during operation.

Care, plus consideration of all possible problems, will pay dividends when arranging the blower mounting. This is especially true when the blower is a "bare" unit furnished without a baseplate. The convenient procedure may be to mount such a unit directly on a floor or small concrete pad, but this generally produces least satisfactory results. It definitely causes the most problems in leveling and alignment.

Direct use of structural framing members is also not a recommended mounting. If unavoidable, the members must be rigidly reinforced when part of a building, and spring type mountings should not be used. Noise transmission can usually be reduced by use of a cork insulating pad 1 to 2 inches (25 to 50 mm) thickness. The pad should be supported by a full steel plate attached to the structure, with a rigid concrete slab laid on top of the cork to carry the blower and driver.

For a blower without base, it is recommended that a well anchored and carefully leveled steel or cast iron mounting plate be provided at the installation point. The plate should be ¾ to 1¼ inches (19 to 32 mm) thick, with its top surface machined flat, and needs to be large enough to provide leveling areas at one side and one end after the blower is mounted. It should have properly sized studs or tapped holes located to match the blower foot drilling. As an alternative, smaller plates at each end of the blower may be used. This is more complicated, usually makes leveling more difficult, and can produce twist or strains in the blower. Use of a high quality machinist's level is important. With the mounting plate in place and leveled, set the blower on it without bolting and check for rocking. If it is not solid, determine the total thickness of shims required under one foot to stop the rocking. Place half of this under each of the two short feet, and tighten the mounting studs or screws. Rotate the drive shaft to make sure the impellers still turn freely. If the blower is to be direct coupled to a driving motor, consider the height of the motor shaft and the necessity for it to be aligned very accurately with the blower shaft. Best arrangement is for the blower to be bolted directly to the mounting plate while the driver is on shims of at least ⅛ inch (3 mm) thickness. This allows adjustment of motor position in final shaft alignment by varying the shim thickness.

Satisfactory installation can be obtained by setting the baseplate on a concrete slab that is rigid and free of vibration, and leveling the top of the base carefully in two directions so that it is free of twist. The slab must be provided with suitable anchor bolts. The use of grouting under and inside the base, after it has been carefully leveled by shimming, is recommended.

When blower and driver have been factory mounted on a common baseplate, the assembly will have been properly aligned and is to be treated as a unit for leveling purposes. It is possible for a base mounted assembly to become twisted during shipment thus disturbing the original alignment. For this reason, make the following checks after the base has been leveled and bolted down. Disconnect the drive and rotate the blower shaft by hand. It should turn freely at all points. Loosen the blower foot hold-down screws and determine whether all feet are evenly in contact with the base. If not, insert shims as required and again check for free impeller rotation. Finally, if blower is direct coupled to the driver, check shaft and coupling alignment carefully and make any necessary corrections prior to grouting.

In planning the installation, and before setting the blower, consider how piping arrangements are dictated by the blower design and assembly.

When a blower is DIRECT COUPLED to its driver, the driver RPM must be selected or governed so as not to exceed the maximum speed rating of the blower. Refer to LIMITATIONS for allowable speeds for various blower sizes. A flexible type coupling should always be used to connect the driver and blower shafts.

For engine drives, couplings with proper stiffness must be selected to avoid resonant torisonal vibrations. Also, safe operating speed must be limited to avoid critical speeds.

Coupling halves must be accurately aligned, and a sufficient gap between shaft ends provided, so that side strains and end thrust on either shaft are avoided or minimized. This will require considerable care in the mounting of the driver. The two shafts must be in as near perfect alignment in all directions as possible, and the gap must be established with the motor armature on its electrical center if end play exists. Coupling halves must be fitted to the two shafts such that they can be worked into place by hand. Maximum deviation in offset alignment of the shafts should not exceed .005" (.13 mm) total indicator reading, taken on the two coupling hubs. Maximum deviation from parallel of the inside coupling faces should not exceed .001" (.03 mm) when checked at six points around the coupling.

CAUTION

Couplings as well as sheave bushings must have a slight slide fit with the blower shaft such that they can be installed in place by hand. Any force used to install them will change blower end clearances resulting in blower damage. If an interference fit is desired for the coupling, the coupling hub should be heated and shrunk on the shaft. For engine drives, use "Locktite" between the coupling hubs and the blower/engine shafts and on the threads of the coupling set screws.

When a blower is BELT DRIVEN, a proper selection of sheave diameters can usually be made to adapt any standard driver speed to the required blower speed. This flexibility can sometimes lead to operating temperature problems caused by blower speed being too low. Make sure the drive speed selected is within the allowable range for the specific blower size, as specified under LIMITATIONS.

Belted drive arrangements usually employ two or more V-belts running in grooved sheaves, and a variety of positions are available for the driver. Installation of the driver is less critical than for direct coupling, but its shaft must be level and parallel with the blower shaft. The driver must also be mounted on an adjustable base to permit installing, adjusting and removing the V-belts. To position the driver correctly, both sheaves need to be mounted on their shafts and the nominal shaft center distance known for the belt lengths to be used.

Install the blower sheave (usually the larger one) so that its inner hub face is not more than ¼ inch (7 mm) from the bearing end cover. The shaft fit should be such that the sheave can be worked into place by hand. A tight or driving fit can damage a bearing, and may cause internal blower damage by forcing the impeller out of its normal operating position. A loose fit or wobbly sheave will cause vibration, and may result in shaft breakage.

The driver sheave should also be mounted as close to its bearing as possible, and again should fit the shaft correctly. Position the driver on its adjustable base so that ⅔ of the total movement is available in the direction away from the blower, and mount the assembly so that the face of the sheave is accurately in line with the blower sheave. This position minimizes belt wear, and allows sufficient adjustment for both installing and tightening the belts. After belts are installed, adjust their tension in accordance with the manufacturer's instructions. However, only enough tension should be applied to prevent slippage when the blower is operating under load. *Excessive tightening* can lead to early bearing failures.

Failure to properly align the blower and drive sheaves will result in the impeller being forced against one of the headplates during operation causing serious damage to the blower.

In the absence of belt manufacturer's instructions for tensioning, the following procedures may be used.

1. With the belts loose, pull the slack on all of them to the bottom side of the drive.
2. Adjust motor position to tighten belt until they appear to be seating in the sheave grooves.
3. Thump the belts with your fist. If they feel dead, tighten them more until they vibrate and feel springy when struck.
4. Run-in the drive for a short period, after preparing the blower as instructed in a following paragraph. While running, adjust until only a very slight bow appears in the slack side of the belts.
5. Stop the motor and compare the tensions of the individual belts by pressing down firmly with one hand on the top surface. It should be possible to deflect each

belt only to the point where its top surface is even with the bottoms of the other undeflected belts.

6. A new set of belts should be first tensioned about ⅓ greater than normal to allow for stretch and wear-in. Before putting the drive into normal operation, increase the tension as obtained above by a small amount. Recheck after each 8 hour operating period during the first 50 hours, and adjust as necessary.

Before operating the drive under power to check initial belt tension, first remove covers from the blower connections. Make sure the interior is still clean, then rotate the shaft by hand. Place a screen over the inlet connection to prevent anything being sucked into the blower while it is operating, and avoid standing in line with the discharge opening. Put oil in the gearhouse per instructions under LUBRICATION.

Before connecting piping, remove any remaining anti-rust compound from blower connections. Piping must be clean and should be sized so that the air velocity will not exceed 75 feet per second (23 m per second). Pipe used should be no smaller than blower connections. In addition, make sure it is free of dirt, scale, cuttings, weld beads, or foreign materials of any kind.

To further guard against damage to the blower, especially when an inlet filter is not used, install a substantial screen of 16 mesh backed with hardware cloth at or near the inlet connections. Make provisions to clean this screen of collected debris after a few hours operation. It should be removed when its usefulness has ended, as the wire will eventually deteriorate and small pieces going into the blower may cause serious damage.

Pipe threads or flanges must meet the blower connections accurately and squarely. Do not attempt to correct misalignment by springing or cramping the pipe. In most cases this will distort the blower casing and cause impeller rubbing. In severe cases it can prevent operation or result in a broken drive shaft. For similar reasons, piping should be supported near the blower to eliminate dead weight strains. Also, installation of flexible connectors or expansion joints is recommended.

Figure 4 represents in diagram form a blower installation with all accessory items that might be required under various operating conditions. Inlet piping should be completely free of valves or restrictions. When a shut-off valve (not shown) cannot be avoided, make sure a full size vacuum relief is installed near the blower inlet. This will protect against blower overload caused by accidental closing.

Need for an inlet silencer will depend on blower speed and pressure, as well as sound-level requirements in the general surroundings. An inlet filter is normally recommended, especially in dusty or sandy locations, for blower protection. A discharge silencer is also normally suggested. Specific recommendations on silencing can be obtained from the nearest Distributor. Silencers should be mounted as close to blower as possible.

Discharge piping requires a pressure relief valve, and should include a manual unloading valve to permit starting the blower under no-load conditions. Reliable pressure/vacuum gauges and good thermometers at both inlet and discharge are recommended to allow making the important checks on blower operating conditions. If the demand is constant, but somewhat lower than the blower output, excess may be blown off through the manual unloading valve.

In multiple blower installations when two or more units discharge into a common header, use of check valves is recommended. These should be of a direct acting or free swinging type, with one valve located in each blower discharge line. Properly installed, they will protect against damage from reverse rotation caused by air back-flow through an idle blower.

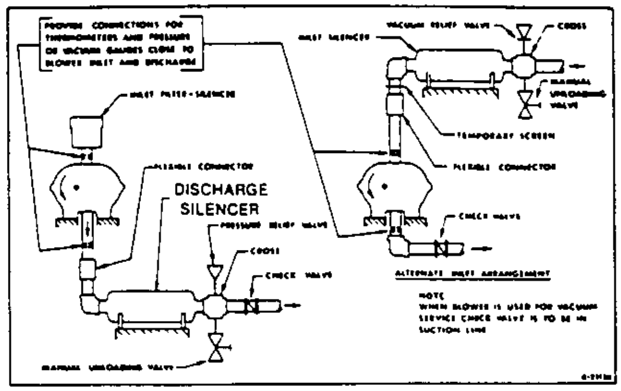


Figure 4 — Installation with Accessories

After piping is completed, and before applying power, rotate the drive shaft by hand again. If it does not move with uniform freedom, look for uneven mounting, piping strain, excessive belt tension or coupling misalignment. Do not operate the blower more than briefly at this time because of possible inadequate oil supply in the gearhouse. Read LUBRICATION section.

LUBRICATION

A simple but very effective lubrication system is employed on UNIVERSAL RAI® blowers. At the drive shaft end the bearings are grease lubricated using hydraulic pressure relief fittings. These relief fittings vent any excess grease, preventing pressure build-up on the seals. A restriction plug and metering orifice prevent loss of lubricant from initial surges in lubricant pressure but permit venting excess lubricant under steadily rising pressures.

The blind end bearings and timing gears are enclosed by a gearhouse located opposite the drive end of the blower. In a side outlet blower, the lower timing gear functions as an oil slinger, carrying lubricant to the upper timing gear and providing splash lubrication for the bearings. Pressure within the gearbox is vented through the breather vent plug (25).

The above description also applies in general to the top or bottom outlet style blower, the principal difference being that both gears dip into the oil sump.

Before starting blower, be sure oil has been put in gearhouse, as ALL OIL WAS DRAINED FOLLOWING SHOP TESTS. For recommended lubricating oil see Table 2. Use a good grade industrial type rust, oxidation, and foam inhibited, non-detergent oil such as Mobil DTE BB, Texaco R&O 220, Amoco 220 or equal.

Table 2 — Recommended Oil Grades

Ambient Temperature ° F.	Viscosity Range SSU at 100° F.	ISO No.
(°C)	(38 °C)	
Above 90° (32°)	1000 - 1200	320
32° to 90° (0° to 32°)	700 - 1000	220
0° to 32° (−18° to 0°)	500 - 700	150
Below 0° (−18°)	300 - 500	100

To fill the gearbox, remove the breather plug and the oil overflow plug (Fig. 3). Fill the reservoir up to the overflow hole. Place the breather and the overflow plug back into their respective holes.

Table 3 — Oil Sump Capacities

Frame Size	Capacity, Fl. Oz. (Liters) Vertical	Horizontal
22	3.4 (.1)	6.1 (.18)
24	3.4 (.1)	6.1 (.18)
32	8.5 (.25)	16.0 (.47)
33	8.5 (.25)	16.0 (.47)
36	8.5 (.25)	16.0 (.47)
42	12.7 (.37)	22.8 (.67)
45	12.7 (.37)	22.8 (.67)
47	12.7 (.37)	22.8 (.67)
53	16.0 (.47)	27.6 (.82)
56	16.0 (.47)	27.6 (.82)
59	16.0 (.47)	27.6 (.82)
65	28.3 (.84)	52.1 (1.54)
68	28.3 (.84)	52.1 (1.54)
615	28.3 (.84)	52.1 (1.54)
76	32.3 (.96)	59.5 (1.76)
711	32.3 (.96)	59.5 (1.76)
718	32.3 (.96)	59.5 (1.76)

Proper lubrication is usually the most important single consideration in obtaining maximum service life and the most satisfactory operation from the unit. Unless operating conditions are quite severe, a weekly check of gearhouse oil level and necessary addition of lubricant should be sufficient. However, oil should be changed after initial 100 hours of operation. Thereafter, a complete oil change normally is made after 1000 operating hours, or less, depending on the type of oil and oil operating temperature.

Shaft bearings at the drive end of the blower are grease lubricated and each bearing housing is equipped with pressure type grease fittings and pressure type relief fittings. When servicing drive end bearings, use a NLGI #2 premium grade, petroleum base grease with high temperature (300° service temperature) and moisture resistance and good mechanical stability. Using a pressure gun, force new lubricant into each drive end bearing housing until traces of clean grease comes out of the relief fitting.

After a long shutdown, it is recommended that the grease relief fittings be removed, the old grease flushed out with kerosene or #10 lubricating oil, drained thoroughly, and bearings refilled with new grease. Be sure grease relief fittings are reinstalled. Grease should be added using hand operated grease gun to the drive end bearings at varying time intervals depending on duty cycle and RPM. Table 4 has been prepared as a general greasing schedule guide based on average operating conditions. More frequent intervals may be necessary depending on the grease operating temperature and under unusual circumstances.

Table 4 — Suggested Bearing Lubrication Intervals

Speed in RPM	Operating Hours Per Day: 8	16	24
	Greasing Intervals in Weeks		
750 - 1000	7	4	2
1000 - 1500	5	2	1
1500 - 2000	4	2	1
2000 - 2500	3	1	1
2500 - 3000	2	1	1
3000 and up	1	1	1

OPERATION

Before operating a blower under power for the first time, check the unit and the installation thoroughly to reduce the likelihood of avoidable troubles. Use the following procedure list as a guide, but consider any other special conditions in the installation.

1. **Be certain** that no bolts, tools, rags or dirt have been left in the blower air chamber.
2. **Be certain** that inlet piping is free of debris. If an outdoor intake without filter is used, be sure the opening is located so it cannot pick up dirt and is protected by a strong screen or grille. Use of the temporary protective screen at the blower as described under INSTALLATION is strongly recommended.
3. **Recheck** blower leveling, drive alignment and tightness of all mounting bolts if installation is not recent. If belt drive is used, adjust belt tension correctly.
4. **Turn** drive shaft by hand to make sure impellers still rotate without bumping or rubbing at any point.
5. **Make sure** oil level in blower gearbox is correct.
6. Check lubrication of driver. If it is an electric motor, be sure that power is available and that electrical overload devices are installed and workable.
7. Open the manual unloading valve in the discharge air line. If a valve is in the inlet piping, be sure it is open.
8. Bump blower a few revolutions with driver to check that direction of rotation is correct, and that both units coast freely to a stop.

After the preceding points are cleared, blower is ready for trial operation under "no-load" conditions as set up under Item 7. The following procedure is suggested to cover this initial operating test period.

a. Start blower, let it accelerate to full speed, then shut off. Listen for knocking sounds, both with power on and as speed slows down.
b. Repeat above, but let blower run 2 or 3 minutes. Check for noises, and vibrations of 5 mils or greater.
c. Operate blower for about 10 minutes unloaded. Check oil levels. Feel cylinder and headplate surfaces for development of spots too hot to touch, indicating impeller rubs. Be aware of any noticeable increase in vibration.

Assuming that all trials have been satisfactory, or that necessary corrections have been made, the blower should now have a final check run of at least one hour under normal operating conditions. After blower is restarted, gradually close the discharge unloading valve to apply working pressure. At this point it is recommended that a good pressure gauge or manometer be connected into the discharge line if not already provided, and that thermometers be in both inlet and discharge lines. Readings from these instruments will show whether pressure or temperature ratings of the blower are being exceeded.

During the final run, check operating conditions frequently and observe the oil levels at reasonable intervals. If excessive noise or local heating develops, shut down immediately and determine the cause. If either pressure rise or temperature rise across the blower exceeds the limit specified in this manual shut down and investigate conditions in the piping system or in the process to which air is being supplied. Refer to the **TROUBLE SHOOTING CHECKLIST** for suggestions on various problems that may appear.

The blower should now be ready for continuous duty operation at full speed. During the first few days make periodic checks to determine whether all conditions remain steady, or at least acceptable. This may be particularly important if the blower is supplying air to a process system where conditions can vary. At the first opportunity, stop the blower and clean the temporary inlet protective screen. If no appreciable amount of debris has collected, the screen may be removed. See comments under **INSTALLATION**. At this same time, verify leveling, coupling alignment or belt tension, and mounting bolt tightness.

Should operating experience prove that blower capacity is a little too high for the actual air requirements, a small excess may be blown off continuously through the manual unloading vent valve. **Never rely on the pressure relief valve as an automatic vent.** Such use may cause the discharge pressure to become excessive and can also

TROUBLE SHOOTING CHECKLIST

TROUBLE	ITEM	POSSIBLE CAUSE	REMEDY
No Air Flow	1	Speed too low	Check by tachometer and compare with speed shown on Roots Order Acknowledgement.
	2	Wrong rotation	Compare actual rotation with Figure 2. Change driver if wrong.
	3	Obstruction in piping	Check piping, screen, valves, silencer, to assure an open flow path.
Low capacity	4	Speed too low	See item 1. If belt drive, check for slippage and readjust tension.
	5	Excessive pressure	Check inlet vacuum and discharge pressure, and compare these figures with specified operating conditions on Order.
	6	Obstruction in piping	See item 3.
	7	Excessive slip	Check inside of casing for worn or eroded surfaces causing excessive clearances.
Excessive Power	8	Speed too high	Check speed and compare with Roots Order Acknowledgement.
	9	Pressure too high	See item 5.
	10	Impellers rubbing	Inspect outside of cylinder and headplates for high temperatures areas, then check for impeller contacts at these points. Correct blower mounting, drive alignment.
Overheating of Bearings, or Gears	11	Inadequate lubrication	Restore correct oil levels in gearbox and lubricate.
	12	Excessive lubrication	Check gear oil level. If incorrect, drain and refill with clean oil of recommended grade.
	13	Excessive pressure rise	See item 5.
	14	Coupling misalignment	Check carefully. Realign if questionable.
	15	Excessive belt tension	Readjust for correct tension.
	16	Speed too low	Speeds lower than the minimum recommended will overheat the entire blower.
Vibration	17	Misalignment	See item 14.
	18	Impellers rubbing	See item 10.
	19	Worn bearings/gears	Check gear backlash and condition of bearings.
	20	Unbalanced or rubbing impellers	Scale or process material may build up on casing and impellers, or inside impellers. Remove build-up to retore original clearances and impeller balance.
	21	Driver or blower loose	Tighten mounting bolts securely.
	22	Piping resonances	Determine whether standing wave pressure pulsations are present in the piping. Refer to Distributors.

result in failure of the valve itself. If blower capacity appears to be too low, refer to the TROUBLE SHOOTING CHECKLIST first. If no help is found there it may be possible to increase the blower speed. Before attempting this change, contact the nearest Distributor for recommendations. Be prepared to furnish data on actual air requirements and operating pressure/temperature conditions.

SAFETY PRECAUTIONS

For equipment covered specifically or indirectly in this instruction book, it is important that all personnel observe safety precautions to minimize the chances of injury. Among many considerations, the following should particularly be noted:

- Blower casing and associated piping or accessories may become hot enough to cause major skin burns on contact.
- Internal and external rotating parts of the blower and driving equipment can produce serious physical injuries. Do not reach into any opening in the blower while it is operating, or while subject to accidental starting. Cover external moving parts with adequate guards.
- Disconnect power before doing any work and avoid bypassing or rendering inoperative any safety or protective devices.
- If blower is operated with piping disconnected, place a strong coarse screen over the inlet and avoid standing in the discharge air stream.
- Stay clear of open inlet piping (suction area) of pressure blowers, and the open discharge blast from vacuum blowers.
- Stay clear of the blast from pressure relief valves and the suction area of vacuum relief valves.
- Avoid extended exposure in close proximity to machinery which exceeds safe noise levels.
- Use proper care and good procedures in handling, lifting, installing, operating and maintaining the equipment.
- Casing pressure must not exceed 25 PSI (172 kPa) gauge. Do not pressurize vented cavities from an external source, nor restrict the vents.
- Do not use air blowers on explosive or hazardous gases.
- Other potential hazards to safety may also be associated with operation of this equipment. All personnel working in or passing through the area should be warned by signs and trained to exercise adequate general safety precautions.

MAINTENANCE & REPLACEMENTS

A good program of inspection and maintenance servicing, followed consistently, is the most reliable method of minimizing repairs to a blower. A simple record of services and dates will help keep this work on a regular schedule. Basic service needs are lubrication, checking for hot spots or increase in vibration and noise and the recording of operating pressures and temperatures. Above all, **a blower must be operated within its specified rating limits,** to obtain satisfactory service life.

A newly installed blower should be checked frequently during the first month of full-time operation. Attention thereafter may be less frequent, depending on what the early checks have shown. Lubrication is normally the most important consideration. Unless operating conditions are unusually severe, a weekly check of oil levels in the gearbox, with addition of oil as required, should be sufficient. Complete oil changes should be made at intervals of 1000 operating hours, or more frequently if oil condition becomes poor.

Driver lubrication practices should be in accordance with the manufacturer's instructions. If direct connected to the blower through a lubricated type coupling, the coupling should be checked and greased each time blower oil is changed. This will help reduce wear and prevent it from causing vibration. In a belted drive system, check belt tension periodically and inspect for frayed or cracked belts. Refer to tensioning instructions under INSTALLATION.

In a new and properly installed blower there are no moving contacts between the two impellers, or between the impeller and cylinder or headplates. Wear is then confined to the bearing which support and locate the shafts, the shaft seals, and the timing gears. All are lubricated, and wear should be nominal if clean oil of the correct grade is always supplied. Seals are subject to deterioration as well as wear, and may require replacement at varying periods.

Shaft bearings have been selected to have optimum life under average conditions with proper lubrication. They are critical in the service life of the blower. Gradual bearing wear may allow a shaft position to change slightly, until rubbing develops between impeller and cylinder headplate. This will cause spot heating, which can be detected by feeling these surfaces. Sudden bearing failure is usually more serious. Since the shaft and impeller are no longer supported and properly located, extensive general damage to the blower casing and gears is likely to occur.

Shaft seals should be considered expendible items, to be replaced whenever drainage from the headplate vent cavity becomes excessive or when the blower is disassembled for any reason. Sealing effectiveness can vary considerably from seal to seal and is also affected by shaft smoothness under the seal lip. Because of these normal variables, minor seal leakage should not be considered an indicator for seal replacement.

Timing gear wear, when correct lubrication is maintained should be negligible over a period of years. Gear teeth are cut to provide the correct amount of backlash, and gears correctly mounted on the shafts will accommodate a normal amount of tooth wear without permitting contact between lobes of the two impellers.

However, a high oil level will cause churning and excessive heating, indicated by an unusually high temperature at the bottom of the gear housing. Consequent heating of the gears will result in loss of tooth-clearance or backlash, and rapid wear of the gear teeth usually will develop. Continuation of this tooth wear will eventually produce impeller contacts (knocking), and from this point serious damage will be unavoidable if blower operation is continued. A similar situation can be produced suddenly by gear tooth fracture, which is usually brought on by sustained overloading or momentary shock loads.

Operating problems may also develop from causes other than internal parts failure. Operating clearances within a blower are only a few thousandths of an inch (hundredths of a mm). This makes it possible for impeller interferences or casing rubs to result from shifts in the blower mounting or from changes in piping support. Foreign materials sucked into the blower will also cause trouble, which can only be cured by disconnecting the piping and thoroughly cleaning the blower interior.

If this type of trouble is experienced, and the blower is found to be clean, try removing mounting strains. Loosen blower mounting bolts and reset the leveling and drive alignment. Then tighten mounting again, and make sure that all piping meets blower connections accurately and squarely before reconnecting it.

A wide range of causes for operating troubles are covered in the TROUBLE SHOOTING CHECKLIST. The remedies suggested there in some cases need to be performed by qualified mechanics with a good background of general experience, using procedures detailed in this manual. Major repairs generally are to be considered beyond the scope of maintenance, and should be referred to the nearest Distributor listed on the last page.

Warranty failures should not be repaired at all, unless specific approval has been obtained through a Distributor or a factory before starting work. Unauthorized disassembly within the warranty period may void the warranty.

When a blower is taken out of service it may require internal protection against rusting or corrosion. The need for such protection must be a matter of judgment based on existing conditions as well as length of downtime. Under favorable conditions, protection will probably not be needed if shut-down is not longer than a month. Under atmospheric conditions producing rapid corrosion, the blower should be protected immediately. If blower is to be shut down for an extended period of time, see suggestions for corrosion protection under installation.

It is recommended that major repairs, if needed, be performed at a Dresser authorized service facility. However, it is recognized that this may not always be practical, especially when a spare blower is not available. If a blower is out of the warranty period, mechanical adjustments and parts replacement may be undertaken locally at the owner's option and risk. It is recommended that Factory Parts be used to insure fit and suitability. The maintenance of a small stock of on-hand spare parts can eliminate possible delays. When ordering parts give Item Numbers and their word descriptions from Figures 5 & 6. Also specify quantities wanted and the blower size and serial number from the nameplate.

Repairs or adjustments are best performed by personnel with good mechanical experience and the ability to follow the instructions in this manual. Some operations involve extra care and patience, and a degree of precision work. This is especially true in timing impellers and in handling bearings. Experience indicates that a high percentage of bearing failure is caused by dirt contamination before or during assembly. Therefore, the work area should be cleaned before starting disassembly, and new or re-usable parts protected during progress of the work.

In the following outlines of repair procedures, numbers shown in brackets ( ) correspond to the Item Numbers used in assembly drawing, Figures 11 & 13. It is recommended that the procedure be studied carefully and completely, with frequent reference to the drawings, before starting work. This will produce better efficiency through an understanding of what work is to be done, and the order of doing it. Before disassembly, mark all parts so that they may be returned to original locations or relative positions.

A — Replacing Timing Gears

1. Drain all oil from the gearhouse by removing drain plug (21) in the bottom. Remove gearhouse by taking out all cap screws (23) in its flange. It may be necessary to bump the sides with a wood block or mallet to break the flange joint.
2. Reach through one of the blower pipe connections and place a chalk mark on the strip of one impeller and the mating waist of the other, so that they may easily be returned to their original relative positions.

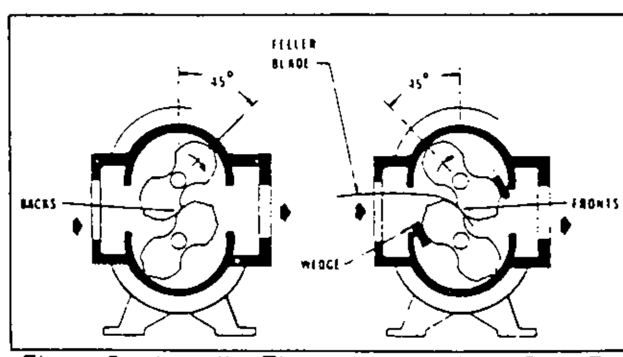


Figure 5 — Impeller Timing Viewed From Gear End

3. GEAR REMOVAL: For this operation, the impellers should be wedged as shown in Figure 5. Back off gear clamping nuts (17) about ¼". Use a puller of the type shown in Figure 10. Position it around the gear per Figure 9. As the puller set screw is torqued, the puller will have a tendency to turn and contact teeth of the other gear. To prevent this contact, hold the puller corner nut with a wrench while torquing the set screw. Once the gear is unseated, remove the puller. Remove gear nuts (17) and the gear. Repeat same procedure for the other gear. NOTE: Do not remove gear nuts (17) completely before the gears are unseated from the taper fits or damage/injury may result.

4. GEAR INSTALLATION: Place impellers in correct position as previously marked. Be sure shafts and gear bores are clean and free of scratches. Clean the shaft tapered fits. Place hardwood wedges as shown in Figure 5. Install drive gear (4) and gear nut (17) so match mark at tooth is at the line of engagement. Tighten the drive gear nut to the torque given in Table 5. Blower assembly must be fastened down for torquing operation.

TABLE 5 — GEAR NUT TORQUE

Gear Size (in.)	Torque lb.-ft.	Torque (kg-m)
2.5	60	(8.3)
3.5	110	(15.2)
4.0	190	(26.3)
5.0	250	(34.6)
6.0	400	(55.3)
7.0	550	(76.1)

5. Installing driven gear (4) - Insert a long, metal feeler gauge between the impellers' lobes at the fronts or backs as shown in Figure 5. Feeler gauge thickness to be a middle value from Table 6 for fronts and backs. Align the gear so the tooth match marks agree with the drive gear, then install nut (17). Tighten lightly with a small wrench, then check front and back clearances against Table 6 for each 45° position. Both fronts and backs should be about the same and within the specified range in Table 6. Adjust gear position, if necessary, then insert the corrected feeler gauge and wedges and use a torque wrench to tighten the gear nut to the torque specified in Table 5. Remove wedges and rotate the drive shaft by hand to make sure there are no gear tight spots or impeller contacts.

   Caution! Keep fingers away from impellers and gears.

6. Check the end clearances between impellers and headplates. Adjust clearances per B-15 below.

7. When clearances are correct, clean and re-install the gearhouse. Check condition of flange gasket (7) and replace if questionable. Fill gearhouse to correct level with proper grade of oil.

B — Replacing Shaft Bearings, and Impellers

Remove coupling or sheave from the drive shaft. Drain and remove gearhouse, and pull the timing gears. If gears are to be re-used, mark them so they may be returned to the same shafts.

1. Break corners and deburr the keyway. Remove bearing end cover at the drive end. Remove bearing clamp plates (34).

2. Make single and double identifying punch marks on the mating edges of headplate and cylinder flanges at the two ends of the blower.

3. At the drive end, drive out the two dowel pins and remove all capscrews holding headplate to cylinder. By inserting jacking screws into the two threaded flange holes, and turning them in evenly, the headplate will be separated from the cylinder. As the headplate comes off the shafts it will bring bearings with it. 2½" and 3½" gear diameter units do not have tapped holes for jack screws in the drive end headplates. Remove dowel pins and all capscrews holding headplate to cylinder and foot on the drive end. Support unit under gear end cylinder flange with the shafts vertical. Using soft metal block against gear end shafts, push them out of gear end headplate.

4. For 2½" and 3½" gear diameter units, support the drive end headplate on the underside, and using soft metal block against drive end, shafts, push them out of drive end headplate.

   For 4", 6" & 7" gear diameter units, from the gear end, using a wood or soft metal block against the ends of the shafts, drive them out of the headplate. If they are to be reused, protect them from damage in this operation.

5. If blower interior surfaces need cleaning, it may be advisable to separate the gear end headplate from the cylinder. Use the same general procedure as employed at the drive end.

6. Working from the back (flat) face of each headplate, push or tap out the bearings and seals. Use a round bar or tube that will pass through the shaft clearance holes in the headplates. All lip seals will be damaged during removal and must be replaced.

7. Clean bearing and seal pockets in headplates and remove burrs or rough edges. (Apply a thin coating of sealant on seal O.D.) Press new seals (27) into gear end headplate using a round tube or bar with recessed end that will bear on the outer metal edge of seal enclosure. Seal lip should point toward the driving tool. Seals to be flush with outboard bore face. Apply a light coat of oil or grease to the seal lips. In a similar fashion, install lip seals into the drive end headplate.

8. Place cylinder on a flat surface. Assemble gear end headplate to cylinder after checking flange punch marks. Drive in the two locating dowel pins before tightening flange screws. Also install gear end foot using the same longer cap screws (32) and washers (41). (on 6" & 7" UNIVERSAL RAI® install both gear and feet.)

9. Place the assembly horizontally on steel blocks with gear end headplate on bottom. The height of the blocks should be sufficient to clear gear end shaft extensions. Assemble impellers into the cylinder with the drive shaft (longer shaft) in same

location as in original assembly. Before starting the shafts through the headplate holes, make sure shaft ends have no sharp or rough edges to damage seal lips. Position impellers at 90° to each other in the cylinder, using lobe-and-waist match marks if original impellers are being re-installed. Install drive end headplate and feet in same manner as gear end.

10. It is recommended that new bearings be used for rebuild. Apply thin film of machine oil on the shaft bearing fit, bearing I.D., and headplate bearing bore. Install drive end bearings into headplate. Use a tube with flanged end that will contact both bearing faces simultaneously. Refer to Fig. 11 for proper bearing depths.

    NOTE: Cylindrical drive bearing should be installed with inner race large shoulder facing outboard.

11. Place blower on its feet on a flat surface. Loosen feet capscrews (32) and square up unit. Re-tighten capscrews (32). Clamp unit down to a solid base for further assembly.

12. Oil the gear end bearing fits as described previously. Install 2½-5" UNIVERSAL RAI® gear end bearings flush with the headplate bearing shoulders using proper drivers. On 6" & 7" UNIVERSAL RAI®, install thrust washer (29) in bearing bores then install gear end bearings so that they protrude $\frac{1}{16}$" (1.6mm) above headplate surface.

13. Install bearing clamp plates (34). On 6" & 7" UNIVERSAL RAI®, impeller end clearances are also to be set during this step. Install clamp plates (34) with capscrews (31) making sure that the gap between the clamp plates and the headplate is even all around, at the same time, set end clearances per Table 5.

14. Install gears and time impellers as in (A).

15. For setting end clearances on 2½-5" gear diameter units, special tools, thrust adjuster fork Fig. 7 and thrust adjuster saddle Figure 8 are required. Refer to Fig. 6 for installation of tools. The flat side of the saddle rests against the bearing inner race and the flat side of the fork rests against the back side of the gear. Install a shim, with thickness equal to gear end clearance (Table 6), between the impeller and the gear end headplates. Tap on top of the fork until the shim becomes snug. Remove the shim and check end clearances. To increase gear end clearance, tap on the end of the gear end shaft with a soft metal mallet. On units, UNIVERSAL RAI®, set end clearances for 6" & 7" by turning capscrews (31) evenly in or out.

16. Install drive end cover (5) after packing bearing cavities with suitable grease. Replace drive shaft seal. Lip must point toward (33) the bearing. Exercise care not to damage the lip as it passes over shaft keyway.

17. Install gasket item (7). Install the gear house after cleaning out the inside. Tighten gear box cap screws (23) evenly. Fill with correct grade of oil until oil flows out through oil level hole. Grease drive and bearings. (See Lubrication.)

18. Reinstall coupling or belt sheave making sure that they have a slight slide fit with the shaft and could be installed by hand.

Where repairs involve parts replacement, it is recommended that Factory Parts be used to insure fit and suitability. Delay in making such repairs can be reduced by having spare parts on hand.

When ordering parts, please furnish all information from the blower nameplate.

Repairs or adjustments to blowers should be performed by personnel with a good back ground of general mechanical experience and the ability to follow the detailed instructions in this manual. No special tools are required. Some operations involve extra care and a degree of precision work. This is especially true in timing impellers, and in handling bearings. Experience indicates that a high percentage of bearing failures is caused by dirt contamination before or during assembly. Therefore, clean the work area before starting disassembly, and protect new or reuseable parts during progress of the work. (See page 23 for Repair Kit Information.)

INTERNAL CLEARANCES

References to operating clearances in this manual include only one mention of the specific amount of clearance to be used or expected. For units in good condition this information is not essential in field service work. Situations may arise, however, when it is desirable to compare existing clearances with the correct Engineering values or to re-establish clearances.

Listed in Table 6 are the ranges of impeller clearances used in factory assembly of normal UNIVERSAL RAI® blowers. It should be kept in mind that clearances may change slightly in service, but should never be less than the minimum values listed. Only well qualified personnel should attempt to measure clearances for direct comparison with this data.

Table 6 — Normal Clearances for UNIVERSAL RAI® Blowers — Inches (MM)

SIZE	IMPELLER ENDS			CYLINDER		IMPELLER
	TOTAL	DRIVE END MINIMUM	GEAR END MINIMUM	INLET & DISCHARGE	CENTER	FRONTS BACKS
22	.006/.010 (.15-.25)	.003 (.08)	.003 (.08)	.004/.005 (.10-.13)	.002/.003 (.05-.08)	.007/.01 (.18-.25)
24	.006/.010 (.15-.25)	.003 (.08)	.003 (.08)	.004/.005 (.10-.13)	.002/.003 (.05-.08)	.007/.01 (.18-.25)
32	.006/.011 (.15-.28)	.003 (.08)	.003 (.08)	.004/.006 (.10-.15)	.002/.003 (.05-.08)	.01/.012 (.25-.30)
33	.006/.011 (.15-.28)	.003 (.08)	.003 (.08)	.004/.006 (.10-.15)	.002/.003 (.05-.08)	.01/.012 (.25-.30)
36	.006/.011 (.15-.28)	.003 (.08)	.003 (.08)	.004/.006 (.10-.15)	.002/.003 (.05-.08)	.01/.012 (.25-.30)
42	.008/.011 (.20-.28)	.004 (.10)	.004 (.10)	.005/.007 (.13-.18)	.003/.004 (.08-.10)	.009/.012 (.23-.30)
45	.008/.013 (.20-.33)	.004 (.10)	.004 (.10)	.005/.007 (.13-.18)	.003/.004 (.08-.10)	.012/.015 (.30-.38)
47	.008/.013 (.20-.33)	.004 (.10)	.004 (.10)	.005/.007 (.13-.18)	.003/.004 (.08-.10)	.012/.015 (.30-.38)
53	.008/.011 (.20-.28)	.004 (.10)	.004 (.10)	.005/.008 (.13-.20)	.003/.004 (.08-.10)	.011/.013 (.28-.33)
56	.008/.013 (.20-.33)	.004 (.10)	.004 (.10)	.005/.008 (.13-.20)	.003/.004 (.08-.10)	.015/.017 (.38-.43)
59	.008/.013 (.20-.33)	.004 (.10)	.004 (.10)	.005/.008 (.13-.20)	.003/.004 (.08-.10)	.015/.017 (.38-.43)
65	.012/.016 (.30-.40)	.008 (.20)	.004 (.10)	.006/.008 (.15-.20)	.006/.008 (.15-.20)	.010/.014 (.25-.36)
68	.014/.018 (.36-.46)	.010 (.25)	.004 (.10)	.006/.008 (.15-.20)	.006/.008 (.15-.20)	.010/.014 (.25-.36)
615	.014/.018 (.36-.46)	.010 (.25)	.004 (.10)	.006/.008 (.15-.20)	.006/.008 (.15-.20)	.010/.014 (.25-.36)
76	.012/.016 (.30-.40)	.008 (.13)	.004 (.10)	.006/.008 (.15-.20)	.006/.008 (.15-.20)	.013/.015 (.33-.38)
711	.014/.018 (.36-.46)	.010 (.25)	.004 (.10)	.006/.008 (.15-.20)	.006/.008 (.15-.20)	.013/.015 (.33-.38)
718	.014/.018 (.36-.46)	.010 (.25)	.004 (.10)	.006/.008 (.15-.20)	.006/.008 (.15-.20)	.013/.015 (.33-.38)

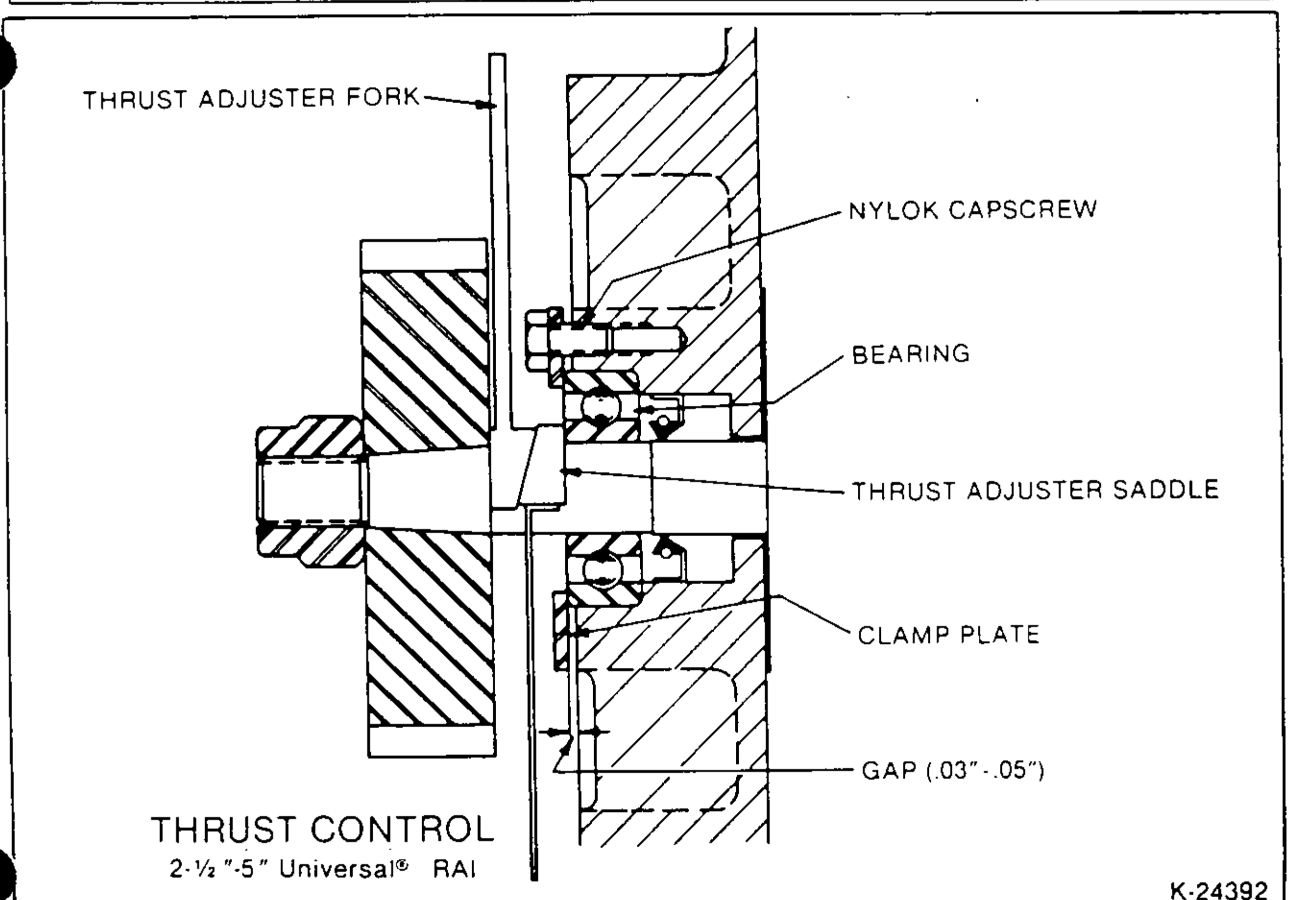
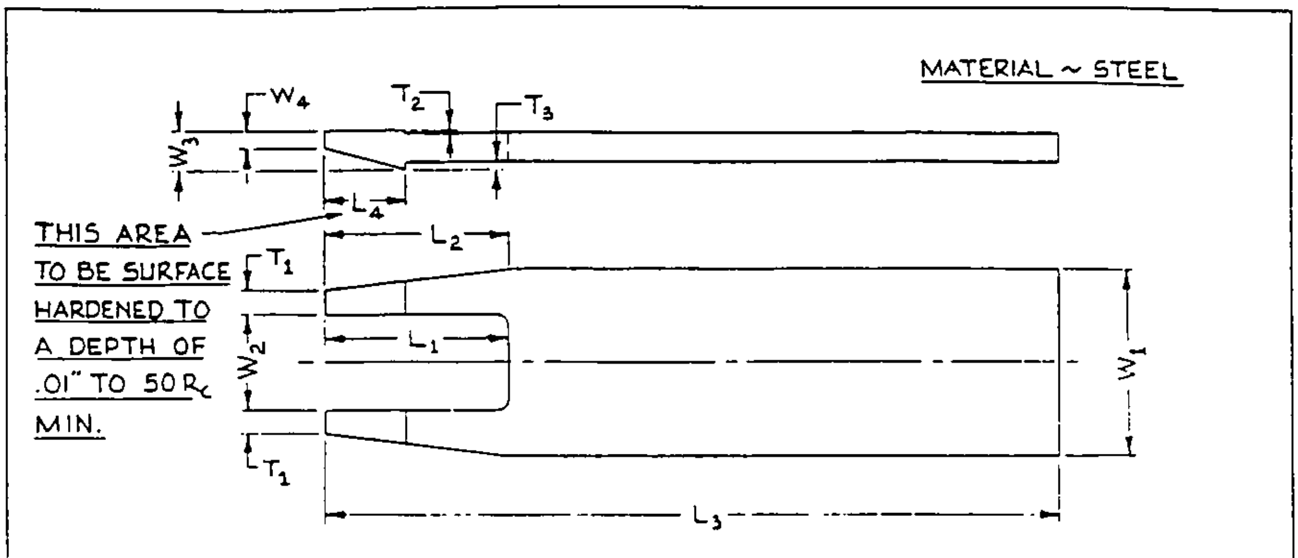
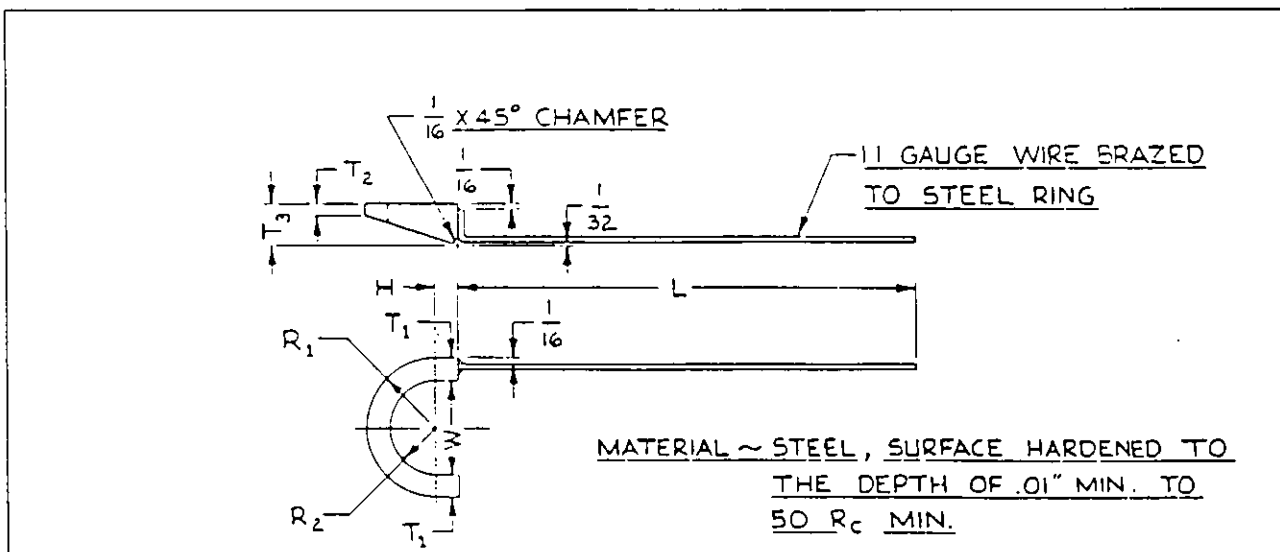


Figure 6 — Thrust Setting, 2½"-5" UNIVERSAL RAI®



PART №	BLW. SIZE	L_1	L_2	L_3	L_4	W_1	W_2	W_3	W_4	T_1	T_2	T_3	NOTES
812-973-001	2 1/2"	1 3/4	1 3/4	6 1/2	9/16	1 3/8	11/16	1/4	1/8	7/32	1/32	1/32	
812-973-002	3 1/2"	2	2	7	7/8	1 1/2	13/16	5/16	1/16	7/32	1/32	1/16	
812-973-003	4"	2	2	7 1/2	1	1 3/4	1 1/32	3/8	1/16	1/4	1/32	1/32	
812-973-004	5"	2 1/4	2 1/4	8	7/8	2	1 1/4	13/32	3/16	1/4	1/32	1/16	

Figure 7 — Thrust Adjuster Fork 812-973



PART №	BLW. SIZE	R_1	R_2	W	T_1	T_2	T_3	H	L	NOTES
812-974-001	2 1/2"	15/32	11/32	11/16	1/8	1/16	1/4	3/16	3	
812-974-002	3 1/2"	5/8	13/32	13/16	7/32	1/16	5/16	3/16	3 1/2	
812-974-003	4"	49/64	33/64	1 1/32	1/4	1/8	7/16	1/4	4	
812-974-004	5"	7/8	5/8	1 1/4	1/4	1/8	7/16	1/4	5	

Figure 8 — Thrust Adjuster Saddle 812-974

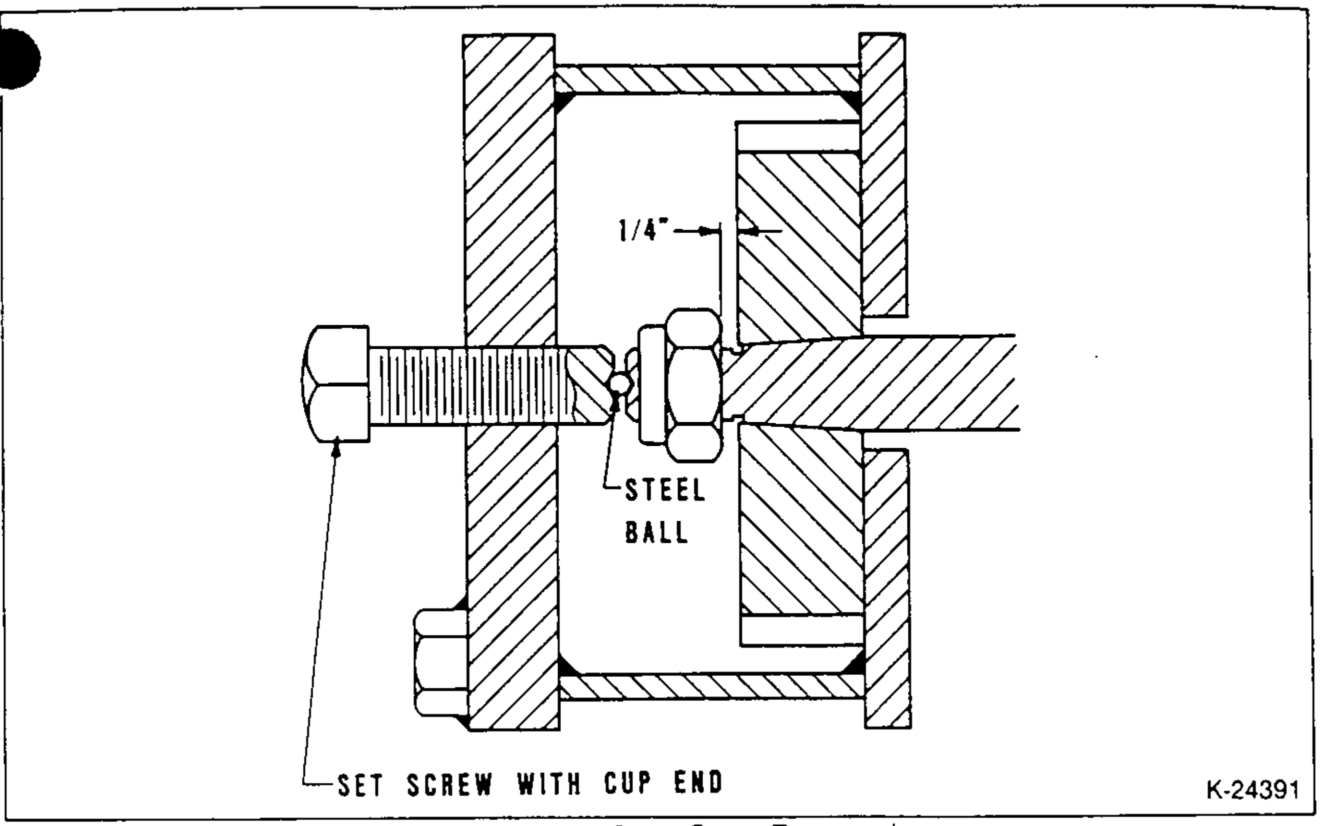
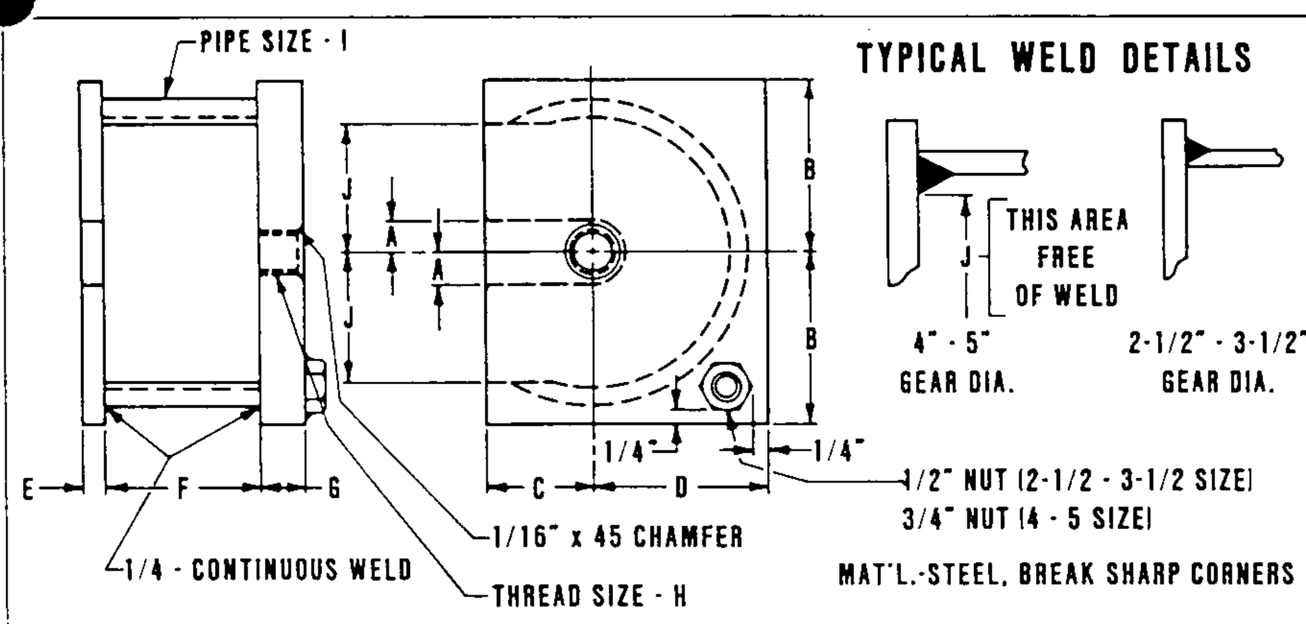


Figure 9 — Gear Removal



BLOWER SIZE	PART NO.	A	B	C	D	E	F	G	H	I	J
2-1/2	812-977-001	3/8	2	1-1/16	2	1/4	2	5/8	7/16-14	3" SCH. - 40	1-3/8
3-1/2	812-977-002	7/16	2-1/2	1-1/4	2-1/2	5/16	2-3/8	3/4	1/2-13	4" SCH. - 40	1-7/8
4	812-977-003	17/32	2-13/16	1-3/4	2-13/16	3/8	2-1/2	3/4	5/8-11	5" SCH. - 40	2-1/8
5	812-977-004	5/8	3-3/8	2	3-3/8	7/16	3	1	3/4-10	6" SCH. - 40	2-11/16

Figure 10 — Gear Pullers for UNIVERSAL RAI® with Tapered Gear Bores 812-977-

NOTES:

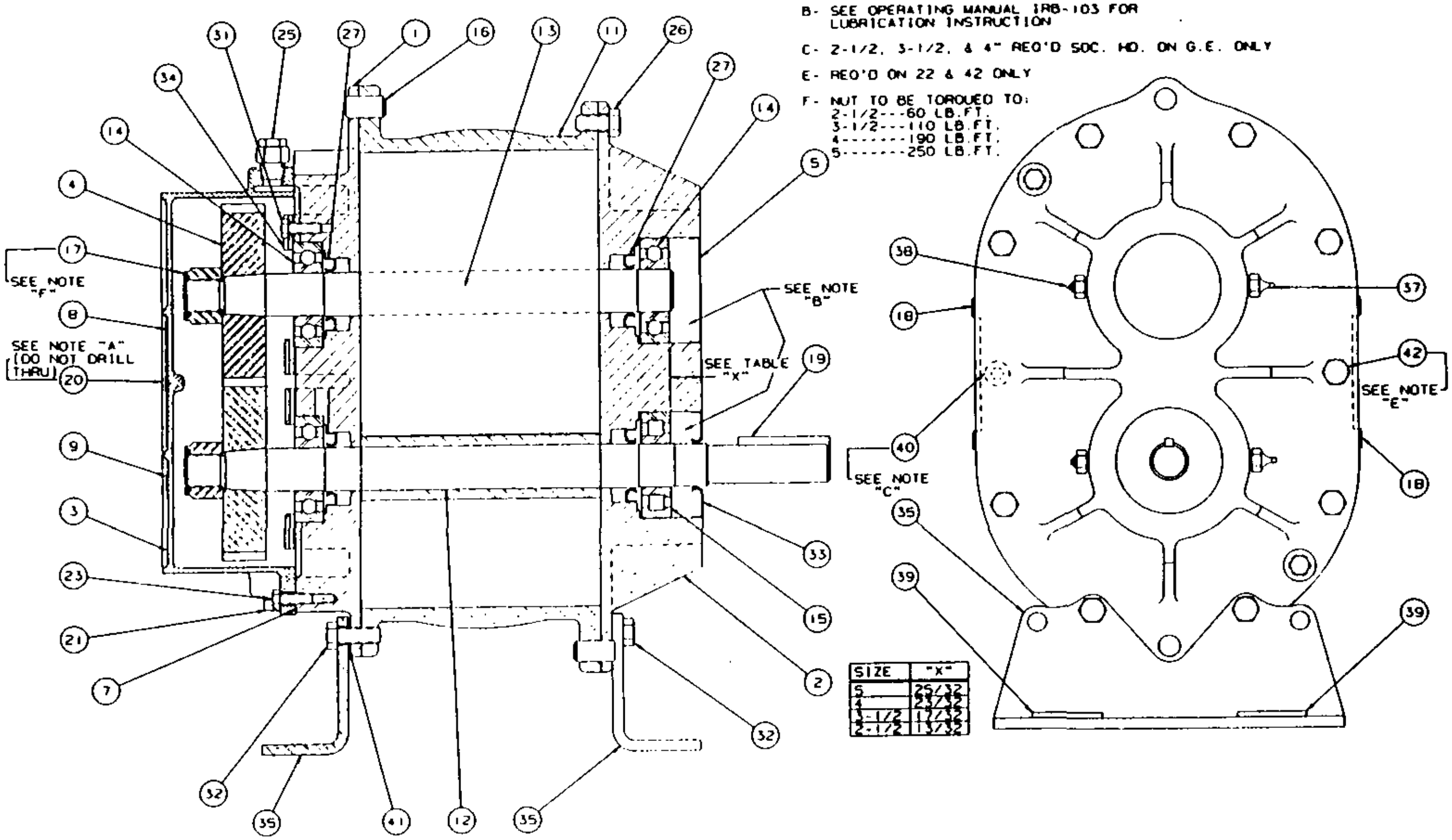
A- #25(.150) DRILL 1/4 DP & INSTALL ITEM #20 (SCREWS) IN ASSEMBLY

B- SEE OPERATING MANUAL IRB-103 FOR LUBRICATION INSTRUCTION

C- 2-1/2, 3-1/2, & 4" REQ'D SOC. HD. ON G.E. ONLY

E- REQ'D ON 22 & 42 ONLY

F- NUT TO BE TORQUED TO:
2-1/2---60 LB.FT.
3-1/2---110 LB.FT.
4-------190 LB.FT.
5-------250 LB.FT.



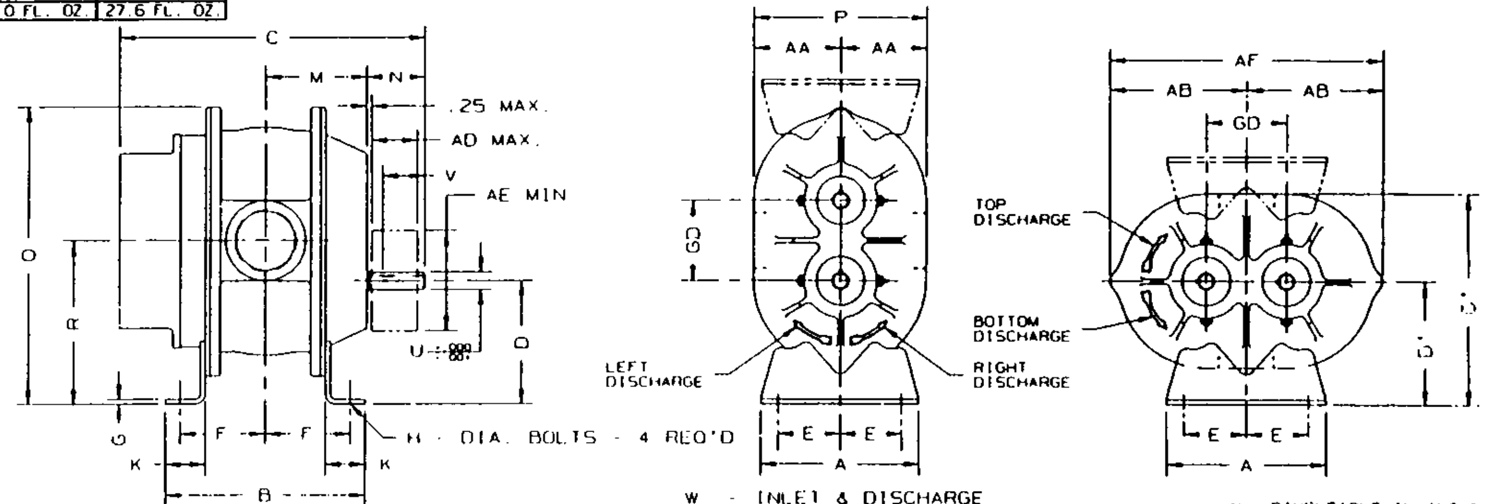
SIZE	"X"
5	25/32
4	23/32
3-1/2	17/32
2-1/2	13/32

ITEM	PART NAME	ITEM	PART NAME	ITEM	PART NAME	ITEM	PART NAME
1	Headplate Gear End	12	Impeller & Shaft-Drive	21	Plug, Pipe	35	Foot
2	Headplate Drive End	13	Impeller & Shaft-Driven	23	Screw, Hex	37	Fitting, Grease
3	Gearbox	14	Bearing G.E.,-Driven	25	Breather	38	Fitting, Relief
4	Gears	15	Bearing D.E.-Drive	26	Screw, Hex	7	Gasket
5	Cover-Blind	16	Pin, Dowel	27	Seal, Lip	39	Washer Flat
8	Nameplate-Serial Number	17	Gear Nut	31	Screw, Hex	40	Screw Socket
9	Nameplate-Lub	18	Plug Tin	32	Screw, Hex	41	Washer
		19	Key	33	Seal Lip-Drive	42	Screw Hex
11	Cylinder	20	Screw, Self Tap	34	Clamp Plate		

864-720-023

Figure 11 — Assembly of UNIVERSAL RAI® Blowers, 2½"-5" Gear Diameter

FRAME	APPROX. OIL CAPACITY	
	VERTICAL	HORIZONTAL
2-1/2	3.4 FL. OZ.	6.1 FL. OZ.
3-1/2	8.5 FL. OZ.	16 FL. OZ.
4	12.7 FL. OZ.	22.8 FL. OZ.
5	16.0 FL. OZ.	27.6 FL. OZ.



UNIVERSAL RAI BLOWER

W - INLET & DISCHARGE
AD - SHEAVE WIDTH
AE - SHEAVE DIAMETER

ALL DIMENSIONS IN INCHES

FRAME SIZE	GD	A	B	C	D	D'	E MIN.	E MAX.	F MIN.	F MAX.	G	H	K	M	N	O	O'	P	R	U	KEYWAY	W NPT.	V	AA	AB	AD	AE	AF	APPROX. WT. LBS
22	2.5	5.13	5.00	9.75	3.75	3.75	1.50	2.00	2.00	2.00	.25	.38	1.25	2.63	2.50	9.63	6.88	6.25	5.00	.625	.188 x .094	1"	1.81	3.13	4.63	1.75	4.00	9.25	32
24	"	"	7.00	11.75	"	"	"	"	3.00	3.00	"	"	"	3.63	"	"	"	"	"	"	"	2"	"	"	"	"	"	"	43
32	3.50	7.25	6.75	11.25	5.00	5.00	2.50	2.88	2.56	2.81	.25	.44	1.75	3.38	2.44	12.81	8.88	7.75	6.75	.750	.188 x .094	1-1/4"	1.63	3.88	6.06	1.91	5.00	12.13	69
33	"	"	7.63	12.13	"	"	"	"	3.00	3.25	"	"	"	3.81	"	"	"	"	"	"		2"	"	"	"	"	"	"	74
36	"	"	10.00	14.63	"	"	"	"	4.18	4.44	"	"	"	5.00	2.56	"	"	"	"	"		2-1/2"	1.75	"	"	"	"	"	102
42	4.00	8.00	7.25	13.00	6.25	6.25	3.00	3.13	2.50	3.13	.31	.44	2.00	3.68	3.18	15.06	10.63	8.75	8.25	.875	.188 x .094	1-1/2"	2.31	4.38	6.81	2.31	5.00	13.63	88
45	"	"	10.00	15.50	"	"	"	"	3.56	4.25	"	"	"	5.06	2.94		"	"	"	"		2-1/2"	2.13	"	"	"	"	"	109
47	"	"	11.75	17.63	"	"	"	"	4.63	5.38	"	"	"	5.94	3.31	"	10.50	8.50	"	"		3"	2.50	4.25	"	"	"	"	128
53	5.00	10.50	8.38	15.38	6.25	6.75	3.50	3.50	3.18	3.68	.25	.50	1.88	4.50	3.68	17.38	11.88	10.25	8.75	1.125	.25 x .125	2-1/2"	2.75	5.13	8.63	3.06	6.00	17.25	143
56	"	"	11.00	18.00	"	"	"	"	4.25	5.00	"	"	"	5.81	3.38	"	12.25	11.00	"	"	"	4"	2.50	5.50	"	"	"	"	170
59	"	"	14.00	21.00	"	"	"	"	6.00	6.50	"	"	"	7.31	3.88	"	"	"	"	"	"	4"	3.00	"	"	"	"	"	204

CERTIFIED CORRECT FOR
CUSTOMER ORDER No. ____________
ROOTS ORDER No. ____________
DATE ____________

V-BELT DRIVE DATA
BELTS
DRIVE SHEAVE
DRIVEN SHEAVE
CENTER DISTANCE

ROOTS DRESSER

DRESSER INDUSTRIES, INC
ROOTS DIVISION
900 WEST MOUNT STREET
CONNERSVILLE, INDIANA 47331

862-795-021

PRINTED IN U.S.A.

Figure 12 — Dimensional Assembly of UNIVERSAL RAI® Blower (2½"-5")

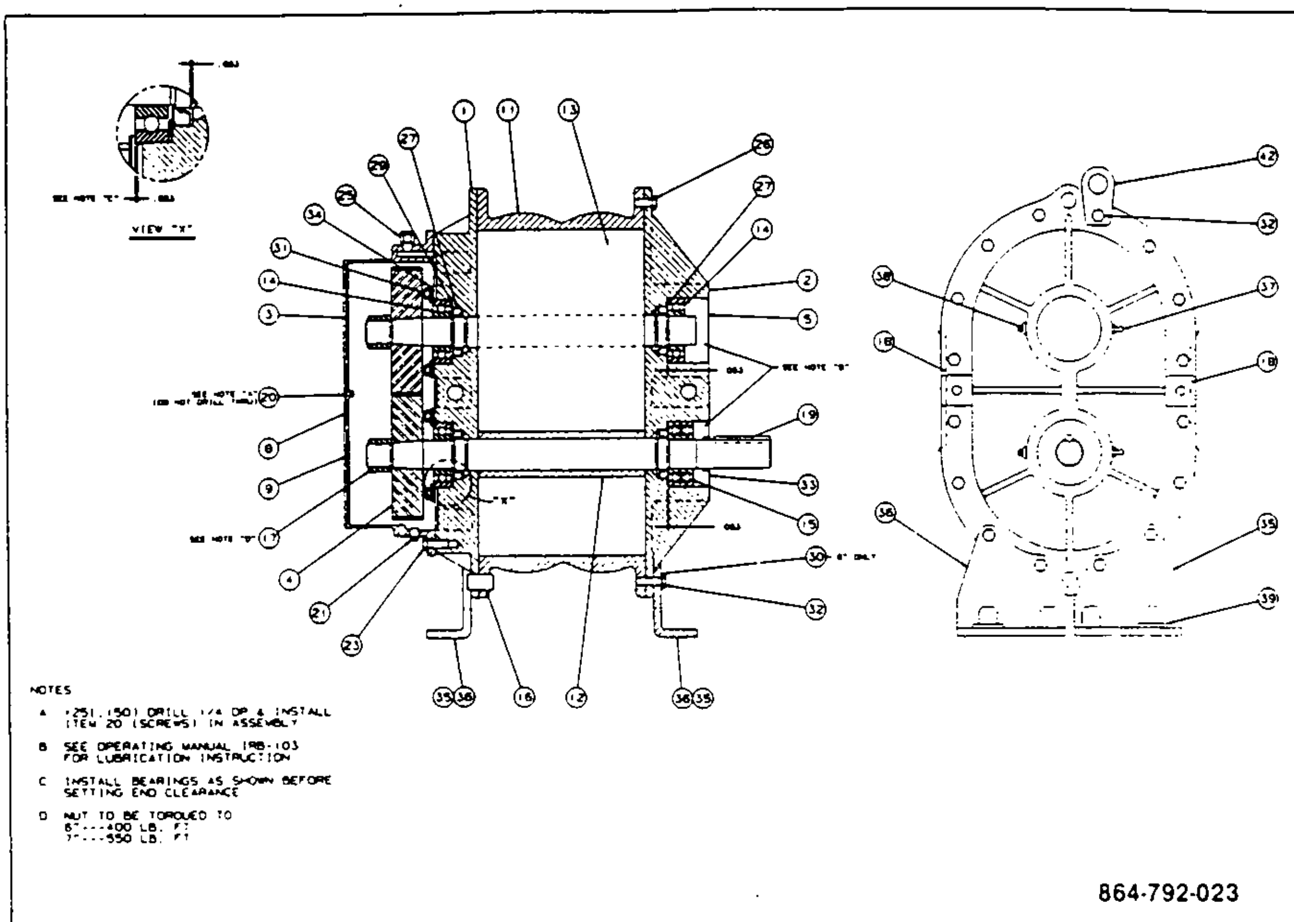
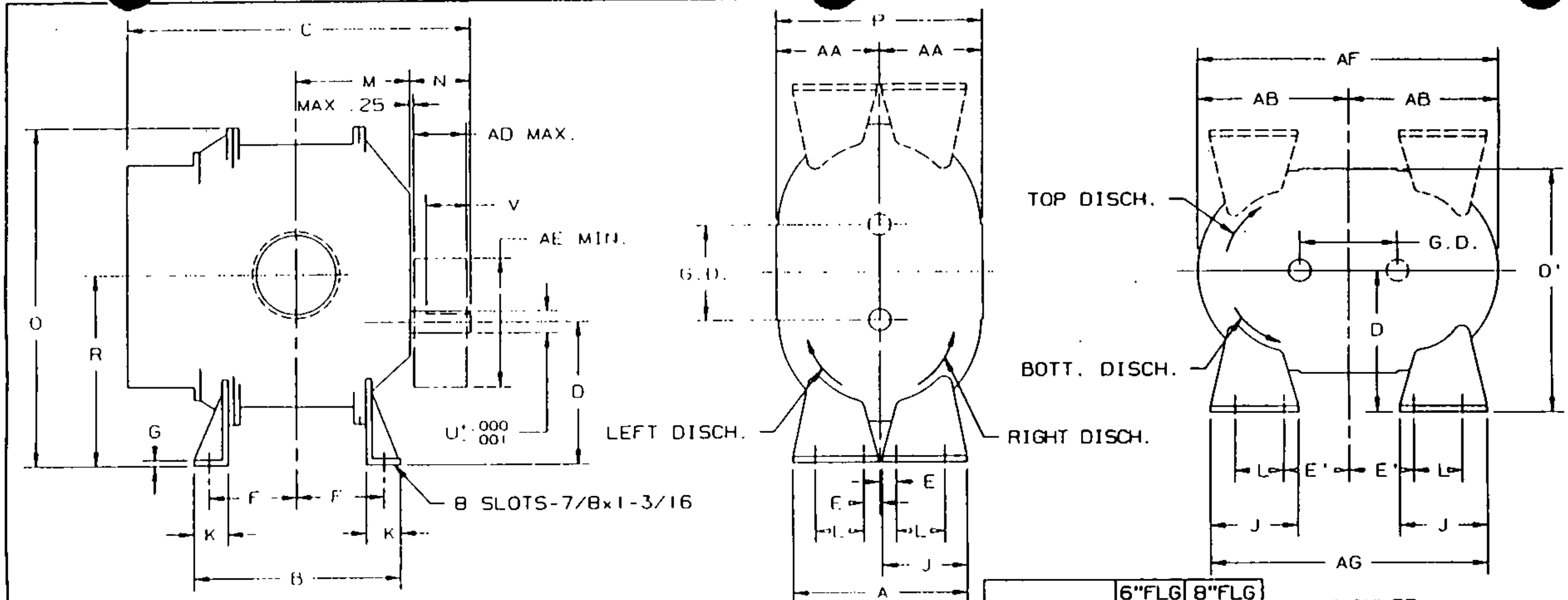


Figure 13 — Assembly of UNIVERSAL RAI® Blowers, 6" and 7" Gear Diameter

PARTS LIST FOR 6"-7" UNIVERSAL RAI®

ITEM	PART NAME	ITEM	PART NAME	ITEM	PART NAME	ITEM	PART NAME
1	Headplate - G.E.	13	Imp & Shaft - Drvn	25	Plug - Vent	36	Foot - Lt. Hand
2	Headplate - D E.	14	Bearing, Ball	26	Screw, Cap - Hex	37	Fitting, Grease
3	Gearbox	15	Bearing, Roller	27	Seal, Lip	38	Plug - Vent
4	Gear Assembly	16	Pin, Dowel	29	Washer - Wavy Spr.	39	Washer - Oblong
5	Plug - Opening	17	Nut, Stop - Hex	30	Washer	40	Pipe - Tbe. (Close)
7	Gasket, Gearbox	18	Plug - Opening	31	Screw, Cap Hex	41	Coupling - Pipe
8	Nameplate - S/N	19	Key, Square	32	Screw, Cap Hex	42	Lifting Lug
9	Nameplate - Lube	20	Screw, Rd. Hd.	33	Seal, Lip		
11	Cylinder	21	Plug, Pipe - Sq. Hd	34	Brg. Clamp Plate		
12	Imp & Shaft — Drive	23	Screw, Cap - Hex	35	Foot - Rt. Hand		



	6"FLG	8"FLG
OPENING	6.00	8.00
BOLT CIRCLE	9.50	11.75
FLANGE O.D	11.00	13.50
NO. TAPPED HOLES	8	8
SIZE HOLES	3/4-10	3/4-10
TAP DEPTH	1.13	1.13

W-INLET
W'-DISCHARGE
AD-SHEAVE WIDTH
AE-SHEAVE DIA.
ALL DIM. IN INCHES

UNIVERSAL RAI® BLOWER

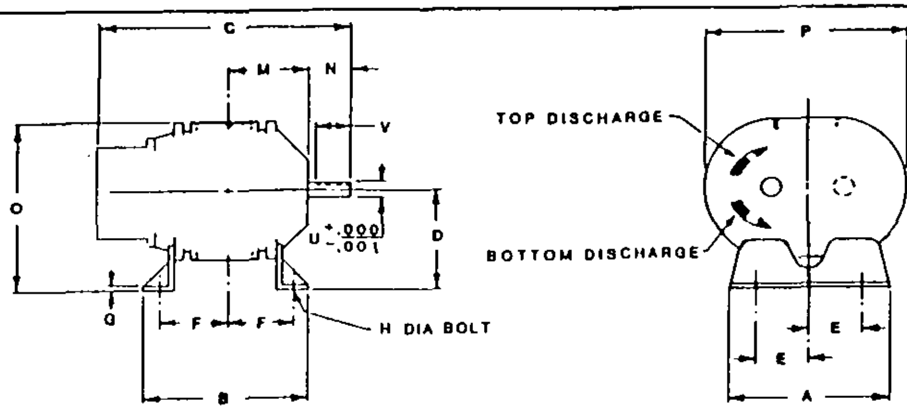
UNIT SIZE	APPROX. OIL CAP.		G.D.
	VERT.	HORIZ.	
6"	28.3 FL OZ	52.1 FL OZ	6.00
7"	32.3 FL OZ	59.5 FL OZ	7.00

FRAME SIZE	A	B	C	D	E	E'	F	G	J	K	L	M	N	O	O'
65	11.00	10.00	18.38	8.75	1.00	4.00	3.81	.38	5.38	2.13	3.00	5.63	3.56	21.63	15.13
68	"	13.00	21.38	"	"	"	5.31	"	"	"	"	7.13	3.69	"	"
615	"	20.00	28.38	"	"	"	8.81	"	"	"	"	10.63	"	"	16.25
76	14.00	11.75	19.94	11.00	2.00	5.50	4.88	.50	6.75	2.38	3.50	5.94	4.06	26.13	20.69
711	"	16.75	25.19	"	"	"	7.38	"	"	"	"	8.44	4.31	"	19.50
718	"	23.75	32.19	"	"	"	10.88	"	"	"	"	11.94	"	"	"

FRAME SIZE	P	R	U	V	KEYWAY	W	W'	AA	AB	AD	AE	AF	AG	APPROX WEIGHT
65	12.75	11.75	1.375	2.75	.312x.156	3"NPT	3"NPT	6.38	9.88	3.44	8.00	19.75	17.00	245 LBS
68	"	"	"	"	"	5"NPT	5"NPT	"	"	"	"	"	"	285 LBS
615	15.00	"	"	"	"	6"FLG	6"FLG	7.50	"	"	"	"	"	425 LBS
76	19.38	14.5	1.562	3.00	.375x.188	4"NPT	4"NPT	9.69	11.63	3.75	9.50	23.25	21.00	400 LBS
711	17.00	"	"	"	"	6"FLG	6"FLG	8.50	"	"	"	"	"	530 LBS
718	"	"	"	"	"	8"FLG	8"FLG	"	"	"	"	"	"	650 LBS

862-753-021

Figure 14 — Dimensional Assembly of UNIVERSAL RAI® Blower (6" & 7")



NOTE:
UNIVERSAL RAI

1. 45 & 56 U-RAI WILL HAVE TO RUN AT REDUCED SPEED TO DUPLICATE AF PERFORMANCE.
2. LARGER STANDARD SHAFT THAN AF. SEE DIMENSION "U".
3. U-RAI INLET & OUTLET CONNECTIONS ARE LARGER THAN AF ON THE FOLLOWING SIZES: 24, 45, 47, 56 & 59. SEE DIMENSION "W".
4. 45 U-RAI REPLACES 44 AF. 56 U-RAI REPLACES 55 AF.
5. FOR ADDITIONAL INFORMATION CONTACT YOUR SALES REPRESENTATIVE OR THE FACTORY.

W-INLET & DISCHARGE

ALL DIMENSIONS IN INCHES

DIMENSIONS NOT CERTIFIED FOR CONSTRUCTION

FRAME SIZE	A	B	C	D	E	F	H	M	N	O	P	U	V	KEYWAY	W
22 U-RAI	5.13	5.00	9.75	3.75	2.00	2.00	3/8	2.63	2.50	6.88	9.25	.625	1.81	3/16 x 3/32	1" NPT
22 AF	5.50	5.06	9.13	3.75	2.00	2.00	3/8	2.63	1.94	6.86	9.25	.5875	1.31	3/16 x 3/32	1" NPT
24 U-RAI	5.13	7.00	11.75	3.75	2.00	3.00	3/8	3.63	2.50	6.88	9.25	.625	1.81	3/16 x 3/32	2" NPT
24 AF	5.50	7.06	11.13	3.75	2.00	3.00	3/8	3.63	1.94	6.88	9.25	.5875	1.31	3/16 x 3/32	1-1/2" NPT
33 U-RAI	7.25	7.63	12.13	5.00	2.68	3.00	3/8	3.81	2.44	8.88	12.13	.750	1.63	3/16 x 3/32	2" NPT
33 AF	7.25	7.44	12.56	5.00	2.68	3.00	3/8	3.81	2.63	8.88	12.13	.6562	1.66	3/16 x 3/32	2" NPT
36 U-RAI	7.25	10.00	14.63	5.00	2.86	4.18	3/8	5.00	2.56	8.88	12.13	.750	1.75	3/16 x 3/32	2-1/2" NPT
36 AF	7.25	9.81	14.94	5.00	2.88	4.18	3/8	5.00	2.63	8.68	12.13	.6562	1.88	3/16 x 3/32	2-1/2" NPT
42 U-RAI	8.00	7.25	13.00	6.25	3.13	2.94	3/8	3.68	3.16	10.63	13.63	.875	2.31	3/16 x 3/32	1-1/2" NPT
42 AF	8.25	7.13	12.68	6.25	3.13	2.94	3/8	3.68	3.00	10.63	13.63	.7812	2.38	3/16 x 3/32	1-1/2" NPT
45 U-RAI	8.00	10.00	15.50	6.25	3.13	3.56	3/8	5.06	2.94	10.63	13.63	.875	2.13	3/16 x 3/32	2-1/2" NPT
44 AF	8.25	8.83	14.13	6.25	3.13	3.56	3/8	4.31	3.00	10.63	13.63	.7612	2.38	3/16 x 3/32	2" NPT
47 U-RAI	8.00	11.75	17.63	6.25	3.13	5.18	3/8	5.94	3.31	10.50	13.63	.875	2.50	3/16 x 3/32	3" NPT
47 AF	8.25	11.63	17.38	6.25	3.13	5.18	3/8	5.94	3.00	10.63	13.63	.7812	2.30	3/16 x 3/32	2-1/2" NPT
53 U-RAI	10.50	8.38	15.38	6.75	4.25	3.69	3/8	4.50	3.66	11.88	17.25	1.125	2.75	1/4 x 1/8	2-1/2" NPT
53 AF	10.75	8.81	15.44	5.75	4.25	3.69	3/8	4.50	3.63	12.00	17.25	.9687	2.86	1/4 x 1/8	2-1/2" NPT
56 U-RAI	10.50	11.00	18.00	6.75	4.25	4.25	3/8	5.81	3.38	12.25	17.25	1.125	2.50	1/4 x 1/8	4" NPT
55 AF	10.75	9.81	16.56	6.75	4.25	4.25	3/8	5.06	3.63	12.00	17.25	.9687	2.08	1/4 x 1/8	2-1/2" NPT
59 U-RAI	10.50	14.00	21.18	6.75	4.25	6.50	3/8	7.31	3.38	12.25	17.25	1.125	3.00	1/4 x 1/8	4" NPT
59 AF	10.75	14.31	21.06	6.75	4.25	6.50	3/8	7.31	3.63	12.00	17.25	.9687	2.88	1/4 x 1/8	3" NPT

ROOTS DRESSER

DRESSER INDUSTRIES INC
ROOTS OPERATIONS
900 WEST MOUNT STREET,
CONNERSVILLE, INDIANA 47331

COMPARING ROOTS UNIVERSAL RAI® TO ROOTS AF

DB 1-7-85

863-813-021

PRINTED IN U.S.A.

Figure 15

Major Changes when Replacing AF with UNIVERSAL RAI® Blower

Size & Type	Sheave Bushing Dia.	Inlet Size	Disch. Size	Mounting Feet
22 UNIVERSAL RAI® 22 AF	.625" .5875"	1" 1"	1" 1"	Interchangeable
24 UNIVERSAL RAI® 24 AF	.625" .5875"	2" 1½"	2" 1½"	Interchangeable
32 UNIVERSAL RAI® 315 AF	.750" .6562"	1¼" ¾"	1¼" ¾"	Special Feet
33 UNIVERSAL RAI® 33 AF	.750" .6562"	2" 2"	2" 2"	Interchangeable
36 UNIVERSAL RAI® 36 AF	.750" .6562"	2½" 2½"	2½" 2½"	Interchangeable
42 UNIVERSAL RAI® 42 AF	.875" .7812"	1½" 1½"	1½" 1½"	Interchangeable
45 UNIVERSAL RAI® 44 AF	.875" .7812"	2½" 2"	2½" 2"	Reverse Feet
47 UNIVERSAL RAI® 47 AF	.875" .7812"	3" 2½"	3" 2½"	Interchangeable
53 UNIVERSAL RAI® 53 AF	1.250" .9687"	2½" 2½"	2½" 2½"	Special Feet
56 UNIVERSAL RAI® 55 AF	1.250" .9687"	4" 2½"	4" 2½"	Special Feet
59 UNIVERSAL RAI® 59 AF	1.250" .9687"	4" 3"	4" 3"	Special Feet

*To maintain AF performance with UNIVERSAL RAI®, the blower speed will have to be reduced by sheave change. See Fig. 15 drawing for your specific blower size.

CAUTION CAUTION CAUTION
MAKE CERTAIN THAT THE BREATHER IS LOCATED ON TOP AND THE DRAIN PLUG IN THE BOTTOM OF THE GEAR BOX.

GENERAL TERMS

CONTRACT PERFORMANCE, INSPECTION AND ACCEPTANCE

A. Unless Seller specifically assumes installation, construction or start-up responsibility, all products shall be finally inspected and accepted within thirty (30) days after receipt at point of delivery. Products not covered by the foregoing and all work shall be finally inspected and accepted within thirty (30) days after completion of the applicable work by Seller. All claims whatsoever by Buyer (including claims for shortages) excepting only those provided for under the WARRANTY AND LIMITATION OF LIABILITY and PATENTS Clause hereof must be asserted in writing by Buyer within said thirty (30) day period or they are waived. If this contract involves partial performance, all such claims must be asserted within said thirty (30) day period for each partial performance. There shall be no revocation of acceptance.

Rejection may be only for defects substantially impairing the value of products or work and Buyer's remedy for lesser defects shall be those provided for under the WARRANTY AND LIMITATION OF LIABILITY Clause.

B. Seller shall not be responsible for nonperformance or delays in performance occasioned by any causes beyond Seller's reasonable control, including, but not limited to, labor difficulties, delays of vendors or carriers, fires, governmental actions and material shortages. Any so occasioned shall effect a corresponding extension of Seller's performance dates which are, in any event, understood to be approximate. In no event shall Buyer be entitled to incidental or consequential damages for late performance or a failure to perform.

TITLE AND RISK OF LOSS

Full risk of loss (including transportation delays and losses) shall pass to the Buyer upon delivery of products to the f.o.b. point or if Seller consents to a delay in shipment beyond the contract date at the request of the Buyer, upon notification by the Seller that the products are manufactured.

WARRANTY AND LIMITATION OF LIABILITY

A. Seller warrants that its products and parts, when shipped, and its work (including installation, construction and start-up), when performed will meet all applicable specifications and other specific product and work requirements (including those of performance), if any, of this agreement, will be of good quality and will be free from defects in material and workmanship. All claims for defective products or parts under this warranty must be made in writing immediately upon discovery and, in any event, within eighteen (18) months after installation (not to exceed twenty-four (24) months after shipment) of the applicable item and all claims for defective work must be made in writing immediately upon discovery and in any event within eighteen (18) months after installation (not to exceed twenty-four (24) months after shipment) of completion thereof by Seller. Defective items must be held for Seller's inspection and returned to the original f.o.b. point upon request. THE FOREGOING IS EXPRESSLY IN LIEU OF ALL OTHER WARRANTIES WHATSOEVER, EXPRESS, IMPLIED AND STATUTORY, INCLUDING WITHOUT LIMITATION, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS.

B. Upon Buyer's submission of a claim as provided above and its substantiation, Seller shall at its option either (i) repair or replace the unit claimed defective within the warranty period defined above, regardless of cause of failure EXCEPT shipping damage, vandalism or mishandling, i.e. dropping or other external impact damage, at the original f.o.b. point of delivery, or (ii) refund an equitable portion of the purchase price.

Seller reserves the right to withdraw the Uncontested Warranty where evidence indicates repeated failures are due to misapplication, abuse, or operation not in accordance with Roots operating instruction bulletin.

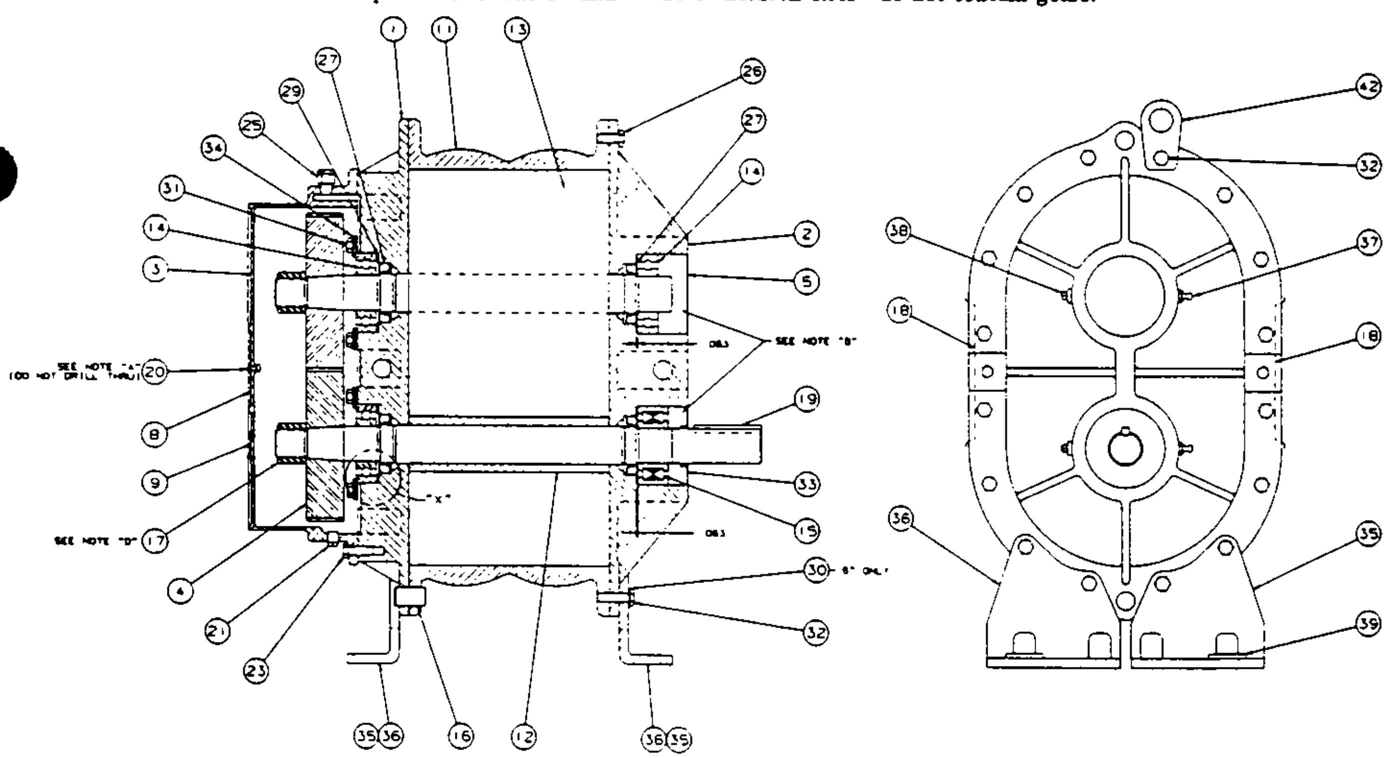
C. The warranty specified herein shall apply to this contract, but it is specifically understood that products sold hereunder are not warranted for operation with erosive or corrosive fluids or those which may tend to build-up within the product quoted. No product or part shall be deemed to be defective by reason of failure to resist erosive or corrosive action of any fluid and Buyer shall have no claim whatsoever against Seller therefore, nor for problems resulting from build-up of material within the unit.

D. The foregoing is Seller's only obligation and Buyer's only remedy for breach of warranty, and except for gross negligence, willful misconduct and remedies permitted under the CONTRACT PERFORMANCE, INSPECTION AND ACCEPTANCE and the PATENTS Clause hereof, the foregoing is Buyer's only remedy hereunder by way of breach of contract, tort or otherwise. In no event shall Buyer be entitled to incidental or consequential damages. Any action for breach of this agreement must commence

REPAIR KIT INFORMATION

UNIVERSAL RAI®				
REF. NO.	QTY.	PART DESCRIPTION	REPAIR KIT PART NOS.	
4	1 Pr.	Timing Gear	FRAME SIZE	REPAIR KIT NO.
5	1	Plug — Opening	2"	65-101-ORK
7	1	Gasket	3"	65-104-ORK
14	1	Bearing, D.E. — DRVN	4"	65-107-ORK
14	2	Bearing, G.E.	5"	65-111-ORK
15	1	Bearing, Dr. Shaft	*6"	65-115-ORK
17	1	Gear Nut	*7"	65-119-ORK
27	2	Seals, D.E.		
27	2	Seals, G.E.		
31	4	Capscrew — Selflock		
33	1	Seal — Dr. Shaft		

*Repair kits for the 6" and 7" UNIVERSAL RAI® do not contain gears.



SEE BACK COVER FOR NEAREST DISTRIBUTOR.

Z-Z Conveying Technology Inc.

ROANOKE CEMENT COMPANY

HYCO POWER PLANT

RECOMMENDED SPARE PARTS
PROJECT NO. A335
CUSTOMER P.O. NO. M1375

DUST COLLECTOR

Part No.	Description	Qty. Recommended	Price/ Each
FK 39(37)	Cartridge Filter Spun Bond Polyester	10	$65.00
5022	Bag Clamp	10	1.00
5007-A.S.	Solenoid valve rep. kit	2	25.00
5012A-A.S.	1" R.A. valve rep. kit	2	24.00

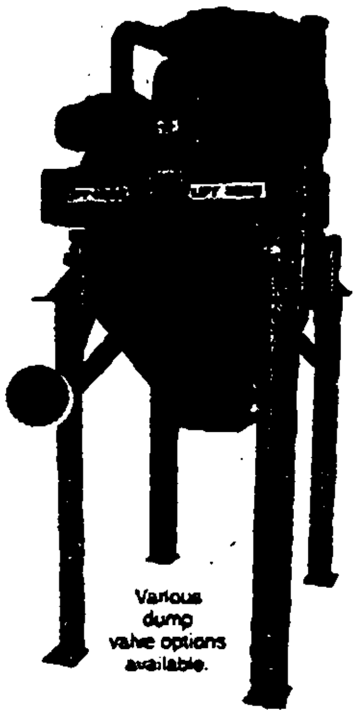
Control Technology Specifications
Emission Point 4
Clean-up Vacuum Vent

Control Equipment:	**Pulse Jet Fabric Filter**
Manufacturer:	**Max Vac**
Model #:	**AK15E**

AK SERIES
5 to 40 HP Industrial Vacuum Systems

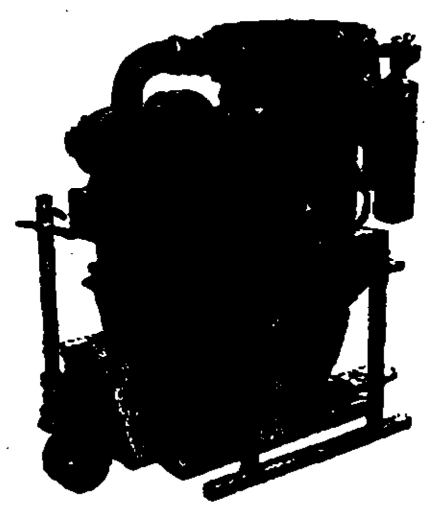
DEMARCO MAX VAC CORPORATION

FEATURING OUR UNEQUALLED AND PATENTED SIMPLISTIC 3 STAGE/2 COMPARTMENT LATERALLY OFFSET MATERIAL SEPARATION FILTRATION CIRCUIT AND SILENCER BASE® MUFFLER



Various dump valve options available.

The AK Series, which can handle up to 12 tons per hour of any wet or dry material, is our new, compact, and versatile MAX VAC® vacuum cleaner/loader specifically designed for smaller volume vacuuming applications requiring up to 4" diameter hose size. It has the identical patented separation and filtration circuit, high suction power, ruggedness, ease-of-use, and maintenance-free features as our technologically advanced larger MAX VAC® vacuum cleaners/loaders.



PATENTED SEPARATION AND "WASHABLE" CARTRIDGE FILTRATION SYSTEM

- Continual compressed air-pulse cleaning of the cartridge filter allows uninterrupted no-plug vacuuming.
- Nonstick membrane cartridge filtration system design provides near HEPA filtration efficiency (99.95% of .33 micron).
- MAXFILTER™ Cartridge Filter is washable, reusable, and near indestructible.
- Low filter drag.
- Cartridge filter has a devoted pulse valve with compressed air receiver for superior high energy pulse filter cleaning.
- No troublesome heavy filter caking, loading, or high differentials which causes dust passage through the vacuum pump and into the atmosphere.
- "Quick Change" cartridge filter is easily replaceable in few minutes.

PATENTED SILENCER BASE® MUFFLER

- Silences the positive displacement vacuum pump noise level down to 85 dBa range or less @ 1 meter freefield.
- Silences LPG or diesel engine driven vacuum pump noise down to acceptable levels.
- No expensive or obstructing sound enclosure required.

GENERAL INDUSTRIES SERVED

Foundry, mining, power plant, paper, cement, railroad, ship yards, brick, shot blast, etc.

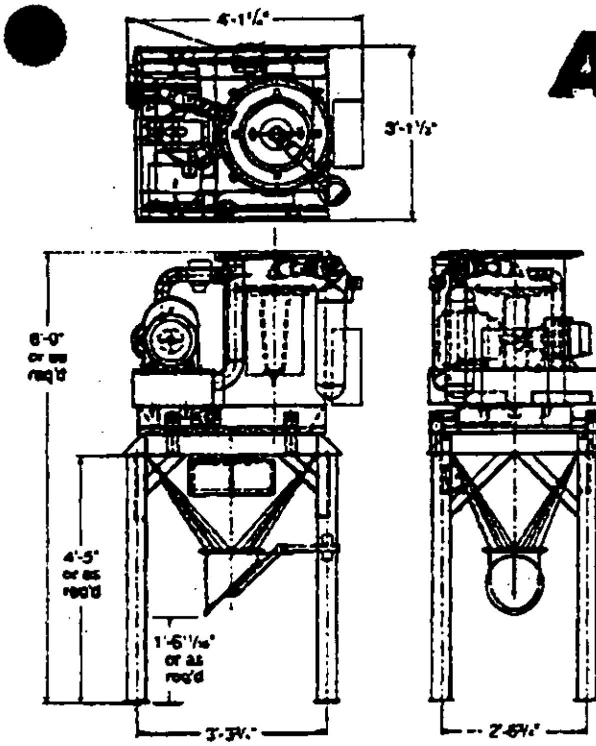
EQUIPMENT USES

Hazardous, environmental, spills, general plant cleanup, pneumatic conveying, raw material reclamation, custom designed turnkey installed manifold systems, bulk loading and unloading, etc.

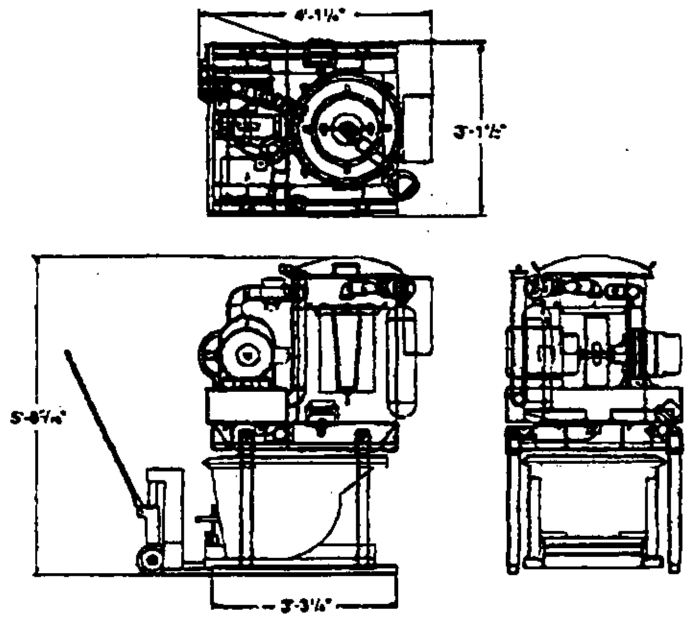
VARIOUS MATERIALS VACUUMED

Any wet/dry, hazardous, or abrasive material including carbon black, coal, cullet, oil sludge, foundry sand, steel shot, food products, paper products, brick particles, powders, aluminum oxide, ore, trona, sludge, machining chips, taconite, etc.

AK SERIES SPECIFICATIONS



STATIONARY



PORTABLE

OTHER SERVICES

On-site demos, rentals, trail purchase, leases, and trade-ins.

POWERHEAD

- Motor/Pump Driveline: Direct-driven or V-belt.
- Drive Options: Electric or as required.
- Required Plant Compressed Air Pressure: 70 PSI@ 15 SCFM. (Option) Self-contained on board air compressor.
- (Option) HEPA Secondary Filtration: For hazardous material vacuuming.

ELECTRICAL CONTROL PANEL

- Power Supply: 460V/3PH/60HZ or as required.
- Enclosure: NEMA 4, NEMA 12, or explosion proof.
- Solid state pulse circuit controls.

PORTABLE MODELS

- Roll-type 1/4 yard end dump hopper with skid-mount transportable base via the supplied hand truck or transportable by a facility forklift truck.
- Support stand.
- Towable trailer types for in-plant or over-the-road.

STATIONARY MODELS

- 8 cubic foot (or as required) bottom dump hopper with various types of dump valve arrangements for continuous or batch discharge.

POWERHEAD SPECIFICATIONS								
MODEL NO.	AK5E	AK7.5E	AK10E	AK15E	AK20E	AK25E	AK30E	AK40E
HORSEPOWER	5	7.5	10	15	20	25	30	40
VACUUM CAPABILITY *	16" Hg.	16" Hg.	16" Hg.	16" Hg.	16" Hg.	16" Hg.	16" Hg.	16" Hg.
WEIGHT (LBS), NOM.	900	950	1000	1100	1200	1400	1750	2000
RANGE OF CONVEYING LINE OR HOSE SIZES ** (in inches)	1-1/2	1-1/2	1-1/2	2	2	2-1/2	3	3-1/2
	2	2	2	2-1/2	2-1/2	3	3-1/2	4
	2-1/2	2-1/2	2-1/2	3	3	3-1/2	4	
NOMINAL CAPACITY TONS/HR @ 50 FT. ***	1.8	2.75	4	5.5	7.5	9	11	15
MAXIMUM CONVEYING DISTANCE	** Depends on material and its characteristics							

* Various sizes available to 25" Hg.
** From SG .2 to SG 4.6 Free Flowing Materials
*** Average for free flowing SG 1 materials

- (Option) Service platform with railing and access ladder.

PIPED MANIFOLD SYSTEMS

Custom designed manifold systems, turnkey installed.

ACCESSORIES

Complete line of hose, nozzles, and manifold components.

CUSTOM DESIGN OPTIONS

Our engineering team will custom design a vacuum system to suit your particular application and needs.

Visit us on the Internet @ http://www.maxvac.com
E-Mail: maxvac@maxvac.com

DeMarco MAX VAC Corporation
1412 Ridgeview Drive
McHenry, IL 60050 U.S.A.
Phone: 815-344-2222 • Fax: 815-344-2223

MAX VAC Canada (Welland, Ontario)
Phone: 905-732-7591 • Fax: 905-732-3310

→ 329 ACFM @ -12" Hg

DEMARCO MAX VAC CORPORATION

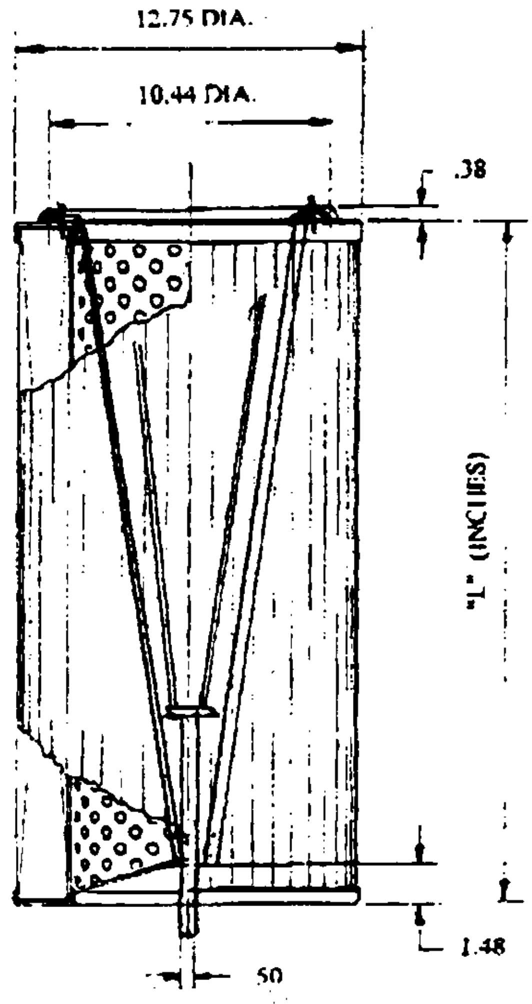
Standard Construction Features:

- 100% Dust-Tough, Spunbond Polyester Media: Forget Cellulose!
- 200° F. Continuous Rating
- Open Pleat Structure
- Washable
- Felt Bag Durability in a Cartridge
- High Filtration Efficiencies: BIA Rated
- Wide Range of Available Filter Areas
- 2" Pleat Depth, Wide Spacing
- Mild Steel Hardware
- Neoprene Seal

- **Available Features:**

Wide Media Choices:
806: White Polyester (Standard)
802: Black Polyester
903: Polyester w/ PTFE Laminate Membrane

- Specialty Finishes:
TR; Oil & Water repelling Impregnation, or
MF; Metallized Finish on Dust Contact Surface to dissipate Static Electricity
- Other Available Features:
High Temperature Construction
Stainless Steel Hardware
Special Lengths & Pleat Count
Silicone Seal



L	FILTER AREA in ft²			
	124 Pleats	166 Pleats	193 Pleats	235 Pleats
26.00	90	120	140	170

674 SOUTH COUNTY LINE ROAD • BENSENVILLE, ILLINOIS 60106 U.S.A.
PHONE: (708) 766 1119 • FAX: (708) 766-1077

Control Technology Specifications
Emission Point 5
Flyash Surge Bin Vent

Control Equipment:	Pulse Jet Fabric Filter
Manufacturer:	Fuller Bulk Handling
Model #:	64DS8

FULLER BULK HANDLING

FULLER BULK HANDLING CORP.
3225 Schoenersville Road • P.O. Box 805
Bethlehem, PA 18016-0805
Tel: (610) 264-6055 • FAX: (610) 264-6735
http://www.fullerbulkhandling.com

3 September 1999

Mr. Frank Hrach
Separation Technologies, Inc.
10 Kearney Road
Needham, MA 02494

Dear Mr. Hrach:

Subject: Jacksonville Electric Project
Your PO #30619
Emissions Guarantee

We have modified the silo vent filter and the two (2) filter receivers on this project to meet the requested emissions guarantee of .015 grains per ACFM outlet grain loading. The modifications include changing the bag materials to meet this requirement

As we discussed, the vent filter change is minimal and requires no price change. However, the filter receivers, which are under a significantly higher grain loading, require a PTFE laminate on the bags at a total cost additon of $2600 for each unit, or a total contract change addition of $5,200.

We are proceeding with these changes as instructed in your phone conversation with Bill Beidleman on 2 September 1999. Please arrange to forward a change order to reflect this addition.

I have recently taken over the administration of this project. Should you have any questions or need information, please contact me directly at 610-264-6237 (fax -6459). I look forward to working with you.

Sincerely,

FULLER BULK HANDLING CORPORATION

Donna Caldwell

Donna E. Caldwell
Contract Manager

cc: W E Beidleman, T LaFavor, B F Strobl

I. APPLICATION:

The DS Filter was developed to complete Fuller-Kovako's line of high ratio, pulse cleaning dust collectors.

The flange-mounted unit can be bolted directly to a silo or bin to handle air displacement from any type of conveying system.

The hopper-designed unit for handling small dust volumes can be installed anywhere there is a remote dust problem that cannot be handled by a centralized dust collector system.

II. SPECIFICATION:

General
Jet-Pulse™ Dust Collector Side Access Series is a compact modular shop assembled unit with an automatic self-cleaning system that utilizes pulse jets of high pressure air to provide efficient, thorough cleaning with no internal moving parts. Bag and cage inspection/replacement is through a full-size (16 1/2" x 5' 10") hinged and gasketed door in the housing.

It handles volumes ranging from 500 to 12,000 CFM (14.2 to 340 cmm) providing an ideal, inexpensive solution to many dust collecting problems.

Bags - Made from 14 to 16 oz/yd^2 polyester needled scrim supported felt. Total cloth area ranges from 170 to 1880 square feet (16 to 175 m^2. Bags are 5" (125 mm) diameter by 8' (2438 mm) long.

Cages - Fabricated of 1/8" (3.18 mm) steel wire.

Plenum - Made from 12 gauge all welded carbon steel to withstand ±20" W.G. differential pressure. Each row of bags is provided with one 1 1/2" (38 mm) pulse valve.

Housing - Fabricated from 12 gauge all welded carbon steel to withstand ±20" W.G. differential pressure. Seals and gaskets capable of withstanding 425° F (218° C). Housing access door (16 1/2" wide x 5' 10" high), hinged and gasketed with quick opening latches.

Hopper - Single Pyramid type, fabricated from 10 and 12 gauge carbon steel complete with inlet stub and baffle, reinforced for ±20" W.G.

Standard Hopper Discharge - Fuller-Kovako's 8" Shrouded Rotary Lock, complete with 1/2 H.P., 35 R.P.M. output, right angle gearmotor; chain drive and OSHA guard. Motor voltage 230/460/3/60.

Structural Supports - Fabricated steel supports to provide for 40" (1016 mm) clearance below discharge lock; designed for 30 PSF (.01 Kg/cm^2).

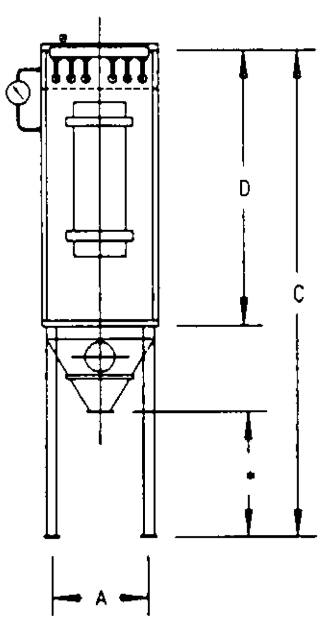
Timer - Solid State, full adjustability of pulse length .05 to .8 seconds and full adjustability of interval between pulses .05 to .130 seconds. Nema IV Timer enclosure. Voltage 115/1/60.

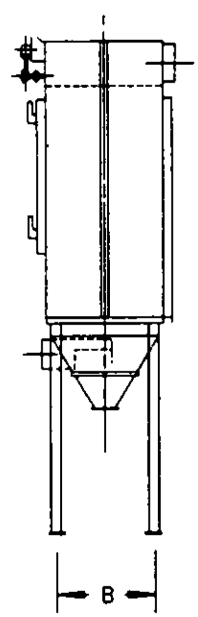
***Options** - Roof-mounted direct drive fan to 2000 CFM (56.6 cmm) cleanside access through roof-mounted doors.

Accessories - Compressed air header with drain cock. 1 1/2" (38 mm) pulse valve. Magnehelic pressure gauge.

Assembly - Housing completely assembled. Hopper and supports assembled to housing. Timer shipped separately for field installation. Units shipped without bags and cages installed.

Model Size	Filter Area Ft^2	Dimensions, Ft. - In. A	B	C	D	No. Filter Tubes	Approx. Wt. Lbs. Module	Supports
16DS 8	170	2-1/4	2-1/4	15-9-3/4	9-10	16	1080	215
16DA 10	210	2-1/4	2-1/4	17-9-3/4	11-10	16	1326	215
25DS 8	265	2-7-3/4	2-7-3/4	16-3	9-10	25	1400	230
25DS 10	330	2-7-3/4	2-7-3/4	18-3	11-10	25	1865	230
36DS 8	380	3-2-1/4	3-2-1/4	16-8-1/2	9-10	36	1725	250
36DS 10	470	3-2-1/4	3-2-1/4	18-8-1/2	11-10	36	2105	250
64DS 8	670	5-1-3/4	4-3-1/4	18-5	9-10	64	2930	305
64DS 10	840	5-1-3/4	4-3-1/4	20-5	11-10	64	3210	305
80DS 8	835	6-3	5-7-1/2	18-11	10-2	80	3760	1270
80DS 10	1045	6-3	5-7-1/2	20-11	12-2	80	4100	1270
80DS 12	1255	6-3	5-7-1/2	22-11	14-2	80	4510	1270
100DS 8	1045	7-4	5-7-1/2	19-8	10-2	100	4810	1355
100DS 10	1300	7-4	5-7-1/2	21-8	12-2	100	5600	1355
100DS 12	1570	7-4	5-7-1/2	23-8	14-2	100	6180	1355
120DS 8	1250	7-4	6-8-1/2	19-10	10-2	120	5655	1355
120DS 10	1570	7-4	6-8-1/2	21-10	12-2	120	6570	1355
120DS 12	1880	7-4	6-8-1/2	23-10	14-2	120	7235	1355





* 4' 4" 16DS 8 thru 80DS 12

4' 7" 100DS 8 thru 120DS 12

Series 64DS 8 thru 120DS 12 has bag access aisle with removable internal walkway.

Available with roof-mounted direct-driven fan up to 2500 CFM.

Control Technology Specifications
Emission Point 6
Mineral Additive Storage Bin Vent

Control Equipment:	Pulse Jet Fabric Filter
Manufacturer:	Chemco
Model #:	VS20 KS5

BD INC. DISTRIBUTING
28TH & A.V.R.R.
PITTSBURGH, PA 15222
TELEPHONE
412-281-0746
FAX
412-281-7126

FACSIMILE COVER SHEET

09/29/99

Post-it® Fax Note 7671	Date 9-29-99 # of pages ▸ 1
To FRANK HRACH	From JIM GODESKY
Co./Dept. STI	Co CHEMCO
Phone #	Phone #
Fax # (781)-455-6518	Fax #

COMPANY: CHEMCO

ATTENTION: Mr. JIM GODESKY

FAX NUMBER: (724) 2587350

FROM: TOM MEANOR

TOTAL PAGES: 1 (INCLUDING THIS PAGE)

SUBJECT: OUTLET EMISSION

****

Jim,

The outlet emission of a DCE Silo Air dust collector will not exceed 2mg/M^3 (0.00088 grain/ft^3) on a time weighted average on particle sizes down to and including 1 micron provided the collector is installed, operated and maintained in accordance with normally recognized good practice and DCE's written instructions.

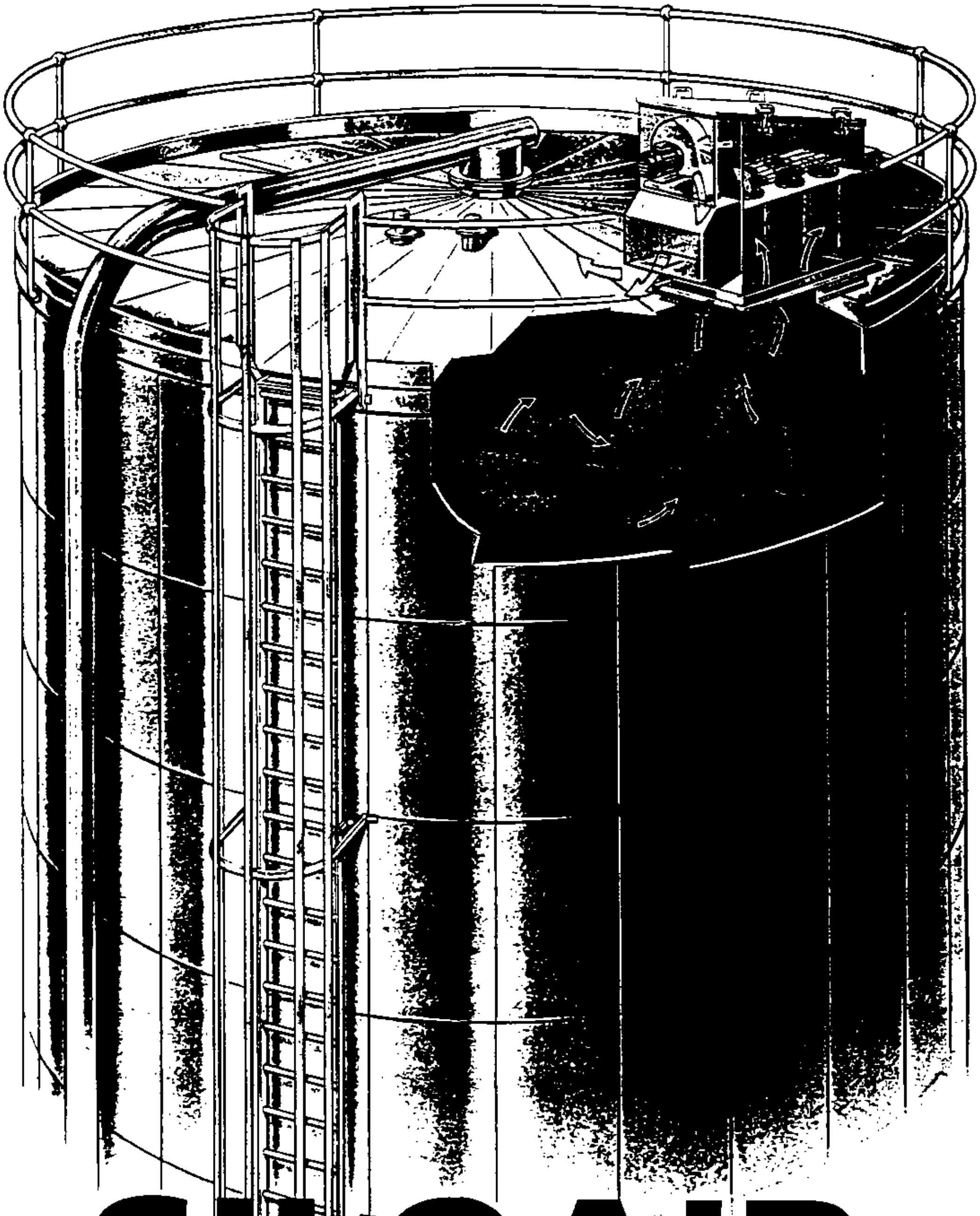
Thanks,

Tom

FRANK,
HERE IS THE INFORMATION YOU REQUESTED.

J. GODESKY

THE HEIGHT OF SUCCESS



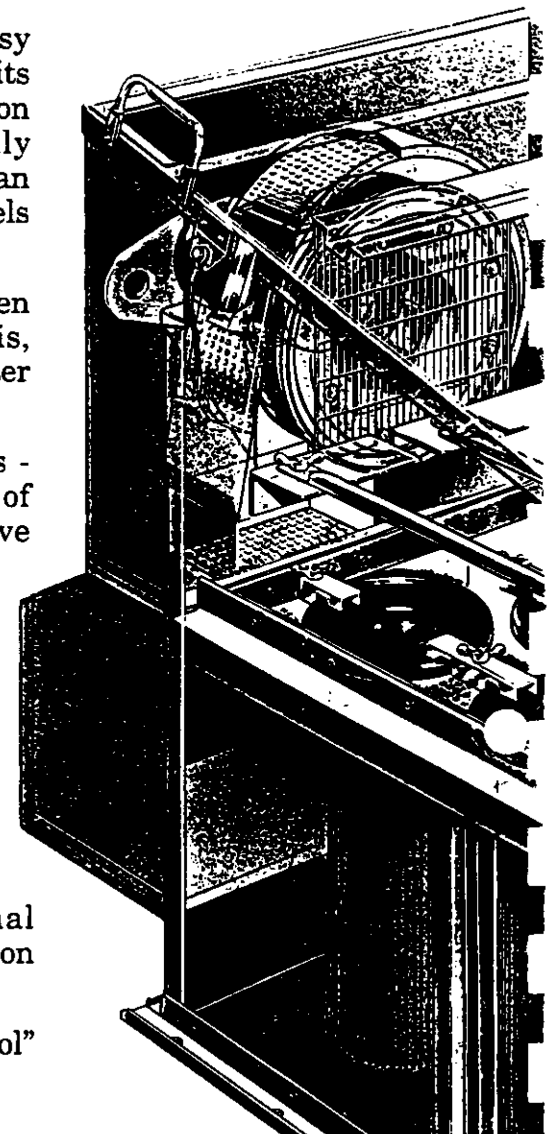
SILOAIR

THE STRAIGHTFORWARD ANSWER TO SILO VENTING

The Siloair from DCE is a distinctive example of the Company's long-standing commitment to providing innovative and effective solutions to customers' dust control problems.

Specifically designed for silo venting applications, the Siloair is available as a complete, fully assembled unit requiring minimum on-site installation.

The low profile design of the Siloair's casing allows easy access to the cartridges - a key feature for venting filter units mounted on top of silos. The unit has excellent noise reduction features comprising of built in fan attenuation and fully enclosed solenoid valves as standard, with the availability of an additional acoustic diffuser for use in areas where noise levels are particularly sensitive.



Efficient dust release is achieved by use of the well proven electronically controlled reverse jet cleaning system. This, together with the generous cartridge spacing within the filter casing, gives low internal velocities around the cartridges.

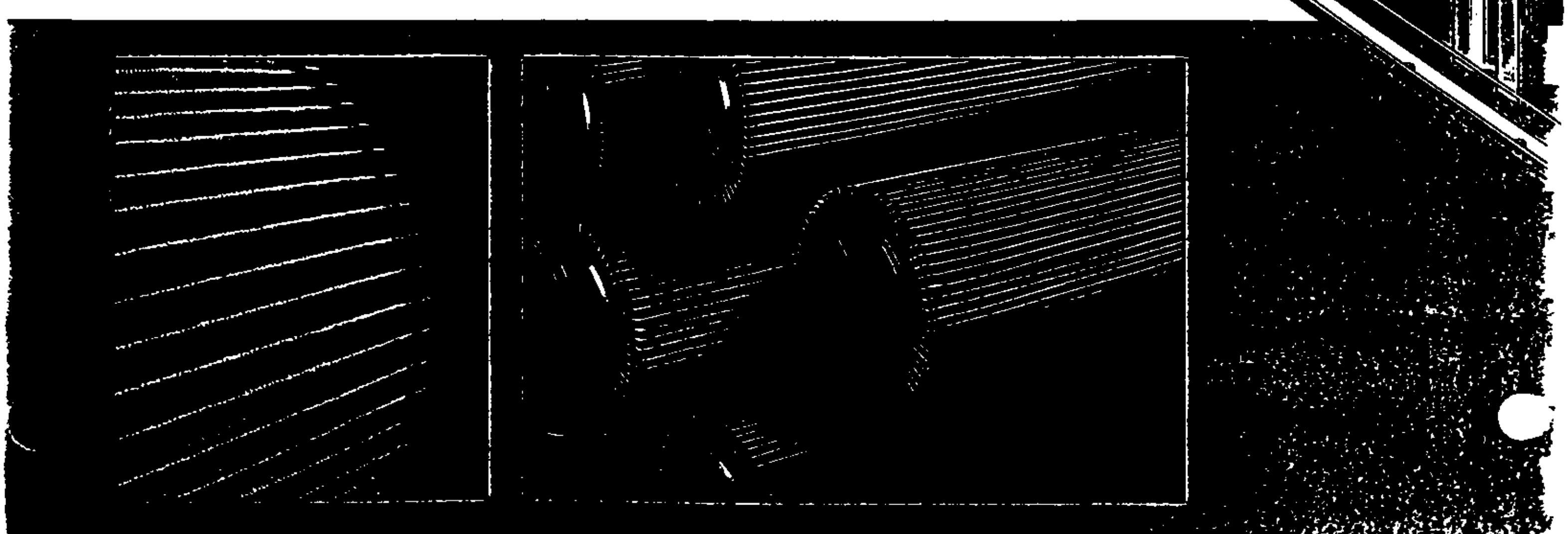
With three sizes available to cover various filtration areas - $10m^2$, $15m^2$ and $20m^2$ ($108ft^2$, $161ft^2$, $215ft^2$) - and a choice of three fans, the Siloair is the most versatile and cost effective filter for silo venting applications on the market.

MORE AIR VOLUME, LESS SPACE, LOW EMISSION LEVELS

The DCE pleated cartridge, manufactured to the highest tolerances from spun-bonded polyester material, incorporating wide pleats and a star-shaped molded base is the center of the Siloair. These special design features ensure optimum filtration area without the risks of bridging and the build-up of dust.

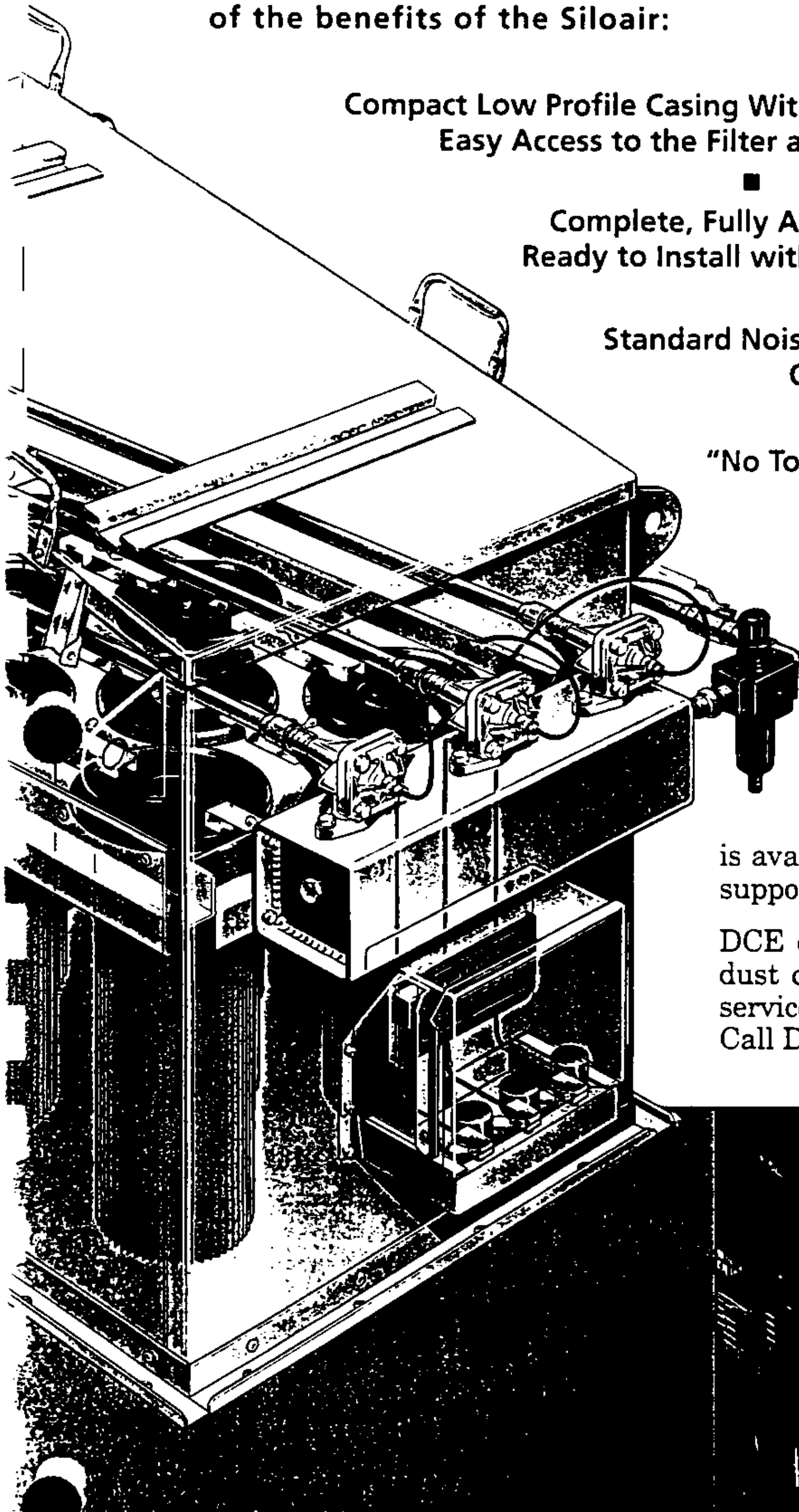
The end result is a unit which provides an exceptional combination of durability, high-dust load capability, low emission levels and maximum cleaning efficiency.

Routine maintenance is reduced to a minimum with "no tool" clean side removal of the elements.



The Key Benefits of the SILOAIR

This DCE filter has been specifically designed to deal effectively with the particular problems posed by silo venting applications. Below are some of the benefits of the Siloair:



Compact Low Profile Casing With a Small Plan Area:-
Easy Access to the Filter and Cartridges

■

Complete, Fully Assembled Unit:-
Ready to Install with Minimum Site-work

■

Standard Noise Suppression Features:-
Quiet Operation

■

"No Tool" Replacement of Cartridges:-
Easy Maintenance

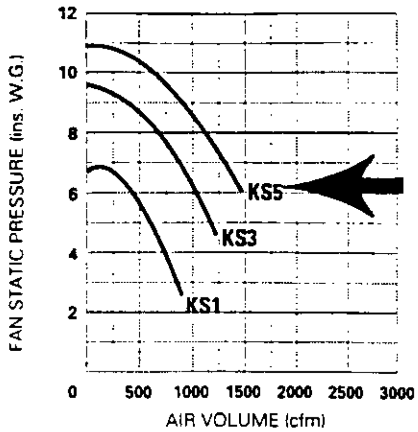
■

High Efficiency Media:-
Low Emission Levels

CUSTOMER ADVICE AND SERVICE

From initial inquiry to installation, the Sales and Service organization of DCE, world leaders in dust control technology, is available to assist with advice, guidance and support.

DCE offers over 70 years of experience in the dust control business, providing products and service to meet every dust control requirement. Call DCE for the experienced solution.



To select the most suitable fan for a given application:

1 Determine the air volume flow ft³/min needed to give effective venting and dust control.

2 Estimate the pressure or suction (in.W.G.) in the housing on which the dust filter is positioned.

3 Assess the operational pressure drop (in.W.G.) across the clean side and dirty side of the filtering element – usually between 2 – 5 in. W.G.

4 The sum of **2** and **3** gives the pressure (in.W.G.) required for fan selection purposes.

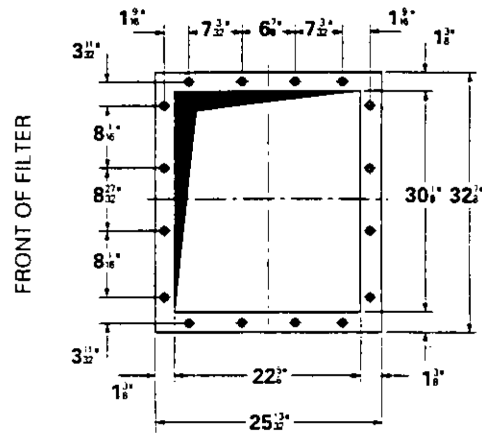
5 Consult graph for fan performances available.

Fan performance curves

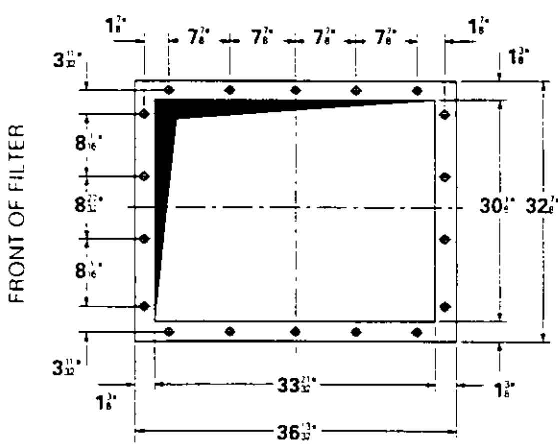
WEIGHTED SOUND PRESSURE LEVELS

All readings were taken in semi-reverberant surroundings 3'3" radius from the equipment housing and 20" above base level, using a precision sound level meter and octave filter.

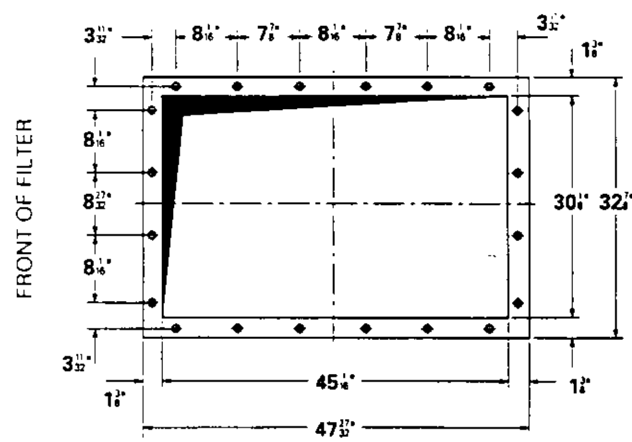
	With acoustic	Without acoustic
VS10 KS1	74dB(A)	83dB(A)
VS10 KS3	74dB(A)	81dB(A)
VS15 KS1	74dB(A)	83dB(A)
VS15 KS3	74dB(A)	81dB(A)
VS20 KS3	74dB(A)	81dB(A)
VS20 KS5	76dB(A)	85dB(A)



VS10



VS15



VS20

Aperture and mounting flange details

All holes 13/32" diameter for 3/8" diameter bolts.

ELECTRICAL REQUIREMENTS

VS10 and VS15 filters: DS 2-way controller

VS20 filter: DS 3-way controller

Voltage input: 110V. (±10%)
A.C. two wire 50-60 Hz

Connection: Line-line or line-neutral

Fan motor (if fitted): To suit local voltage

DESIGN LIMITS (standard equipment)

Temperature range: 14°F to 140°F

Pressure range: –20" W.G. to +15" W.G.

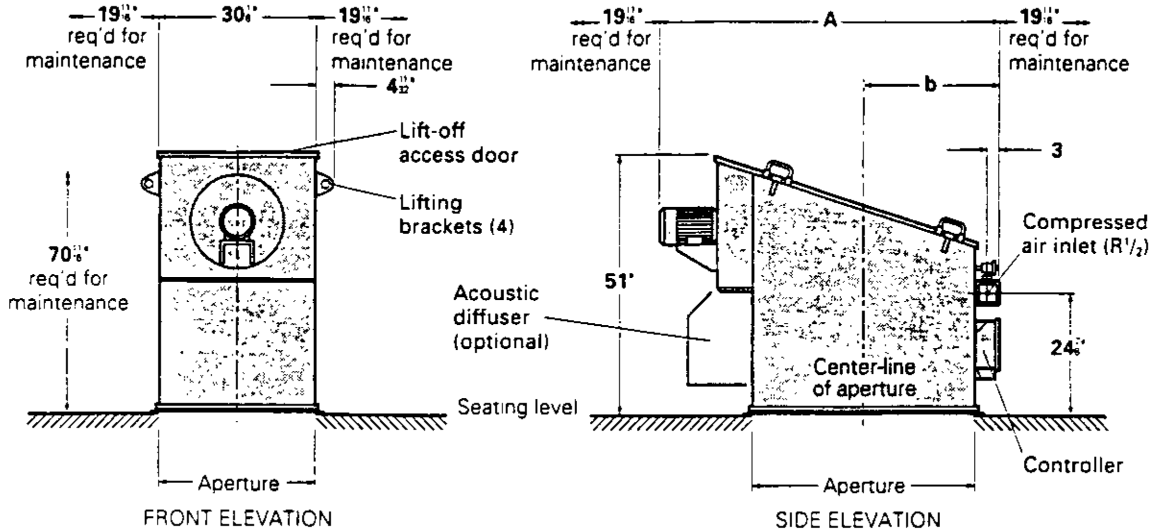
Dimension tolerances: ± 3/16" on main dimensions;
± 1/16" on detail dimensions

DCE, Inc.
11301 Electron Drive Jeffersontown KENTUCKY 40299-3867 TEL (502) 267-0707 FAX (502) 267-3074
1-800-767-0702

PRINTED IN ENGLAND 0193

DUST CONTROL EQUIPMENT

SILOAIR DUST FILTERS – SERIES VS



Siloair filter with integral fan

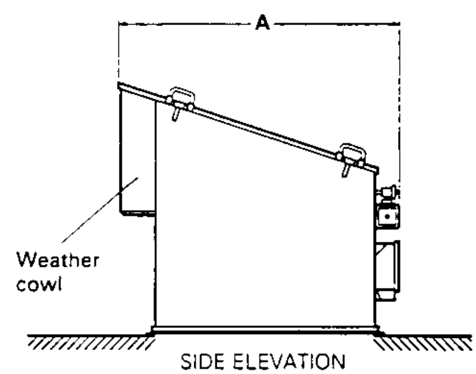
Model VS20 KS5 illustrated

Filter type	Filtration area	No. of cartridges	DIMENSIONS A	DIMENSIONS b	Fan type	Fan motor	Approx. net weight
VS10	108 ft²	4	44 7/8" 45 15/32"	17 17/32"	KS1 KS3	1.0 HP 2.0 HP	423 lbs* 443 lbs*
VS15	161 ft²	6	55 29/32" 56 1/2"	23 1/32"	KS1 KS3	1.0 HP 2.0 HP	492 lbs* 511 lbs*
VS20	215 ft²	8	67 29/32" 68 29/32"	28 3/4"	KS3 KS5	2.0 HP 3.0 HP	593 lbs* 604 lbs*

*For filters fitted with acoustic diffuser add 33 lbs

Filter type	DIMENSIONS A	Approx. net weight.
VS10W	35 13/16"	370 lbs
VS15W	46 27/32"	439 lbs
VS20W	58 9/32"	520 lbs

For all other dimensions refer to table above



Siloair filter with weather cowl

Model VS20W illustrated

COMPRESSED AIR REQUIREMENTS

Filter type	Working compressed air pressure[a]	Atmospheric air volume – F.A.D.[b] at 12 sec. intervals[c]	Pulse duration
VS10	70 psig	6.6 cfm	200 millisec.
VS15	80 psig	8.5 cfm	200 millisec.
VS20	80 psig	8.5 cfm	200 millisec.

[a]Normal operating pressure. [b]Recommended atmospheric air volume of clean, dry compressed air.
[c]Recommended initial settings; these may be varied with experience.
For connection details please refer to DCE.

DCE, Inc
dust control equipment

Through pioneering work and innovative technology, DCE has been established as world leaders in industrial dust control.

Awareness of our customers' needs and providing the appropriate solution, is the basis of DCE's philosophy. This approach is applied throughout our operating companies worldwide.

Like proven technology found in the Sintamatic, Dalamatic and Unimaster, the development of the Siloair is an example of DCE's philosophy and problem solving capability.

DCE

DUST CONTROL
EQUIPMENT

DCE, Inc.
11301 Electron Drive, Jeffersontown, KENTUCKY 40299-3867 Tel: (502) 267-0707
Fax: (502) 267-4490 Toll Free (800) 767-0702

PUBLICATION 1743A(USA) PRINTED IN ENGLAND 1293/900316

Control Technology Specifications
Emission Point 7
Gas-fired Dryer Stack

NOx Control Equipment:	Low NOx Burner
Manufacturer:	Scott Equipment Company
Model #:	Eclipse AH-MA
PM/PM_{10} Control Equipment:	Pulse Jet Fabric Filter
Manufacturer:	Fuller Bulk Handling
Model #:	8TR10 x80

SCOTT
BUILT FOR TODAY
TO LAST FOR TOMORROW

MANUFACTURERS OF PROCESSING EQUIPMENT
• AGRICULTURE • INDUSTRIAL
• CHEMICAL • FOOD

September 30, 1999

SEPARATION TECHNOLOGY, INC.
10 Kearney Rd.
Needham, MA 02494

Phone: 781-455-8824 ext.311
Fax: 781-433-0289

Attn: Frank Hrach

Frank,

The burner selected for your application is an Eclipse AH-MA burner. The emissions of this burner in your application are as follows:

1. NO_x emission at 0.01 lbs/MM Btu
2. CO emission at 0.144 lbs/MM Btu

The emission criteria stated here reflect the system while operating at full production capacity. These emission criteria are relatively consistent throughout the firing range of the burner.

If you have any questions, please call me at 612-758-2591.

Regards,
SCOTT EQUIPMENT COMPANY

Chris Dolan
Engineering

Emission Point 7

INDEX

EQUIPMENT DESCRIPTIONS SECTION

ORDER SUMMARY SECTION

WARRANTY SECTION

LITERATURE

EQUIPMENT DESCRIPTIONS SECTION

Item 1-A

Qty. 1 **SECTIONALIZED MCF FILTER, MCF 756 - 450**
FEATURING:

- 6525 sq. ft. of media, with an air to media ratio of 4.6:1. @ 30,000 CFM. Full welded quarter panel construction. Gear drive rotating surge tank, diaphragm valve, and distribution arm, with a 1 HP explosion proof motor, pneumatically controlled indexing sensor and firing mechanism which activates the diaphragm valves mounted inside the clean air plenum. 7 ½ Hp positive displacement blower for cleaning mechanism.
- Service door, 60" tall x 32" wide, gasketed and hinged to left side for access to walk-in plenum. Explosion vents to provide a 65:1 vent ratio.
- Filter stressed for 30" W.C.
- Low pressure tangential inlet with vortex breakers (CW) (CCW).
- 60° conical hopper with a 40" dia. flanged discharge.
- 40" dia. transition to match customer supplied airlock. Transition includes a 20" dia. bolted inspection opening.
- (11) Rupture explosion vents.
- Service platform with guard rail, ladder and safety cage (includes intermediate platform).
- Differential pressure gauge, photohelic switch NEMA (12) kit.
- Structural steel support structure to provide 12" clearance below airlock discharge
- High temperature paint and components
- SSPC-SP6 sandblasting prior to painting
- (450) 4.6" dia. x 144" long 16 oz. P-84 composite, snap band type bags.
- (450) 4.6" dia. x 144" long galvanized bag cage.
- 306 - Filter tubesheet blank-out plugs.
- Filter Arrangement:

	High Entry Inlet		Tangential Inlet	
	Standard	Special	Standard	Special
– Service Door	6:00	____	1:30	____
– Air Outlet	3:00	____	3:00	____
– Inlet Entry	3:00	____	6:00	____

- Mount Pads - 1 @ 12:00 remainder spaced 45° apart
- Stainless steel identification tag
- Tag number:

Sell Price for Item 1-A $108,857

~~[illegible]~~
Add 31,097
to Rev 3

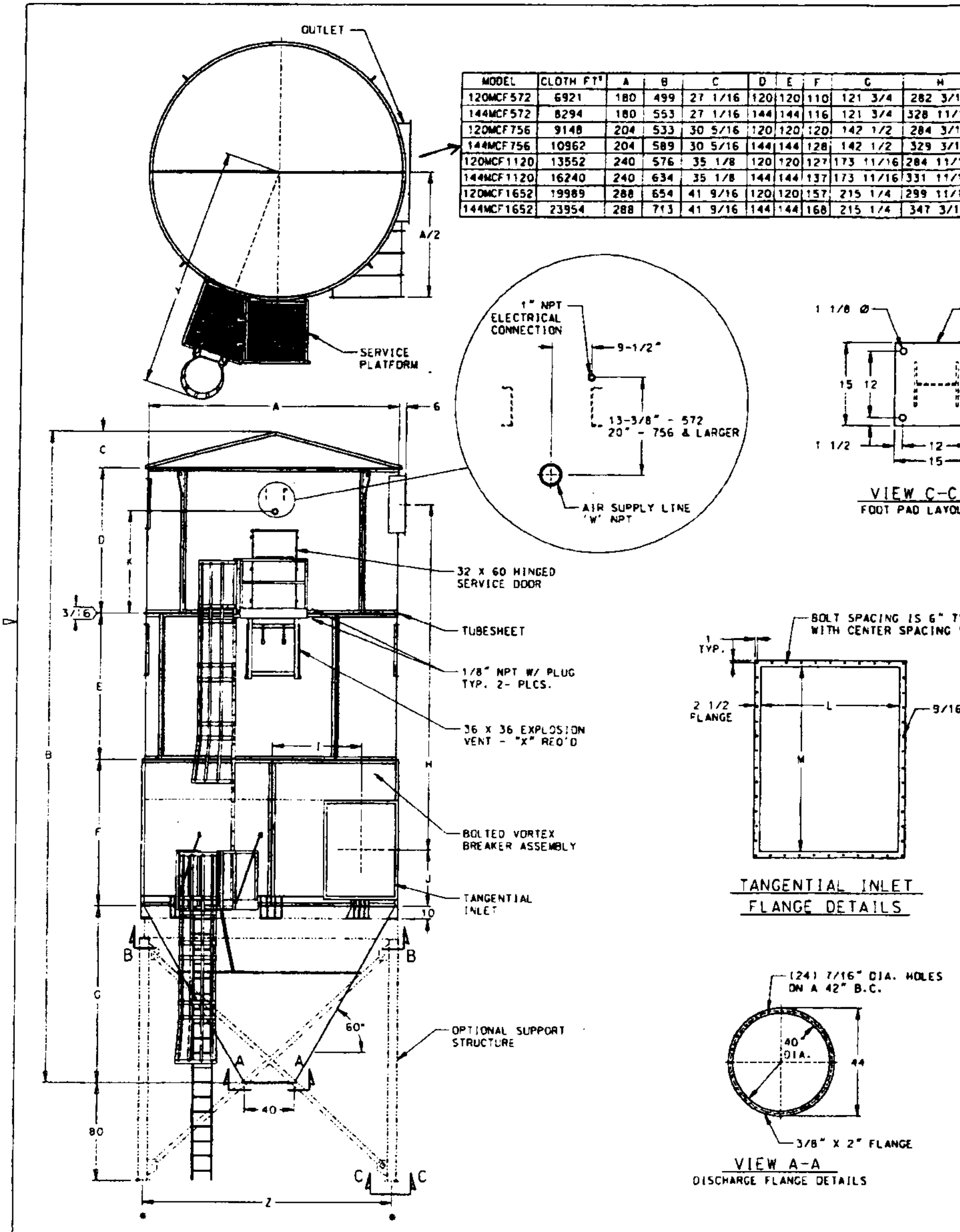
427,267
Total

EQUIPMENT DESCRIPTIONS SECTION

Optional Equipment:

- Each additional feet of support structure required. **ADD $142.00 per fo**
- Each additional feet of ladder and safety cage required. **ADD $44.00 per fo**
- Sprinkler tap kit, with heat sensitive type heads plumbed to side wall. Specify temperature range: (135° - 170°F) (175°- 225°F) (250° - 300°F) **ADD $580.**
- Transition from tangential inlet to 30" diameter duct **ADD $875**
- Removable 180 degree A.R. wear liner on inlet **ADD $1,630.**

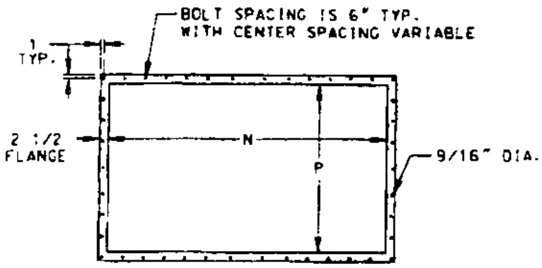
MODEL	CLOTH FT²	A	B	C	D	E	F	G	H
120MCF572	6921	180	499	27 1/16	120	120	110	121 3/4	282 3/16
144MCF572	8294	180	553	27 1/16	144	144	116	121 3/4	328 11/16
120MCF756	9148	204	533	30 5/16	120	120	120	142 1/2	284 3/16
144MCF756	10962	204	589	30 5/16	144	144	128	142 1/2	329 3/16
120MCF1120	13552	240	576	35 1/8	120	120	127	173 11/16	284 11/16
144MCF1120	16240	240	634	35 1/8	144	144	137	173 11/16	331 11/16
120MCF1652	19989	288	654	41 9/16	120	120	157	215 1/4	299 11/16
144MCF1652	23954	288	713	41 9/16	144	144	168	215 1/4	347 3/16



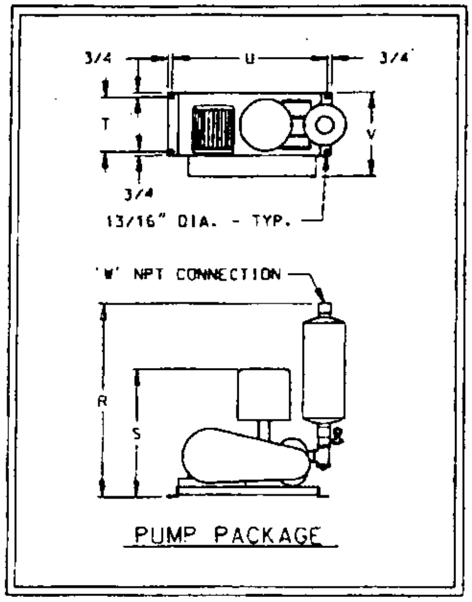
LTR.	DESCRIPTION	DATE	BY
C	REVISED PER ECO AP98011	08/11/98	JRC

I	J	K	L	M	N	P	C	R	S	T	U	V	W	X	Y	Z	PUMP HP	WEIGHT	ESTIMATED ASSEMBLY HOURS
64	41	101 3/16	52	66	78	42	182	39 7/16	25 1/2	10 1/2	29 3/8	16	2 1/2	7	182 7/8	178 1/2	5	30797	180
61	44	113 7/8	58	72	78	51	182	39 7/16	25 1/2	10 1/2	29 3/8	16	2 1/2	8	182 7/8	178 1/2	7 1/2	32492	180
73 1/2	46	84	57	76	80	48	206	51	31 1/2	11 1/2	35 3/4	17	3	10	194 7/8	202 1/2	7 1/2	38325	260
70 1/2	50	84	63	84	80	62	206	51	31 1/2	11 1/2	35 3/4	17	3	11	194 7/8	202 1/2	7 1/2	40640	260
89	49 1/2	84	62	83	103	54	242	54 3/4	35 1/2	13	38 1/4	18 1/2	3	14	215 11/16	238 1/2	10	44895	350
85	54 1/2	84	70	93	103	66	242	54 3/4	35 1/2	13	38 1/4	18 1/2	3	16	215 11/16	238 1/2	10	48004	350
101 1/2	64 1/2	84	85	113	152	54	290	63 7/8	40 1/8	15 1/2	49 1/2	21	4	23	239 15/16	286 1/2	15	52854	420
97 1/2	70	84	93	124	152	66	290	63 7/8	40 1/8	15 1/2	49 1/2	21	4	25	239 15/16	286 1/2	15	56461	420

3/4" THK.
BOTTOM
PLATE

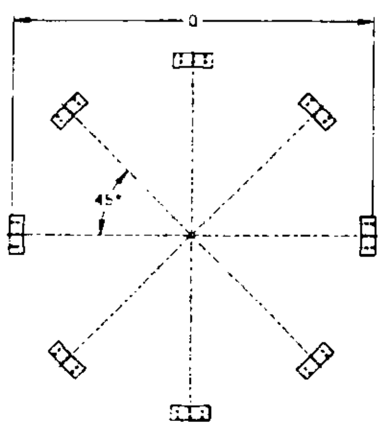


OUTLET FLANGE DETAIL



PUMP PACKAGE

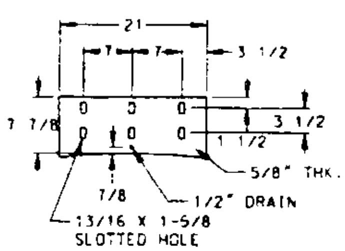
DIA.



VIEW B-B
MOUNT PAD LAYOUT

NOTES:

1. ALL DIMENSIONS ARE IN INCHES.
2. 7 GA. CARBON STEEL CONSTRUCTION.
3. STANDARD NUMBER OF EXPLOSION VENTS PROVIDE 65:1 VENT RATIO.
4. CUSTOMER TO PROVIDE SUPPLY LINE FROM PUMP PACKAGE OUTLET TO CONNECTION ON FILTER.
5. SERVICE LADDER WILL REQUIRE AN INTERMEDIATE PLATFORM.
6. FILTER HOUSING CONSISTS OF:
   DOME TOP: 2 HALF SECTIONS
   PLENUM: 1 OUTLET SECTION.
   1 DOOR SECTION.
   2 QUARTER SECTIONS.
   TUBESHEET: 2 HALF SECTIONS
   BAGHOUSE: 4 QUARTER SECTIONS.
   TANG. INLET: 1 INLET SECTION.
   3 QUARTER SECTIONS.
   HOPPER: 2 TOP HALF SECTIONS
   1 BOTTOM CONE SECTION.
   INTERNAL COMPONENTS CONSIST OF CLEANING MECHANISM TANK, VORTEX BREAKERS, BAGS AND CAGES, AND TUBESHEET SUPPORT COLUMN AND BEAMS.
   EXTERNAL COMPONENTS CONSIST OF ACCESS PLATFORMS, LADDERS, OPTIONAL SUPPORT STRUCTURE, AND OPTIONAL DISCHARGE EQUIPMENT.
7. SECTIONS ARE ROTATABLE IN FOLLOWING INCREMENTS.
   MCF572 - 3.46°
   MCF756 - 3.21°
   MCF1120 - 3.21°
   MCF1652 - 3.21°
8. WEIGHT IS FOR FILTER ONLY. IT DOES NOT INCLUDE STRUCTURE, SERVICE PLATFORMS, FILTER BAGS, AND CAGES.



MOUNT PAD DETAIL

DOMESTIC 1-800-821-2476 INTERNATIONAL 1-816-891-9300 FAX 1-816-891-8978

DC1735

SECTIONALIZED MCF FILTER WITH TANGENTIAL INLET GENERAL DIMENSION

CK 10/10/96

1/48"=1"

PMCF

DC1735 C

INFORMATION ON THIS DRAWING SUBJECT TO CHANGE WITHOUT NOTICE. 8-11-1998 19:05:38 CK

ATTACHMENT F

STI

Separation Technologies, Inc.

Ash Processing Facility
St. John's River Power Park
Jacksonville Florida

Operating and Maintenance Manual for Fabric Filter Dust Collectors

Purpose

The purpose of this document is to describe the function, operation, and maintenance procedures for the fabric dust collection filters used at the STI flyash processing facility at the St. John's River Power Park. For information on other process equipment at the facility refer to other O/M manuals.

Adhering to proper operation and maintenance procedures for the facility dust collectors is essential in order to minimize the release of flyash particulate to the atmosphere, and is part of maintaining compliance with the Florida Department of Environmental Protection particulate emission requirements.

Facility Description

The STI flyash processing facility is designed to (1) transport coal combustion flyash from the existing storage silos to the ash processing building, (2) process the flyash by removing residual carbon and ammonia, and (3) transport the mineral-rich and carbon-rich flyash products back to the existing storage silos for loadout. The two-step beneficiation process consists of (1) removal of the residual carbon from the flyash using STI's patented electrostatic separation technology, and (2) removal of residual ammonia from the flyash using the STI ammonia removal technology.

STI's triboelectric carbon separator segregates flyash into a mineral-rich and carbon-rich fraction. The mineral-rich flyash is sold as a replacement for cement in making concrete. The carbon-rich flyash can be landfilled or reburned to produce electricity.

In addition to residual carbon, the flyash at SJRPP also contains trace amounts of ammonia that makes it unsuitable as a cement replacement. To solve this problem, the STI ammonia removal process to used to remove ammonia from the mineral-rich flyash, making it salable as a cement replacement. The recovered ammonia gas is recycled back to the power plant.

In order to control particulate emissions from the various flyash handling steps in the process, the facility is designed with seven fabric filter dust collectors that vent to the atmosphere and are sources of particulate emissions to the air.

Fabric Filters

1. Filter-Receiver A (FR101A)

Description:

This pulse jet filter receives unprocessed flyash from Silo 1A pneumatic convey system and discharges into Separator A. It contains 1280 square feet of total cloth area consisting of eighty (80) 6" diameter x 96" filter elements of 16 oz. Polyester felt with a PTFE laminate on the surface. The filter bags are continuously cleaned with a reverse pulse of compressed air. The design air supply requirement is 8-10 SCFM @ 90-100 psig. Refer to the filter operating manual for the recommended pulse air pressure and timer settings.

The filter is equipped with a Dwyer Photohelic differential pressure gauge for monitoring the filter differential pressure. A high differential pressure switch and a high level switch on the filter hopper is interlocked to the flyash feed system via the BOP A PLC control system.

Manufacturer :	Fuller Bulk Handling 3225 Schoenersville Rd Bethlehem PA 1801600805 (610) 264-6055
Model:	8TR10x80 (Camco)
STI PO:	30619
FBH PO:	2007506
Manufacturer Contact:	Bill Beidleman Fuller Bulk Handling

Operation/Maintenance:

When the AUTOSTART SEPARATOR A button is pressed on the control system touchscreen terminal, the filter will start operation as part of the starting sequence for the Separator A system. If an upset condition is detected by the photohelic or high level sensor, the system will automatically initiate the AUTOSTOP sequence.

Since this filter is used as a receiver to the feed ash pneumatic convey system, careful attention to the pulse air settings is critical for stable operation. Refer to the Camco operating manual for the recommended settings.

As part of the routine system checks, the discharge vent from the filter must to checked for visible emissions of flyash. If visible emissions are detected, the system must be shutdown and the source of the emission identified and eliminated.

As part of the routine system checks, the filter differential pressure is logged. When differential pressure becomes excessively high, the filter elements must be replaced. A maintenance log must be kept to record the date, time, and details of each filter maintenance event. An example of the maintenance logsheet is included at the end of this document.

2. Filter-Receiver B (FR101B)

Description:

This pulse jet filter receives unprocessed flyash from Silo 2B pneumatic convey system and discharges into Separator B. It contains 1280 square feet of total cloth area consisting of eighty (80) 6" diameter x 96" filter elements of 16 oz. Polyester felt with a PTFE laminate on the surface. The filter bags are continuously cleaned with a reverse pulse of compressed air. The design air supply requirement is 8-10 SCFM @ 90-100 psig. Refer to the filter operating manual for the recommended pulse air pressure and timer settings.

The filter is equipped with a Dwyer Photohelic differential pressure gauge for monitoring the filter differential pressure. A high differential pressure switch and a high level switch on the filter hopper is interlocked to the flyash feed system via the BOP B PLC control system.

Manufacturer :	Fuller Bulk Handling 3225 Schoenersville Rd Bethlehem PA 1801600805 (610) 264-6055
Model:	8TR10x80 (Camco)
STI PO:	30619
FBH PO:	2007506
Manufacturer Contact:	Bill Beidleman Fuller Bulk Handling

Operation/Maintenance:

When the AUTOSTART SEPARATOR B button is pressed on the control system touchscreen terminal, the filter will start operation as part of the starting sequence for the Separator B system. If an upset condition is detected by the photohelic or high level sensor, the system will automatically initiate the AUTOSTOP sequence.

Since this filter is used as a receiver to the feed ash pneumatic convey system, careful attention to the pulse air settings is critical for stable operation. Refer to the Camco operating manual for the recommended settings.

As part of the routine system checks, the discharge vent from the filter must to checked for visible emissions of flyash. If visible emissions are detected, the system must be shutdown and the source of the emission identified and eliminated.

As part of the routine system checks, the filter differential pressure is logged. When differential pressure becomes excessively high, the filter elements must be replaced. A maintenance log must be kept to record the date, time, and details of each filter maintenance event. An example of the maintenance logsheet is included at the end of this document.

3. Separator Dust Collector (FR102)

Description:

This pulse jet filter and exhaust fan package pulls a slight vacuum on both the Separator A and Separator B systems to control dust emissions from the separation equipment. The collected flyash is returned to either FR101A or FR101B via an eductor system. The filter contains 784 square feet of total cloth area consisting of sixty-four (64) 6" diameter x 96" filter elements of 16 oz. Polyester felt. The filter bags are cleaned on demand with a reverse pulse of compressed air. The design air supply requirement is 8 SCFM @ 80 psig. Refer to the filter operating manual for the recommended pulse air pressure and differential pressure settings.

The filter is equipped with a Dwyer Photohelic differential pressure gauge for monitoring the filter differential pressure and setting on demand cleaning. A high differential pressure switch is interlocked to the flyash feed systems via the BOP A and BOP B PLC control systems.

Manufacturer :	Z and Z Conveying 270 Pennsylvania Ave Concord Ontario Canada (905) 738-4343
Model:	64-08(6)-20
STI PO:	30646
Manufacturer Contact:	Zoran Zlatic Z and Z Conveying

Operation/Maintenance:

When either AUTOSTART SEPARATOR A or AUTOSTART SEPARATOR B button is pressed on the control system touchscreen terminal, the filter will start operation as part of the starting sequence for the Separator A or B system. If an upset condition is detected by the diff pressure switch, the system will automatically initiate the AUTOSTOP sequence.

Since this filter is used to maintain a negative pressure on the separators, careful attention to the pulse air settings is critical for a clean operation. Refer to the Z and Z operating manual for the recommended settings.

As part of the routine system checks, the discharge vent from the filter must to checked for visible emissions of flyash. If visible emissions are detected, the system must be shutdown and the source of the emission identified and eliminated.

As part of the routine system checks, the filter differential pressure is logged. When differential pressure becomes excessively high, the filter elements must be replaced. A maintenance log must be kept to record the date, time, and details of each filter maintenance event. An example of the maintenance logsheet is included at the end of this document.

4. Clean-up Vacuum

Description:

This industrial vacuum system package produces about 320 CFM of air flow at – 12" HG to allow cleanup of the process building floors. Any floor dust is collected in the pulsejet filter portion of the package. The collected floor dust discharges into a sealed bin beneath the unit for eventual disposal. The filter contains 120 square feet of total filter area consisting of 30" spun bond polyester filter elements. The filter elements are cleaned with a continuous reverse pulse of compressed air. Refer to the filter operating manual for the recommended pulse air pressure.

The self contained vacuum package is controlled from a local pushbutton panel.

Manufacturer :	MaxVac 1412 Ridgeview Drive McHenry IL 60050 (815) 344-2222
Model:	AK15E
STI PO:	

Operation/Maintenance:

Refer to the MaxVac operating and maintenance manual.

5. Flyash Surge Bin Vent (FR103)

Description:

This pulse jet filter vents the air used for conveying the mineral-rich flyash form Separator A and Separator B to the ammonia process surge bin. The filter contains 670 square feet of total cloth area consisting of sixty-four (64) 6" diameter x 80" filter bags of 16 oz. Polyester felt. The filter bags are cleaned on with a continuous reverse pulse of compressed air. The design air supply requirement is 8 SCFM @ 80 psig. Refer to the filter operating manual for the recommended pulse air pressure and differential pressure settings.

The filter is equipped with a Dwyer Photohelic differential pressure gauge for monitoring the filter differential pressure. A high differential pressure switch is interlocked to the Separator A and B mineral-rich feed systems via the BOP A and BOP B PLC control systems.

Manufacturer :	Fuller Bulk Handling 3225 Schoenersville Rd Bethlehem PA 1801600805 (610) 264-6055
Model:	64DS8
STI PO:	30619
FBH PO:	2007506
Manufacturer Contact:	Bill Beidleman Fuller Bulk Handling

Operation/Maintenance:

When Mineral-rich Product Divert Valve switch procedure is initiated from the touchscreen and the Ammonia Process Flyash Surge Bin is selected as the destination for either Separator A or B, the operation of this filter is started as part of the automatic switching sequence. If an upset condition is detected by the diff pressure switch, the system will automatically initiate the AUTOSTOP sequence.

As part of the routine system checks, the discharge vent from the filter must to checked for visible emissions of flyash. If visible emissions are detected, the system must be shutdown and the source of the emission identified and eliminated.

As part of the routine system checks, the filter differential pressure is logged. When differential pressure becomes excessively high, the filter elements must be replaced. A maintenance log must be kept to record the date, time, and details of each filter maintenance event. An example of the maintenance logsheet is included at the end of this document.

6. Mineral Additive Storage Bin Vent (FR104)

Description:

This pulse jet filter vents the air used for conveying the mineral additive from a tanker delivery truck to the mineral additive storage bin. The filter contains 215 square feet of total cloth area consisting of eight (8) spun bound polyester filter cartridges. The cartridges are cleaned with a continuous reverse pulse of compressed air. The design air supply requirement is 8 SCFM @ 80 psig. Refer to the filter operating manual for the recommended pulse air pressure and differential pressure settings.

The filter is equipped with a Dwyer Photohelic differential pressure gauge for monitoring the filter differential pressure. A high differential pressure switch is interlocked to the truck unloading control panel located near the truck fill line.

Manufacturer :	DCE 11301 Electron Drive Jeffersontown KY 40299 (502) 267-0707
Model:	VS20 KS5
STI PO:	30641 (purchased through Chemco Equipment)
Manufacturer Contact:	Jim Godesky Chemco Equipment (724) 258-7333

Operation/Maintenance:

When the mineral additive truck unloading sequence is started at the truck unloading panel, operation of this filter is automatically started. If an upset condition is detected by the diff pressure switch, an audible alarm will sound at the truck unloading panel.

As part of the routine truck unloading procedure, the discharge vent from the filter must to checked for visible emissions of the mineral additive. If visible emissions are detected, the system must be shutdown and the source of the emission identified and eliminated.

A maintenance log must be kept to record the date, time, and details of each filter maintenance event. An example of the maintenance logsheet is included at the end of this document.

7. Dryer Filter (FR105)

Description:

This reverse air flow filter receives hot dry flyash from the Scott AST dryer and discharges into the final product conveying system. It contains 6524 square feet of total cloth area consisting of four hundred fifty (450) 4.6" diameter x 144" filter elements of 16 oz. Polyester felt with a P84 composite on the surface. The filter bags are continuously cleaned with a reverse flow of air supplied from a dedicated PD blower. Refer to the filter operating manual for the recommended cleaning air settings.

The filter is equipped with a Dwyer Photohelic differential pressure gauge for monitoring the filter differential pressure. A high differential pressure switch and a high level switch on the filter hopper is interlocked to the flyash feed system via the Ammonia process PLC control system.

Manufacturer :	Mac Equipment 7901 NW 107th terrace Kansas City MO 64153 (816) 891-9300
Model:	MCF 756-450
STI PO:	30649
Manufacturer Contact:	Rich Lucas Scott Equipment (612) 758-2591

Operation/Maintenance:

When the ammonia process dryer is started via the touchscreen terminal, the filter will start operation as part o this sequence. If an upset condition is detected by the photohelic or high level sensor, the system will automatically initiate the AUTOSTOP sequence.

Since this filter is used as a receiver to Scott AST dryer, careful attention to the dryer burner lighting procedures is critical for safe operation. Refer to the Scott dryer operating manual for the dryer burner lighting procedure. The filter outlet temperature must also be monitored during ammonia process startup. Before ash feed flow is started, the filter outlet temperature must exceed the system dewpoint of 130 deg F; otherwise condensation is possible on the filter bags resulting in high differential pressure. Refer to the Mac operating manual for the recommended settings.

As part of the routine system checks, the dryer stack must to checked for visible emissions of flyash. If visible emissions are detected, the system must be shutdown and the source of the emission identified and eliminated.

As part of the routine system checks, the filter differential pressure is logged. When differential pressure becomes excessively high, the filter elements must be replaced. A maintenance log must be kept to record the date, time, and details of each filter maintenance event. An example of the maintenance logsheet is included at the end of this document.

ProAsh Baghouse Maint Log

DATE	SILO	TYPE MAINTENANCE	FIX	TIME
12/20/97	2	Blowby	Repaired filters	10 hrs
01/21/98	2	Return elbow leak	R+R elbow	3 hrs
02/15/98	3	Blow-by	R+R (2) filters	3 hrs
03/14/98	3	Loose bag filter	repaired filter	3 hrs
04/28/98	3	Loose bag filter	repaired filter	4 hrs
05/21/98	2	Blow-by	R+R all filters	16 hrs
05/15/98	3	Loose filter	repaired filter	2 hrs
06/02/98	2	sep B installation	tie in to existing lines	2 hrs
06/16/98	2	Hy Vac installation	tie in to existing lines	7.0 hrs
06/30/98	2	Mod to dust return	install large CFM pulleys	4 hrs
07/03/98	2	Blow-by	repaired filters	10 hrs
07/17/98	3	Blow-by	repaired blown filters	3 hrs
08/14/98	2	Blow-by	pulled & reinstalled all filters	10 hrs
08/17/98	2	Blow-by	pulled & replaced (2) filters	2 hrs
08/18/98	2	Blow-by	pulled & replaced 2 filters	4 hrs
08/19/98	2	Blow-by	pulled & repaired ~~boot~~ 6 filters	4 hrs
08/21/98	2	Blow-by	pulled & repaired boot	1 hr
01/07/99	3	Blow-by	re-tightened filters (3)	3 hrs
03/16/99	2	Blow-by	R+R all filters	10 hrs

ATTACHMENT G

MAC Equipment Inc.

Particle Emissions Test (PET)

Prepared for:

Scott Equipment Company

Test #E99054

Sept. 23, 1999

Prepared By:
MAC Equipment Inc.
Sabetha, Kansas

Table of Contents

What is a Particle Emission Test 1

Material Analysis 2
- Particle Density
- Particle Size Analysis
- Material Characteristics
- Material Horizontal/Vertical Convey Velocity

Operation Printouts 3

Summary / Recommendations 4

Literature / Appendix 5

Material Analysis

The following pages contain results of tests that were preformed to determine the optimum operating conditions. The tests included the following:

True Density: Is used in the equation to determine particle size.

Particle Analysis: Determines particle size distribution and mean particle size.

Bench Test Results: These tests determine material properties including:

- Bulk Density
- Angle of Repose
- Slide Angle
- Moisture
- Abrasiveness
- Hygroscopic
- Minimum Horizontal Velocity
- Terminal Velocity

MAC EQUIPMENT, INC

Small Sample Consolidated Test of

Fly Ash

for

Scott Equipment Company

605 4th Ave. NW
New Prague, MN 56071

Test Report: E99054

9/23/99

Written By:
Craig Kauffman

	Test No.: E99054
	DATE: 9/23/99
TEST RESULTS:	Page 2

MATERIAL PROPERTIES:

Ambient Temperature:	66	deg F
Ambient Humidity:	45	Percent
Bulk Density:	60.4	PCF
Settled Density:	74.6	PCF
Angle of Repose:	39	Degrees
Slide Angle:	38	Degrees

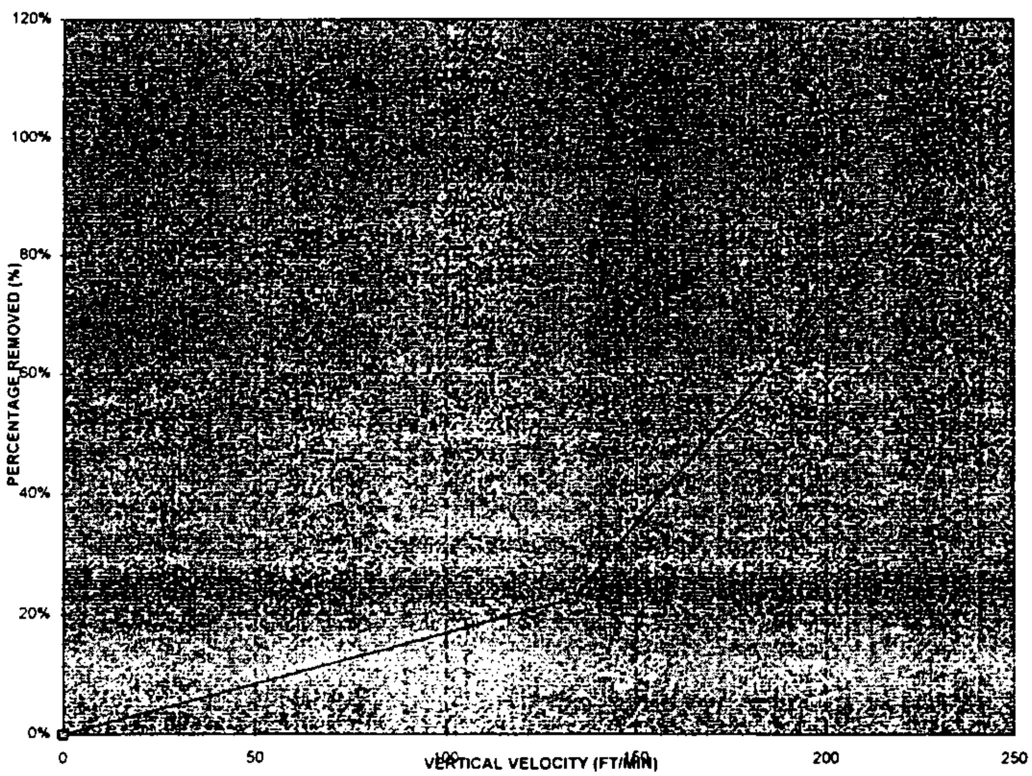
SUBJECTIVE PROPERTIES	1 TO 5 VALUE	RANGE 1 2 3 4 5
ABRASIVENESS	3	LOW------- ---HIGH
ADHESIVENESS	1	LOW------- ---HIGH
AIRLOCK BUILD-UP	1	NO-------- -----YES
BUILD-UP IN ELBOWS	1	NO-------- -----YES
COHESIVENESS	1	LOW------- ---HIGH
COMPRESSIBILITY	1	LOW------- ---HIGH
DEAERATES	3	FAST------ ----SLOW
DUSTINESS	4	LOW------- ----HIGH
FLOW FROM HOPPER	3	EASY------ ---HARD
FLOWABILITY	1	GOOD------ ----POOR
FLUIDIZABLE	1	GOOD------ ----POOR
FRIABILITY	1	LOW------- ----HIGH
HYGROSCOPIC	1	LOW------- ---HIGH
SHAPE	1	O--------- -------*
SIZE CONSISTENCY	1	YES------- ------NO
STATIC CHARGE	1	NO-------- -----YES

SMALL SAMPLE TERMINAL VELOCITY ANALYSIS:

Grams Retained	@ FPM	Percentage Removed
100.0	0	0
77.4	133	23%
4.6	230	95%

Maximum Interstitial Velocity:	150 FPM
Vertical Velocity for Fines (approx 5%):	80 FPM
Minimum Vertical Conveying Velocity (95%):	230 FPM

TERMINAL VELOCITY TEST



REMARKS:

Test No.: E99054
DATE: 9/23/99
Page 4

TEST RESULTS:

SIEVE ANALYSIS:

Weighted Particle Mean Diameter: 64 Microns = 0.0025 Inches

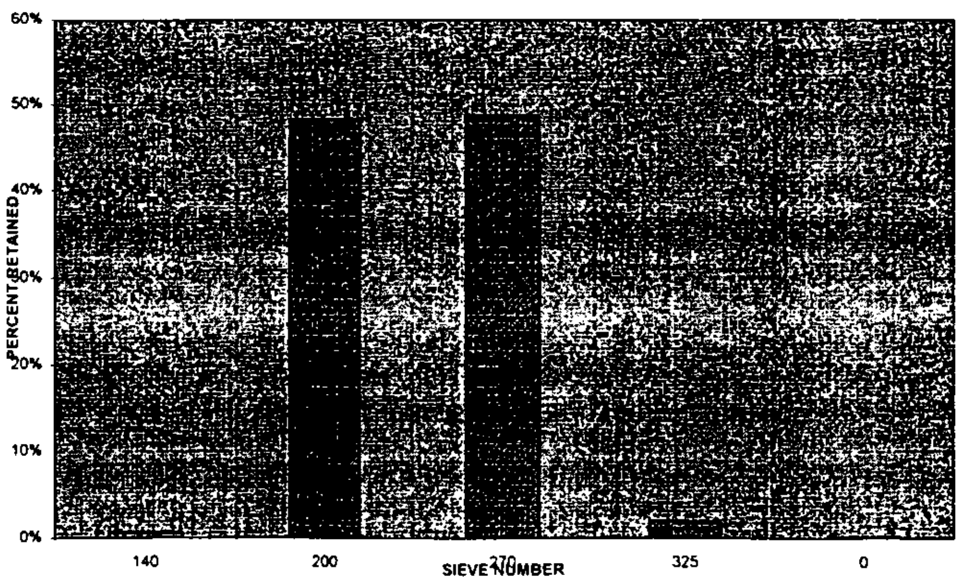
Sieve Number	Sieve Gross	Sieve Tare	Grams Retained	% Retained	% Passing	Micron
140	525.9	525.2	0.7	0.7%	99.3%	106
200	541.5	493.2	48.3	48.3%	51.0%	75
270	534.9	486.2	48.7	48.7%	2.2%	53
325	482.1	480.1	2.0	2.0%	0.2%	45
0	372.0	371.8	0.2	0.2%	0.0%	

MATERIAL CLASSIFICATION:

	Micron Range
Very Fine Powder	0 to 75
Fine Powder	75 to 106
Powder	106 to 180
Granular	180 to 425
Coarse Granular	425 to 2360
Pellets	2360 to 5600
Pebbles	5600 to 12500
Fibrous Flake	-

This material is classified as a: Very Fine Powder

SIEVE ANALYSIS HISTOGRAM



REMARKS:

MULTIPYCNOMETER DENSITY WORKSHEET
TRUE POWDER DENSITY (SPECIFIC GRAVITY)

(Not bulk density)

Test Number E99054

Sample I.D. Fly Ash
Source: Scott Equipment

Date: 9/22/99
Operator: Craig Kauffman

Total Weight	19.049
Container Weight	4.610
Sample Weight	14.439

Reference Volume (Vr) 13.502 cubic cm
Cell Volume (Vc) 29.537 cubic cm

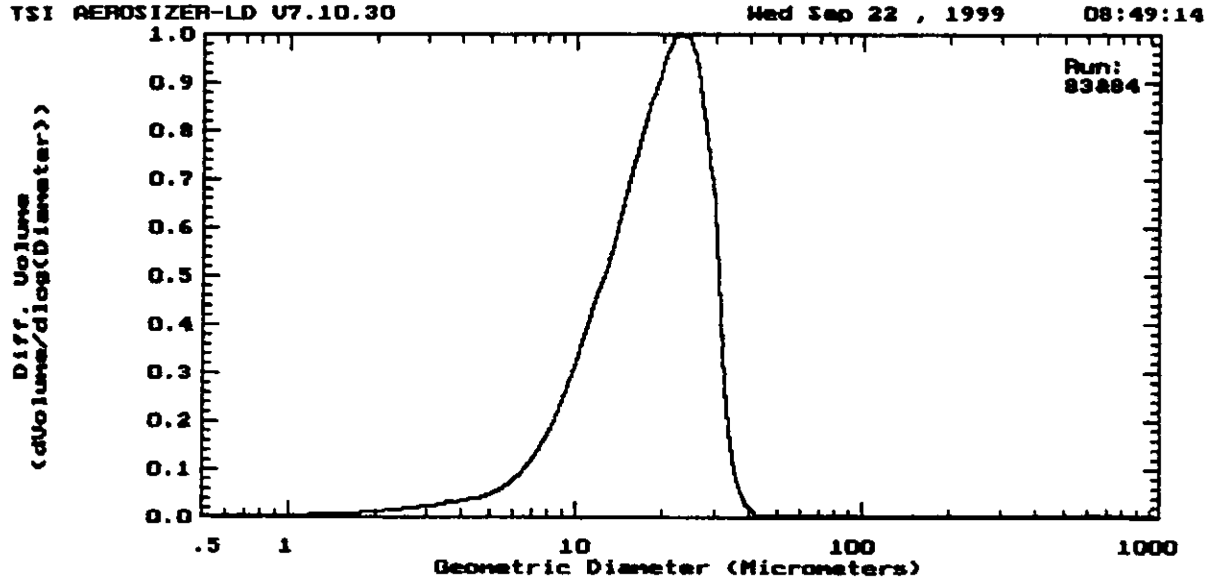
	Run 1		Run 3
P1	17.194	17.317	17.131
P2	6.333	6.381	6.313
Vp	6.381	6.397	6.400
Density	2.263	2.257	2.256

Average Density =	2.259

Vp = Volume of powder (cubic cm)
Vc = Volume of sample cell (cubic cm)
Vr = Reference Volume (cubic cm)
P1 = Pressure reading after pressurizing the reference volume
P2 = Pressure reading after including Vc
Density = Grams per cubic centimeter

Operation Equation: Vp = Vc - Vr ((P1 / P2) - 1)
Density Equation: Sample Weight / Vp

TSI AEROSIZER-LD V7.10.30 Wed Sep 22 , 1999 08:49:14

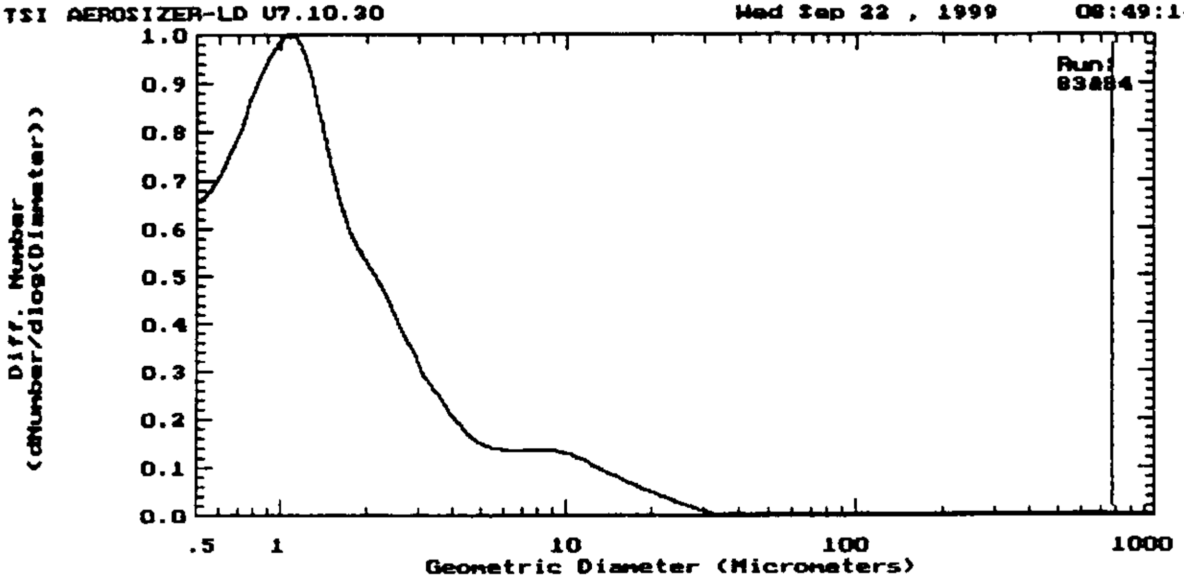


Directory: c:\api Run 83 taken on Wed Sep 22 08:49:14 1999 Volume Distribution by Geometric Diameter
Scott Equipment Regularization: Low
Fly Ash

PARAMETERS		DISPERSER CONTROL		%UNDER	SIZE	%UNDER	SIZE
Material	: Fly Ash	Disperser Type :	AeroDisperser	5%	6.902	55%	20.04
Density	: 2.26	Shear Force :	Low	10%	9.230	60%	21.12
Run Length (sec)	: 435.0	Feed rate :	Med	15%	10.83	65%	22.22
PMT Voltage (volts)	: 1100.0			20%	12.17	70%	23.34
Laser Current (mA)	: 48.3	Deagglomeration :	Normal	25%	13.43	75%	24.53
Clock Freq (MHz)	: 20.0	Pin Vibration :	On	30%	14.62	80%	25.79
Sum of channels	: 1869691			35%	15.74	85%	27.19
Lower Size Limit	: 0.50			40%	16.83	90%	28.86
Upper Size Limit	: 770.00			45%	17.90	95%	30.97
Nozzle Type	: 700um	SCANS 83 AND 84 COMBINED		50%	18.97		
Baseline Offset	: 0.10	BETWEEN 4.8 & 4.9 MICRONS					
Noise Filter	: 6.00						
Mean Size	: 17.15	D(4,3) :	18.98	Mode (Log Scale) :			23.44
Standard Deviation	: 1.654	D(3,2) :	14.44	Spec surf area:		0.184 sq meter/g	

UPPER SIZE	% IN	LOWER SIZE	% UNDER	UPPER SIZE	% IN	LOWER SIZE	% UNDER	UPPER SIZE	% IN	LOWER SIZE	% UNDER	UPPER SIZE	% IN	LOWER SIZE	% UNDER
				501	0.0000	431	100.00	50.1	0.0000	43.1	100.00	5.01	0.6093	4.31	2.1225
				431	0.0000	371	100.00	43.1	0.3939	37.1	99.606	4.31	0.4908	3.71	1.6318
				371	0.0000	316	100.00	37.1	3.5166	31.6	96.089	3.71	0.4196	3.16	1.2122
				316	0.0000	271	100.00	31.6	11.520	27.1	84.570	3.16	0.3190	2.71	0.8931
				271	0.0000	231	100.00	27.1	15.826	23.1	68.744	2.71	0.2591	2.31	0.6340
				231	0.0000	200	100.00	23.1	13.721	20.0	55.023	2.31	0.1700	2.00	0.4640
				200	0.0000	170	100.00	20.0	14.044	17.0	40.979	2.00	0.1431	1.70	0.3209
				170	0.0000	145	100.00	17.0	11.331	14.5	29.647	1.70	0.1052	1.45	0.2157
				145	0.0000	125	100.00	14.5	8.2466	12.5	21.401	1.45	0.0774	1.25	0.1384
				125	0.0000	110	100.00	12.5	5.6930	11.0	15.708	1.25	0.0498	1.10	0.0885
				110	0.0000	90.2	100.00	11.0	6.2727	9.02	9.4349	1.10	0.0482	0.90	0.0403
				90.2	0.0000	80.2	100.00	9.02	2.3862	8.02	7.0488	0.90	0.0161	0.80	0.0242
				80.2	0.0000	70.2	100.00	8.02	1.8663	7.02	5.1825	0.80	0.0115	0.70	0.0127
702	0.0000	601	100.00	70.2	0.0000	60.1	100.00	7.02	1.4060	6.01	3.7765	0.70	0.0077	0.60	0.0050
601	0.0000	501	100.00	60.1	0.0000	50.1	100.00	6.01	1.0447	5.01	2.7318	0.60	0.0050	0.50	0.0000

TSI AEROSIZER-LD U7.10.30 Wed Sep 22 , 1999 08:49:14

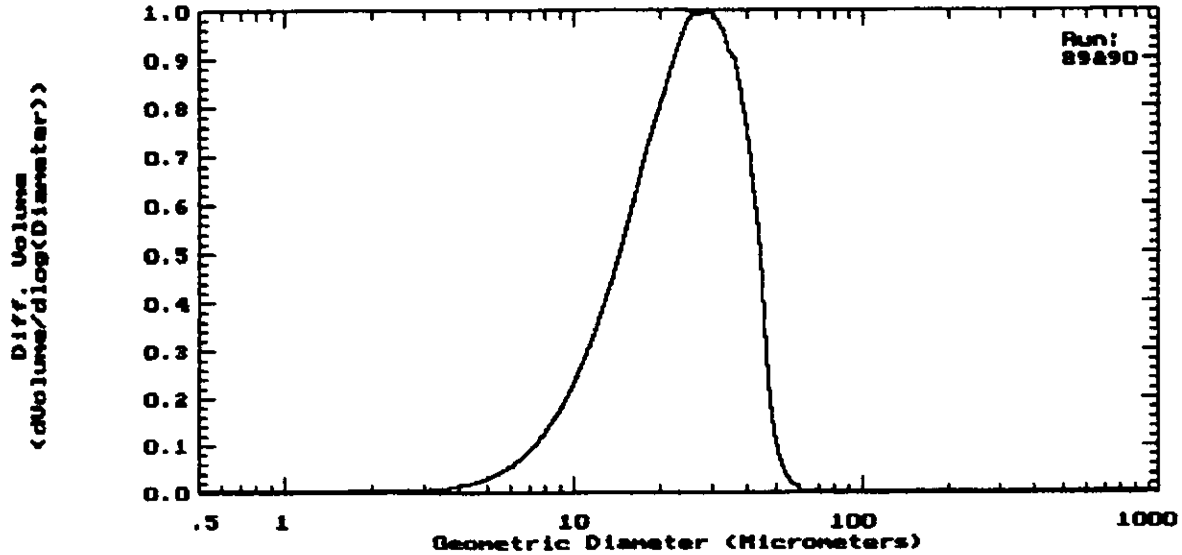


Directory: c:\api Run 83 taken on Wed Sep 22 08:49:14 1999 Number Distribution by Geometric Diameter
Scott Equipment Regularization: Low
Fly Ash

PARAMETERS		DISPERSER CONTROL	%UNDER	SIZE	%UNDER	SIZE
Material	: Fly Ash	Disperser Type : AeroDisperser	5%	0.5642	55%	1.379
Density	: 2.26	Shear Force : Low	10%	0.6311	60%	1.523
Run Length (sec)	: 435.0	Feed rate : Med	15%	0.7003	65%	1.711
PMT Voltage (volts)	: 1100.0		20%	0.7712	70%	1.961
Laser Current (mA)	: 48.3	Deagglomeration : Normal	25%	0.8434	75%	2.288
Clock Freq (MHz)	: 20.0	Pin Vibration : On	30%	0.9178	80%	2.754
Sum of channels	: 1869691		35%	0.9955	85%	3.553
Lower Size Limit	: 0.50		40%	1.077	90%	5.413
Upper Size Limit	: 770.00		45%	1.165	95%	9.655
Nozzle Type	: 700um	SCANS 83 AND 84 COMBINED	50%	1.263		
Baseline Offset	: 0.10	BETWEEN 4.8 & 4.9 MICRONS				
Noise Filter	: 6.00					
Mean Size	: 1.546	D(4,3) : 18.98	Mode (Log Scale) :		1.09	
Standard Deviation	: 2.313	D(3,2) : 14.44	Spec surf area:		0.184 sq meter/g	

UPPER SIZE	% IN	LOWER SIZE	% UNDER	UPPER SIZE	% IN	LOWER SIZE	% UNDER	UPPER SIZE	% IN	LOWER SIZE	% UNDER	UPPER SIZE	% IN	LOWER SIZE	% UNDER
				501	0.0000	431	100.00	50.1	0.0000	43.1	100.00	5.01	1.5918	4.31	87.694
				431	0.0000	371	100.00	43.1	0.0018	37.1	99.998	4.31	2.0165	3.71	85.677
				371	0.0000	316	100.00	37.1	0.0251	31.6	99.973	3.71	2.7424	3.16	82.935
				316	0.0000	271	100.00	31.6	0.1243	27.1	99.849	3.16	3.3519	2.71	79.583
				271	0.0000	231	100.00	27.1	0.2700	23.1	99.579	2.71	4.3594	2.31	75.223
				231	0.0000	200	100.00	23.1	0.3638	20.0	99.215	2.31	4.4737	2.00	70.750
				200	0.0000	170	100.00	20.0	0.5856	17.0	98.629	2.00	5.9209	1.70	64.829
				170	0.0000	145	100.00	17.0	0.7632	14.5	97.866	1.70	7.0797	1.45	57.749
				145	0.0000	125	100.00	14.5	0.8795	12.5	96.987	1.45	8.2504	1.25	49.499
				125	0.0000	110	100.00	12.5	0.9186	11.0	96.068	1.25	8.0145	1.10	41.484
				110	0.0000	90.2	100.00	11.0	1.6424	9.02	94.426	1.10	12.522	0.90	28.963
				90.2	0.0000	80.2	100.00	9.02	1.0124	8.02	93.413	0.90	6.8209	0.80	22.142
				80.2	0.0000	70.2	100.00	8.02	1.1515	7.02	92.262	0.80	7.0422	0.70	15.100
702	0.0000	601	100.00	70.2	0.0000	60.1	100.00	7.02	1.3340	6.01	90.928	0.70	7.2905	0.60	7.8091
601	0.0000	501	100.00	60.1	0.0000	50.1	100.00	6.01	1.6424	5.01	89.285	0.60	7.8091	0.50	0.0000

TSI AEROSIZER-LD V7.10.30 Thu Sep 23 , 1999 10:27:49

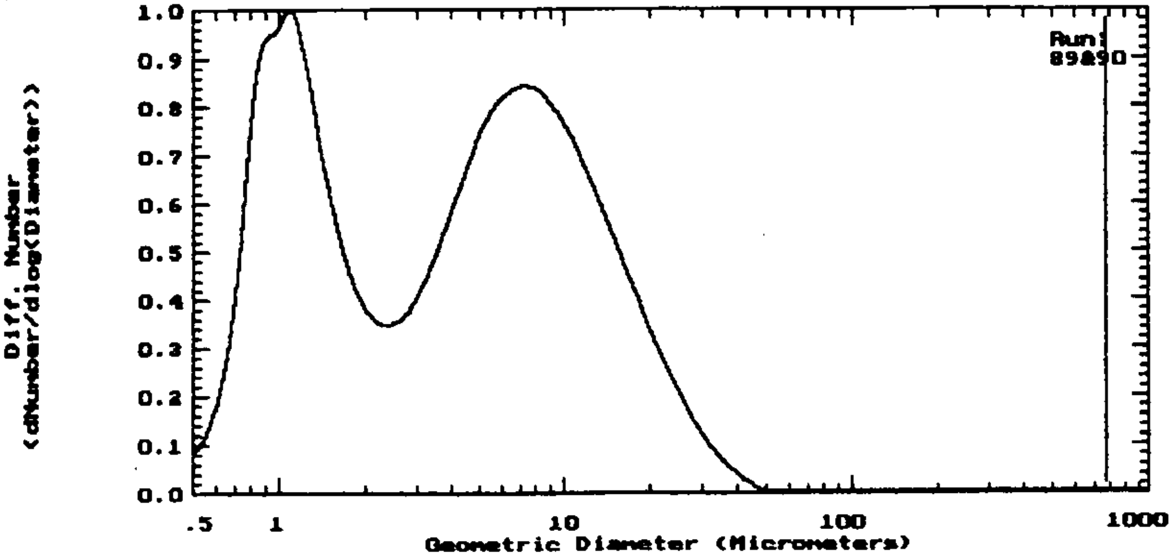


Directory; c:\api Run 89 taken on Thu Sep 23 10:27:49 1999 Volume Distribution by Geometric Diameter
Scott Equipment Company Regularization: Low
Fly Ash - Virgin

PARAMETERS		DISPERSER CONTROL		%UNDER	SIZE	%UNDER	SIZE
Material	: Fly Ash	Disperser Type :	AeroDisperser	5%	9.205	55%	25.90
Density	: 2.26	Shear Force :	Low	10%	11.69	60%	27.47
Run Length (sec)	: 439.8	Feed rate :	Med	15%	13.65	65%	29.13
PMT Voltage (volts)	: 1100.0			20%	15.39	70%	30.89
Laser Current (mA)	: 48.3	Deagglomeration :	Normal	25%	16.99	75%	32.78
Clock Freq (MHz)	: 20.0	Pin Vibration :	On	30%	18.50	80%	34.87
Sum of channels	: 1457331			35%	19.98	85%	37.20
Lower Size Limit	: 0.50			40%	21.45	90%	39.93
Upper Size Limit	: 770.00			45%	22.92	95%	43.51
Nozzle Type	: 700um	SCANS 89 AND 90 COMBINED		50%	24.39		
Baseline Offset	: 0.10	BETWEEN 18.8 & 19.1 MICRONS					
Noise Filter	: 6.00						
Mean Size	: 22.70	D(4,3) :	25.18	Mode (Log Scale) :	29.51		
Standard Deviation	: 1.626	D(3,2) :	19.82	Spec surf area:	0.134 sq meter/g		

UPPER SIZE	% IN	LOWER SIZE	% UNDER	UPPER SIZE	% IN	LOWER SIZE	% UNDER	UPPER SIZE	% IN	LOWER SIZE	% UNDER	UPPER SIZE	% IN	LOWER SIZE	% UNDER
				501	0.0000	431	100.00	50.1	4.6891	43.1	94.516	5.01	0.2568	4.31	0.3248
				431	0.0000	371	100.00	43.1	9.7494	37.1	84.767	4.31	0.1382	3.71	0.1866
				371	0.0000	316	100.00	37.1	12.905	31.6	71.862	3.71	0.0759	3.16	0.1107
				316	0.0000	271	100.00	31.6	13.131	27.1	58.730	3.16	0.0373	2.71	0.0734
				271	0.0000	231	100.00	27.1	13.268	23.1	45.463	2.71	0.0217	2.31	0.0517
				231	0.0000	200	100.00	23.1	10.240	20.0	35.223	2.31	0.0124	2.00	0.0392
				200	0.0000	170	100.00	20.0	10.047	17.0	25.176	2.00	0.0109	1.70	0.0283
				170	0.0000	145	100.00	17.0	7.6967	14.5	17.479	1.70	0.0088	1.45	0.0195
				145	0.0000	125	100.00	14.5	5.4344	12.5	12.044	1.45	0.0070	1.25	0.0124
				125	0.0000	110	100.00	12.5	3.5319	11.0	8.5125	1.25	0.0049	1.10	0.0075
				110	0.0000	90.2	100.00	11.0	3.8152	9.02	4.6972	1.10	0.0048	0.90	0.0027
				90.2	0.0000	80.2	100.00	9.02	1.4802	8.02	3.2171	0.90	0.0016	0.80	0.0011
				80.2	0.0000	70.2	100.00	8.02	1.1757	7.02	2.0414	0.80	0.0008	0.70	0.0004
702	0.0000	601	100.00	70.2	0.0266	60.1	99.973	7.02	0.8719	6.01	1.1695	0.70	0.0003	0.60	0.0001
601	0.0000	501	100.00	60.1	0.7679	50.1	99.206	6.01	0.5879	5.01	0.5817	0.60	0.0001	0.50	0.0000

TSI AEROSIZER-LD V7.10.30 Thu Sep 23 , 1999 10:27:49



Directory: c:\api Run 89 taken on Thu Sep 23 10:27:49 1999 Number Distribution by Geometric Diameter
Scott Equipment Company Regularization: Low
Fly Ash - Virgin

PARAMETERS		DISPERSER CONTROL		%UNDER	SIZE	%UNDER	SIZE
Material	: Fly Ash	Disperser Type	: AeroDisperser	5%	0.7856	55%	5.186
Density	: 2.26	Shear Force	: Low	10%	0.9028	60%	6.017
Run Length (sec)	: 439.8	Feed rate	: Med	15%	1.021	65%	6.928
PMT Voltage (volts)	: 1100.0			20%	1.149	70%	7.960
Laser Current (mA)	: 48.3	Deagglomeration	: Normal	25%	1.304	75%	9.171
Clock Freq (MHz)	: 20.0	Pin Vibration	: On	30%	1.534	80%	10.66
Sum of channels	: 1457331			35%	1.949	85%	12.61
Lower Size Limit	: 0.50			40%	2.699	90%	15.41
Upper Size Limit	: 770.00			45%	3.571	95%	20.24
Nozzle Type	: 700um	SCANS 89 AND 90 COMBINED		50%	4.386		
Baseline Offset	: 0.10	BETWEEN 18.8 & 19.1 MICRONS					
Noise Filter	: 6.00						
Mean Size	: 3.803	D(4,3)	: 25.18	Mode (Log Scale)	: 1.10		
Standard Deviation	: 2.958	D(3,2)	: 19.82	Spec surf area:	0.134 sq meter/g		

UPPER SIZE	% IN	LOWER SIZE	% UNDER	UPPER SIZE	% IN	LOWER SIZE	% UNDER	UPPER SIZE	% IN	LOWER SIZE	% UNDER	UPPER SIZE	% IN	LOWER SIZE	% UNDER
				501	0.0000	431	100.00	50.1	0.0864	43.1	99.904	5.01	4.3859	4.31	49.528
				431	0.0000	371	100.00	43.1	0.2712	37.1	99.633	4.31	3.7015	3.71	45.827
				371	0.0000	316	100.00	37.1	0.5677	31.6	99.065	3.71	3.2337	3.16	42.593
				316	0.0000	271	100.00	31.6	0.9222	27.1	98.143	3.16	2.5538	2.71	40.040
				271	0.0000	231	100.00	27.1	1.4897	23.1	96.654	2.71	2.3993	2.31	37.640
				231	0.0000	200	100.00	23.1	1.7958	20.0	94.858	2.31	2.1682	2.00	35.472
				200	0.0000	170	100.00	20.0	2.7701	17.0	92.088	2.00	3.0089	1.70	32.463
				170	0.0000	145	100.00	17.0	3.4294	14.5	88.658	1.70	3.9484	1.45	28.515
				145	0.0000	125	100.00	14.5	3.8351	12.5	84.823	1.45	4.9901	1.25	23.525
				125	0.0000	110	100.00	12.5	3.7715	11.0	81.052	1.25	5.2747	1.10	18.250
				110	0.0000	90.2	100.00	11.0	6.6201	9.02	74.431	1.10	8.2811	0.90	9.9689
				90.2	0.0000	80.2	100.00	9.02	4.1648	8.02	70.267	0.90	4.3444	0.80	5.6245
				80.2	0.0000	70.2	100.00	8.02	4.8087	7.02	65.458	0.80	3.1273	0.70	2.4972
702	0.0000	601	100.00	70.2	0.0002	60.1	100.00	7.02	5.4738	6.01	59.984	0.70	1.6422	0.60	0.8550
601	0.0000	501	100.00	60.1	0.0090	50.1	99.991	6.01	6.0697	5.01	53.914	0.60	0.8550	0.50	0.0000

Pet Machine Printouts

The following pages contain information that was printed from the PET machine during actual testing of material.

The first page shows all operating parameters of the PET machine including Air-to-cloth ratio, inlet velocity, can velocity, interstitial velocity, grain loading, differential pressure, cleaning mode, and emissions.

The second page shows real time operation of the filters including the fluctuation of emissions and differential pressure when pulsing occurs.

A variety of tests may conducted to find the optimum performance and several results may be included in this section.

Scott Equipment
E99054
Fly Ash

MAC Environmental

9/22/99
2:14:06 PM
70 °F 70 psi

Particle Emission Test - MCF/MPH Filter

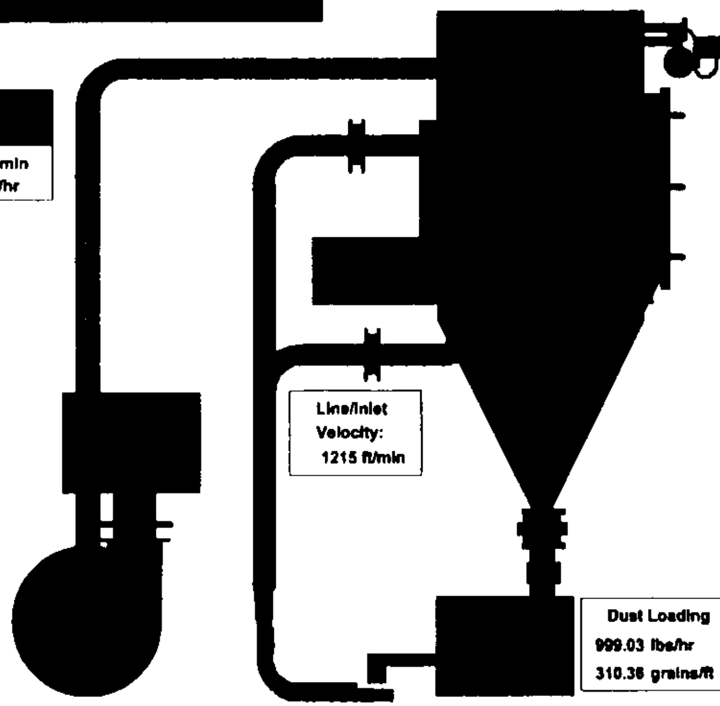
[redacted]

[redacted]

Actual Filter ACFM: 375.5 ft^3/min
638.0 m^3/hr

Emissions
0.066 mg/m^3
0.00002884 $grains/ft^3$
Avg.: 0.059 mg/m^3

Fan Speed
1250 2500 3750
RPM
3600 RPM



Line/Inlet Velocity: 1215 ft/min

Dust Loading
999.03 lbs/hr
310.36 $grains/ft^3$

Cleaning Mode: On Demand

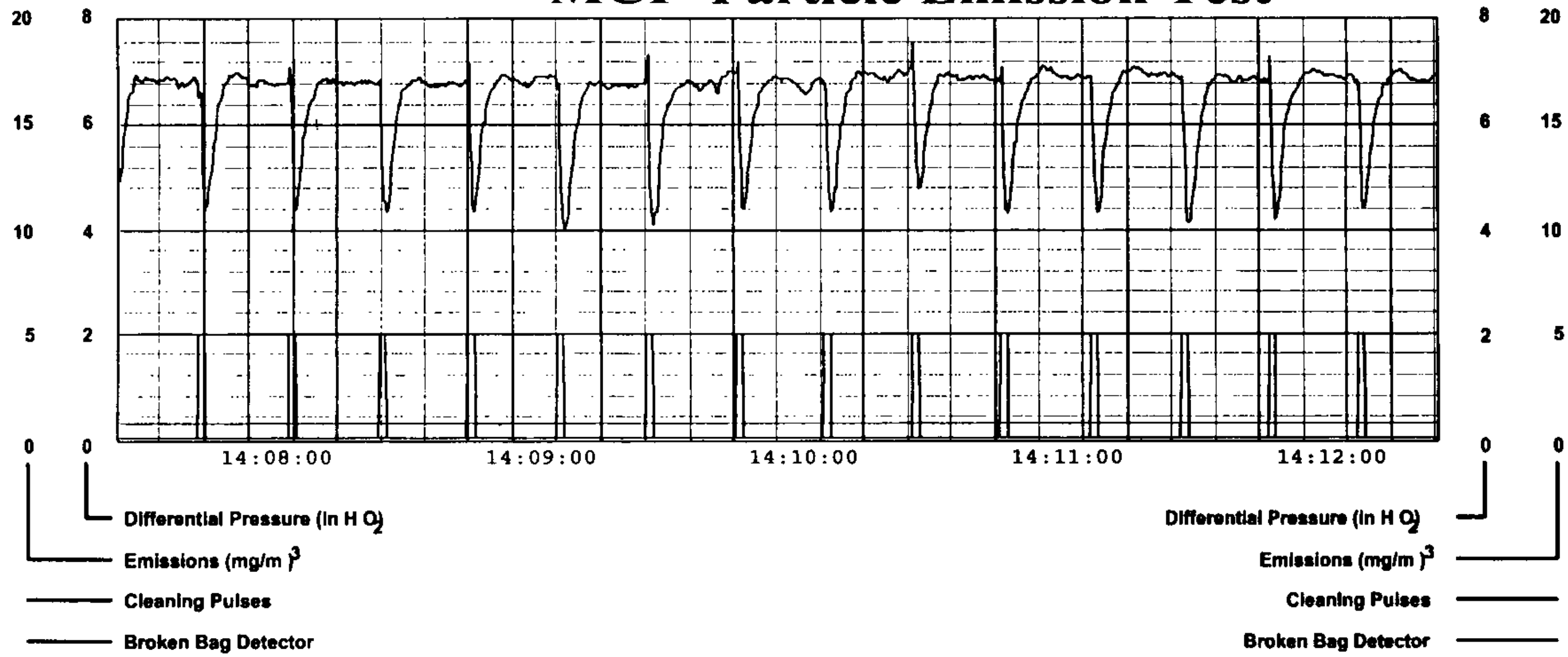
Differential Pressure
5 10 15
in H_2O
6.92 in H_2O
176.53 mm H_2O

MCF Pulse Duration	0.25 s
MCF Delay Between Pulses	20.0 s
MCF Cycle Delay	0.0 s
High DP Setpoint	3.00 in H_2O
Low DP Setpoint	2.00 in H_2O

Scott Equipment
E99054
Fly Ash

9/22/99
2:12:20 PM
70 °F

MCF Particle Emission Test



Pulse Pressure:	70 (psi)	Peak Emissions:	0.000	(mg/m^3)	Average DP:	6.5	(in H_2O)
Cleaning Mode:	On Demand	Average Emissions:	0.059	(mg/m^3)	Actual Filter ACFM:	383.2 ft^3/min	
Inlet Loading:	304.14 (grains/ft^3)	Average Filter Efficiency:	100.000	%	Air/Cloth Ratio:	4.12	
	695978.81 (mg/m^3)						

C:\PET\DATA\E99054005.pdf

Scott Equipment
E99054-2
Fly Ash

MAC Environmental

Particle Emission Test - MCF/MPH Filter

9/23/99
9:51:28 AM
70 °F 70 psi

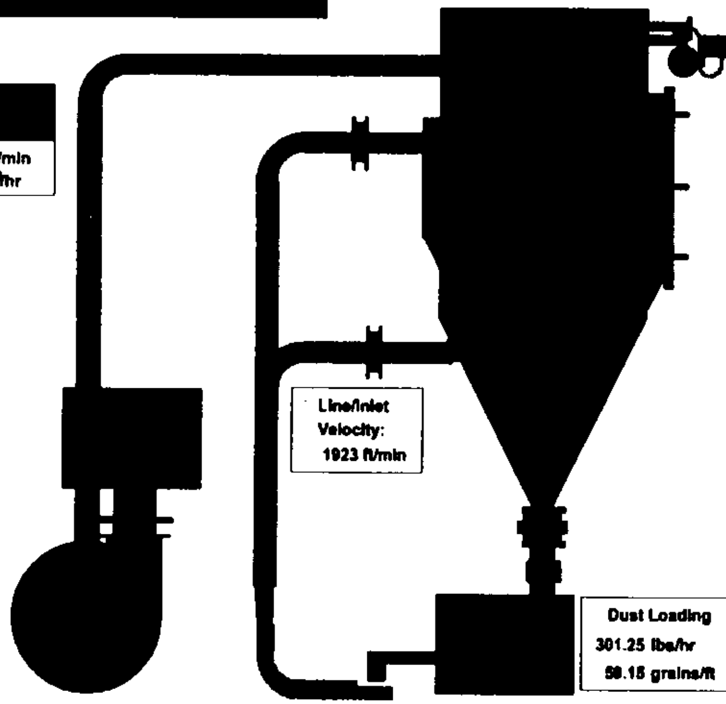
[redacted]

[redacted]

Actual Filter ACFM: 594.2 ft^3/min
1009.6 m^3/hr

Emissions
0.051 mg/m^3
0.00002229 $grains/ft^3$
Avg.: 0.061 mg/m^3

Fan Speed
1250 2500 3750
RPM
2700 RPM



Line/Inlet Velocity: 1923 ft/min

Dust Loading
301.25 lbs/hr
59.15 $grains/ft^3$

Cleaning Mode: On Demand

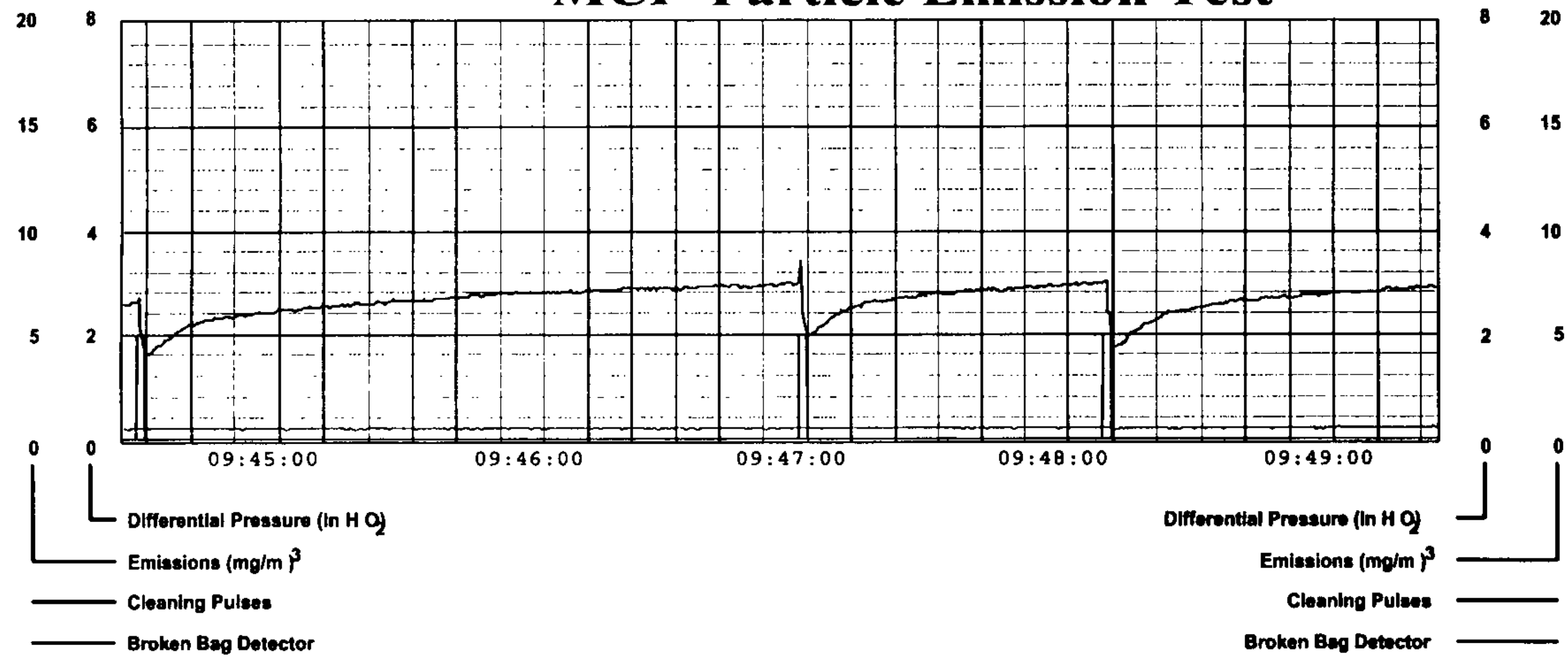
Differential Pressure
0 5 10 15
in H_2O
1.79 in H_2O
45.47 mm H_2O

MCF Pulse Duration 0.25 s
MCF Delay Between Pulses 20.0 s
MCF Cycle Delay 0.0 s
High DP Setpoint 3.00 in H_2O
Low DP Setpoint 2.00 in H_2O

Scott Equipment
E99054-2
Fly Ash

9/23/99
9:49:24 AM
70 °F

MCF Particle Emission Test



Pulse Pressure:	70	(psi)	Peak Emissions:	0.000	(mg/m^3)	Average DP:	2.6	(In H_2O)
Cleaning Mode:	On Demand		Average Emissions:	0.061	(mg/m^3)	Actual Filter ACFM:	411.9	ft^3/min
Inlet Loading:	85.33	(grains/ft^3)	Average Filter Efficiency:	100.000	%	Air/Cloth Ratio:	4.42	
	195256.31	(mg/m^3)						

Summary / Recommendations

The purpose of the test was to determine the optimum baghouse configuration, media type, air-to-cloth ratios, and emission levels for the Fly Ash Scott Equipment Company. Two tests were preformed using MAC Equipment's 96MCF7 filter with P84 Composite Bags. Each test ran approximately 24 hours to obtain a constant operating condition. The summary and recommendation are as follows:

Test #1

96MCF7 (medium pressure cleaning - 10 psi)
Media - 16 oz. P84/Polyester Composite Bags
Air/Cloth – 4.10 to 1
Inlet - Tangential Inlet
Dust Loading - 322 grains/ft^3
Air Temperature - Ambient
Cleaning Mode - On Demand (High DP Setpoint-3.0" , Low DP setpoint-2.0")

Conditions:

Inlet Velocity: 1169 ft/min.
Can Velocity: 106 ft/min.
Interstitial Velocity: 178 ft/min.
Average Delta Pressure: 6.5" w.c. (stabilized at 7.2" w.c.)
Average Emissions: 0.059 mg/m^3 (.000026 grains/ft^3)
Average Efficiency: 100.00%

Test #2

96MCF7 (medium pressure cleaning - 10 psi)
Media - 16 oz. P84/Polyester Composite Bags
Air/Cloth – 5.52 to 1
Inlet – High Entry Inlet
Dust Loading - 79 grains/ft^3
Air Temperature - Ambient
Cleaning Mode - On Demand (High DP Setpoint-3.0". Low DP setpoint-2.0")

Conditions:

Inlet Velocity: 1439 ft/min.
Average Delta Pressure: 2.6" w.c.
Average Emissions: 0.061 mg/m^3 (.000027 grains/ft^3)
Average Efficiency: 100.00%

Summary:

Test #1 was considered a failure due to the differential pressure across bags increasing to 7.2" w.c. and stabilizing. The high pressure differential was attributed to the extremely aggressive inlet loading. It was determined the MCF filter could not handle a 300 grains/ft^3 application. It was decided a cyclone pre-filter would be required to remove at high percentage of the dust prior to MCF. It was calculated a H96 cyclone would remove 87% of the inlet dust. Test #2 was setup to simulate the MCF collecting the 13% emission from the cyclone. The test performed very well at the 5.5 to 1 air-to-cloth ratio. The differential pressure stabilized at 2.6" w.c. with minimal pulsing/cleaning to maintain that level. Also, the bags were inspected after the test for excessive material build-up. No material build-up was evident. MAC Equipment would recommend a Cyclone pre-filter and a MCF with a maximum air-to-cloth ratio of 5.0 to 5.5 to 1 utilizing 16 oz. P84/ Polyester Composite Bags for this application.

Collector Efficiencies

CPO:

Job #

Item # of

Revision #

Description:

Customer: Scott Equipment

Engineer: C. Kauffman

Date: 9/22/1999

Collector Model: H96

Material: Fly Ash

Gas Flow Rate = 30000 CFM

Gas Temperature = 250 deg F

Particle Density = 60.4 lbm/cu.ft.

Particle Flow Rate = 76371 lbs/hr.

Number of Particle Sizes to Calculate: 5

Particle Size (Microns)	% By Weight	Inlet Load	Collection Effic. %	Lbs. Collected	Emmi. Rate Lbs./Hr.	% of Emmision
106	23.2	17718.1	94.7234	16783.15430	934.91797	9.7
75	18.2	13899.5	91.0206	12651.43457	1248.08789	13.0
53	26.2	20009.2	86.0997	17227.86719	2781.33398	28.9
45	9.1	6949.8	83.3994	5796.05762	1153.70361	12.0
38	23.3	17794.4	80.3884	14304.67383	3489.76953	36.3
	Totals:	76371.0		66763.188	9607.81250	

Calc. Tot. Eff.: 87.420

Pressure Drop (in. wg.): 2.56 @ 250 F

(Approximate) 3.43 @ S.T.P.

ATTACHMENT H

List of References:

1. Buonicore, A.J., Davis, W.T., "Air Pollution Engineering Manual," Air & Waste Management Association, 1992, p.114-132.

flange-to-flange cost by a factor of 2 to 3. Note that a totally stainless-steel collector would be much more expensive because the discharge electrodes, rappers, hangers, and so on, are also converted to stainless. The preceding equations can be used for other grades of stainless steel or other materials of construction by inserting material costs obtained from local vendors on a dollar-per-pound basis.

FABRIC FILTERS

John D. McKenna and Dale A. Furlong

Fabric filters remove dust from a gas stream by passing the stream through a porous fabric. Dust particles form a more or less porous cake on the surface of the fabric. It is normally this cake that actually does the filtration.

The manner in which the dust is removed from the fabric is a crucial factor in the performance of the fabric filter system. If the dust cake is not adequately removed, the pressure drop across the system will increase to an excessive amount. If too much of the cake is removed, excessive dust leakage will occur while fresh cake develops. The selection of design parameters is crucial to the optimum performance of a fabric filter system.

Fabric filter systems are frequently referred to as baghouses, since the fabric is usually configured in cylindrical "bags." The two most common baghouse designs are the reverse-air and the pulse-jet types. These names describe the cleaning system used with the design.

Reverse-air baghouses operate by directing the dirty flue gas into the inside of the bags; therefore, the collection of dust is on the inside surface of the bags. The bags are cleaned periodically by reversing the flow of air, causing the previously collected dust cake to fall from the bags into a hopper below. Since this cleaning procedure is accomplished at relatively low gas velocity, the fabric is not exposed to violent movement, and so the reverse-air cleaning technique normally results in maximum bag life. In a variation of reverse-air baghouse design and the forerunner of the reverse-air baghouse (i.e., the shaker baghouse), the bags are shaken during the reverse-air cleaning interval.

Pulse-jet baghouses are designed with internal frame structures, called cages, to allow collection of the dust on the outside of the bags. The dust cake is periodically removed by a pulsed jet of compressed air into the bag causing a sudden bag expansion; dust is removed primarily by inertial forces when the bag reaches its maximum expansion. This bag cleaning technique is quite effective, however, the vigorousness of the technique and frequently the bag-to-cage fit tend to limit bag life and also tend to increase dust migration through the fabric, thus decreasing dust collection efficiency.

The selection of the fiber material and fabric construction is important to baghouse performance. The fiber material from which the fabric is made must have adequate strength characteristics at the maximum gas temperature expected and adequate chemical compatibility with both the gas and the collected dust. Felted fabric construction generally gives better removal of fine dust particles as compared with woven fabrics. However, not all fiber materials can be felted into a fabric of adequate strength and hence most filtration fabrics are constructed, at least in part, of filaments and/or fibers that are first twisted into yarns, and then woven or knitted into a fabric.

The published literature for fabric filtration is quite extensive. The reader is referred to *Fabric Filter—Baghouses I*, available from ETS, Inc., for one listing of references and for a more extensive discussion of subjects briefly included here.[1]

CONTROL OF TOXIC AIR POLLUTANTS

Spray adsorption, or dry scrubbing, followed by a fabric filter is a rapidly maturing technology for simultaneously controlling particulate matter and acidic gases emitted from combustion processes. In addition, this combination is used to control emissions of other toxic air contaminants—heavy metal compounds and products of incomplete combustion such as chlorinated hydrocarbons (including dioxins), for example—that may be emitted from solid waste incinerators.

Dry scrubbing followed by a fabric filter is considered the best available technology for controlling emissions from solid waste incinerators for two basic reasons:

1. The dry scrubber both reacts with acidic gases to form solid particulate and causes other toxic vapors, including most heavy metals and chlorinated hydrocarbons, to condense. The condensed substances have been shown to collect preferentially on the very fine dust particles owing to the greater available surface area of the fine particulate.
2. The fabric filter is the best currently available technology for high-efficiency removal of fine particulate.

Baghouses are generally considered to be a superior choice, relative to electrostatic precipitators (ESPs), for fine-particulate control. A multifield precipitator with a very large plate area is required to provide comparable fine-particulate collection performance; therefore, an ESP of comparable performance is usually more expensive. Figure 1 illustrates the greatly improving trend in the control of particulate emissions by both ESPs and fabric filters since 1970. Figure 2 indicates that for typical two-field ESPs, the removal efficiency for fine, submicron particles is considerably less than that achieved in a fabric filter.

As experience with the use of baghouses has increased, their reliability also has increased as a result of the availabil-

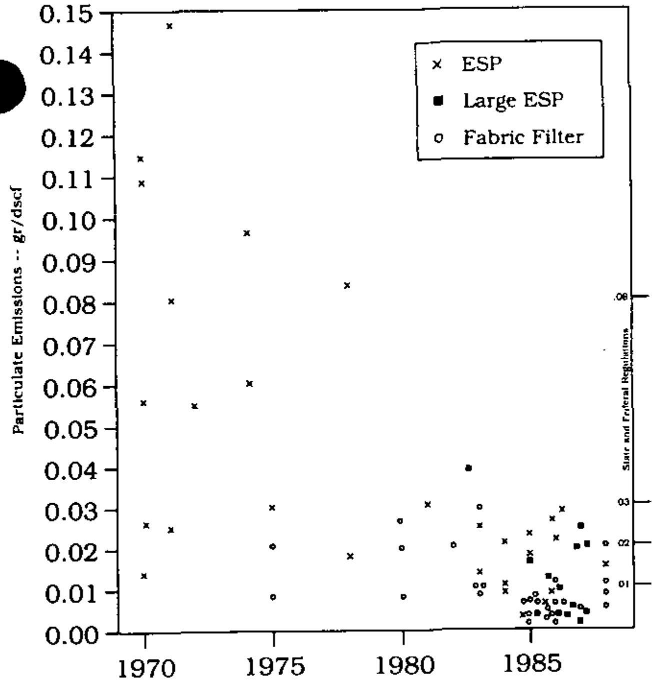


FIGURE 1. Particulate Emissions from MSW Incineration, 1970–1988

ity of different fibers/fabrics and improvements in the design of bag fabrics and in cleaning techniques. These measures have extended bag life to an average of five years, or more in some cases. Well-designed and operated baghouses have been shown to be capable of reducing overall particulate emissions to less than 0.010 gr/dscf, and in a number of cases, to as low as 0.001–0.005 gr/dscf. Based on the potential for greater removal efficiencies overall and in the submicron particle-size range, a number of states, including California, Connecticut, and Michigan, as well as Canada, prefer the use of scrubber/baghouses for solid-waste resource-recovery plants.

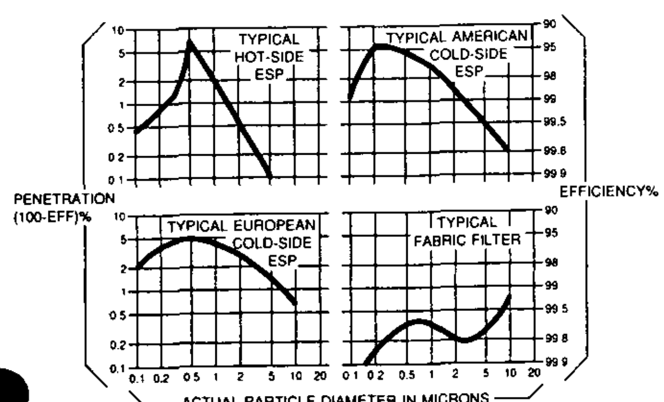


FIGURE 2. Typical Fractional Efficiencies For Existing Collectors (From *Electric Power Research Institute Economics of Fabric Filters vs. Precipitators*, Denver, CO June 1978)

FILTRATION PROCESSES

Mechanisms

Several particle collection mechanisms are normally responsible for filter efficiency. Theoretical equations exist for the capture efficiency of each mechanism based on single particles approaching single fibers. For an operating fabric filter, however, the fabric is covered with a dust cake and the dust cake is of continually varying thickness. Once the dust cake has reformed after each cleaning, sieving is probably the dominant mechanism. As particles approach the porous mass of dust that constitutes the cake, they either will strike one or more surface particles or enter a pore. If the particle is larger than the pore it attempts to enter, it will be sieved out. If the particle is smaller than the pore it enters, it will continue traveling through the pore until it touches the pore wall and adheres (rather than bounding or rolling along the wall); or until the pore narrows to dimensions smaller than the particle, causing the particle to be sieved out; or until the particle passes through the dust pore and a fabric pore and exits on the clean-air side of the air filter. Ordinarily, only one out of 1000, or an even 10,000, particles finds its way through the filter.

One might expect that larger particles would be sieved out with greater efficiency than smaller particles; that is, that the particles leaving the filter would have a smaller median diameter than the particles entering the filter. Experimentation has shown, however, that size distribution across the filter surface changes only slightly. The reason for the lack of change in size distribution stems from the manner in which most particles find their way through the filter. Most particles that transit the filter do so by a leakage process.[2]

The influence of electrically charged particles, a condition that is most common, on oppositely charged fibers of the filter has been shown to enhance attraction to an extent that particle-to-particle agglomeration is increased.

Consider a freshly cleaned bag: As filtration resumes, the cleaned areas of the fabric present pores of various sizes to the oncoming dust cloud. Individual particles strike the edges of pores or attach and begin to form chains or dendrites, a condition encouraged by the attraction produced as a result of opposing charge polarities. Before long, the smaller pores are bridged over by the chains and eventually become completely covered by porous cake. As time passes, more and more pores become covered with cake and the gas velocity through the remaining, uncovered pores becomes higher. Instead of a face velocity of a few feet per minute, we now have a pore velocity of up to several thousand feet per minute. Eventually, the velocity through the few remaining uncovered pores becomes so high and the pores so large that they cannot be bridged. For the remainder of the filtration cycle, these relatively free pores will be leakage points in the filter, and most of the particles passing through the filter will pass through these leakage points.

Billings and Wilder[3] report work by Tomaides suggesting that particles can bridge over a gap in a filter about 10 particle diameters wide. Presumably, the adhesive forces holding the chain together are exceeded by the aerodynamic forces trying to rupture the chain if its length exceeds 10 particle diameters.

Gas-to-Cloth Ratio

Gas-to-cloth ratio, *G/C*, is a measure of the amount of gas driven through each square foot of fabric in the baghouse, and is given in terms of the number of cubic feet of gas per minute passing through 1 square foot of cloth ($[\mathrm{ft}^3/\mathrm{min}]/\mathrm{ft}^2$ or fpm):

$$G/C = \frac{\mathrm{ft}^3 \text{ per minute of gas}}{\mathrm{ft}^2 \text{ of fabric}}$$

G/C can correctly be considered a superficial gas velocity. This is not the actual velocity through the openings in the fabric, built rather the apparent velocity of the gas approaching the cloth, although it is often referred to as "the gas velocity" and reported as feet per minute or meters per minute.

As the gas-to-cloth ratio increases, pressure drop (ΔP) also increases. Pressure drop is normally measured and reported as inches of water (in. H_2O, also written as inches water gauge, in. WC), the convention in the United States.

Pressure Drop

During the mid-1800s, Darcy formulated the following law for flow of fluid through a porous bed.

$$\Delta P = \frac{L u_f V}{K}$$

where: ΔP = pressure difference across the bed
L = bed thickness
u_f = fluid viscosity
V = superficial fluid velocity
K = bed permeability

This equation assumes that the fluid is essentially incompressible and steady, the fluid viscosity is Newtonian, and the velocity is low enough that only viscous effects occur. Over the past 100 years, investigators have been trying to find ways to predict K and to refine the Darcy equation.

The basic Darcy equation can be used to predict the pressure drop for an operating fabric filter with dust cake accumulating on the fabric.

$$\Delta P = S_E \mathrm{V} + + K_2 C_i V^2 t \quad (1)$$

where: ΔP = pressure drop, in. H_2O
S_E = effective residual drag, in. H_2O/fpm
V = velocity, fpm
K_2 = specific cake coefficient
C_i = inlet dust concentration, gr/cubic foot
Δt = filtration time, minutes

Energy loss through a fabric filter is composed of two parts. The first, $S_E V$, represents drag or energy expended in pumping system gas through the cleaned equilibrium fabric of the fabric filter. The second part of the equation, $K_2 C_i V^2 t$, represents energy required to pump gas through the filter cake that builds up on the surface of the fabric. Gas velocity appears in both terms, but because it is squared for the cake portion of the equation, it is especially important for describing the energy consumed in pumping gas through the filter cake. Another important part of the equation is K_2, the specific cake coefficient. This term is characteristic of the dust, varies for different dusts, and is a measure of how rapidly pressure drop will build up in a system.

A fabric filter in stable, cyclic operation will normally reach a point of constant drag characteristics. That is, the resistance to gas flow of the freshly cleaned fabric is the same at the beginning of successive filtration cycles. In practice, the value may change as the fabric ages. Residual drag is a measured value. There is no useful predictive equation for residual drag.

Experimental Measurements of K_2

Many researchers have conducted laboratory and pilot-scale fabric filter tests to measure K_2. Billings and Wilder[3] reported an extensive field survey of K_2 as a function of the air–cloth ratio (filtration velocity) and particle size. In this early work, K_2 was determined from the reported values of operating air–cloth ratio (V), dust loading (C_i), filtration time (t), and residual and maximum pressure drops (ΔP_R, ΔP_m). While this earlier work was quantitative, the wide range of dusts, quality of reported data, and configuration of the individual systems (single compartment, multiple compartment, type of cleaning, etc.) led to considerable scatter. The relationship showed order-of-magnitude variations in K_2 at a given particle size.

In more recent tests, obtained under controlled conditions, the relationships among K_2, particle size, and velocity have been shown more clearly.

Data from Dennis et al.[4] and Davis and Kurzynske[5] are shown in Figures 3 and 4, respectively. The solid lines represent each researcher's best fit to the data, where available. The data reported by Dennis et al. were summarized from eight different sources for fly ash, mica, and talc at 2–6 fpm; the data by Davis and Kurzynske were on talc dusts at a velocity of 4 fpm. Both sets of data clearly indicate a strong dependence of K_2 on the particle size.

It is evident from these data that velocity also has an effect on K_2. While this observed effect may be partially attributed to the effect of velocity on dust cake packing and/or Reynold's number, most researchers have reported that K_2 is a function of velocity such that

$$K_2 = kV^x$$

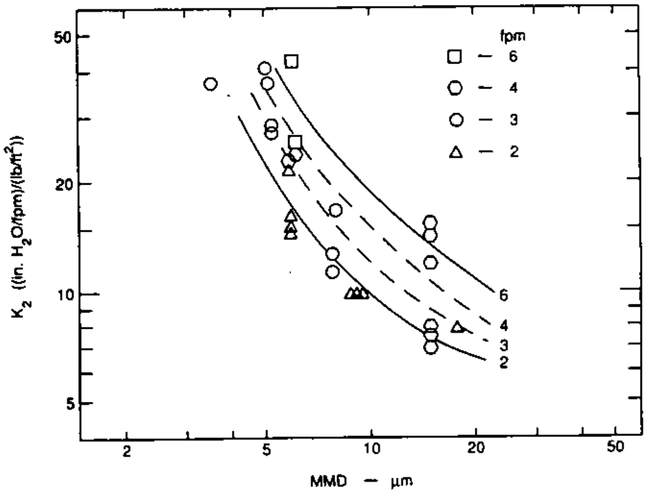


FIGURE 3. K_2 versus *MMD* and Face Velocity (Copyright ASTM. Reprinted with permission.)

Dennis et al.[4] reported that x had a value of 0.5 for fly ash and varied from 0.5 to 1.0. Davis and Frazier,[6] in a series of tests on fly ash using 11 different filter materials, reported an average value of 0.7 for fly ash. The data in Figures 3 and 4, data by Davis and Frazier,[6] and data by Frazier and Davis,[7] were normalized to a velocity of 3 fpm and replotted in Figure 5 assuming an average value for x of 0.6. The normalized data show that there is a well-defined relationship between K_2 and the particle size.

A best-fit equation was determined for the data:

$$K_2 = 118.4\ MMD^{-1.10}$$

where K_2 is measured in the English system and *MMD* is in microns. The best-fit equation predicts the K_2 value within a factor of two. The agreement between various sets of data is excellent considering that measurements obtained under carefully controlled laboratory conditions for a constant particle size distribution have shown a factor-of-two variation within a single laboratory.[6]

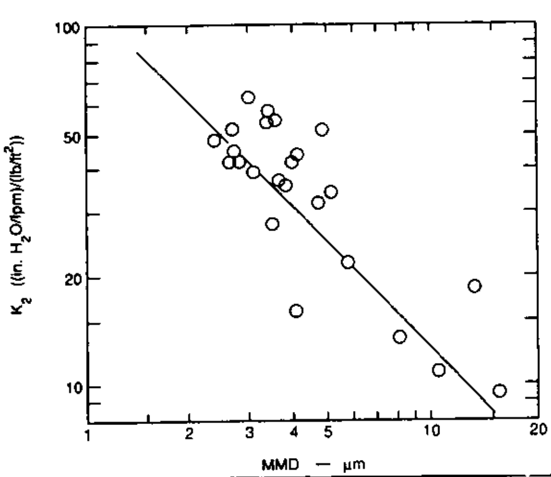


FIGURE 4. K_2 versus *MMD* for Talc at 4 fpm (Copyright ASTM. Reprinted with permission.)

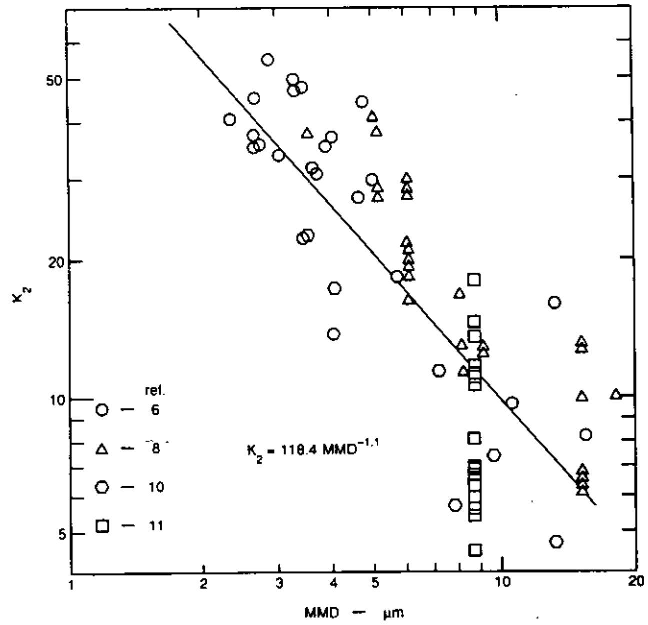


FIGURE 5. K_2 Normalized to 3 fpm versus *MMD* (Copyright ASTM. Reprinted with permission.)

Pressure Drop in Multicompartment Baghouses

Equation 1 describes the instantaneous pressure drop after some definite period of filtration through an area of fabric. When the area is distributed across several compartments operated in parallel, the compartments are generally cleaned sequentially. The total pressure drop across the baghouse, in terms of drag, is analogous to a set of electrical resistances in parallel. Robinson et al.[8] used Hemeon's equation:

$$\frac{N}{S_T} = \frac{1}{S_1} + \frac{1}{S_2} + \cdots + \frac{1}{S_N} \tag{2}$$

where: S_T = total baghouse drag = $\dfrac{\Delta P}{V_T}$

V_T = total gas volume = $V_1 + V_2 \cdots VN$

or

$$S_T = N\left[\sum \frac{1}{S_1}\right]^{-1}$$

N = number of compartments filtering

Subscripts refer to individual compartments

If one knows the drag in each compartment at a given time, the instantaneous drag (and, therefore, pressure drop) could be easily calculated for the entire system. Equation 2 lends itself primarily to computer applications.

Efficiency

Efficiency is a measure of how well a filter separates dust from gas. For an operating baghouse, overall efficiency is calculated from:

$$\text{Efficiency} = \frac{C_i - C_o}{C_i} = n$$

where: C_o = outlet concentration
C_i = inlet concentration

Penetration (1 − efficiency) is also used as a measure of performance.

Efficiency and penetration may be measured or calculated for specific particle sizes or size ranges. Inertial impactors are used to measure efficiency by measuring particle concentration over several size ranges on the inlet and outlet streams of a baghouse.

There is no satisfactory set of published equations that allows a designer to calculate efficiency for a prospective baghouse.

FILTRATION FABRICS

Fiber Types

This section discusses fibers and fabric properties that will help the user select and specify fabrics for particular fabric filter applications. Fabrics made of natural fibers such as cotton or wool are still employed for many filter applications; the development of synthetic fibers, however, has greatly extended the possible range of applications for fabric filters. Continuing developments in fiber and fabric technology may be anticipated.

Synthetic fibers are widely used for filtration fabrics because of their low cost, better temperature- and chemical-resistance characteristics, and small fiber diameter. Synthetics used include acetates, acrylics, polyamides, polyesters, polyolefins, and polyvinyl chlorides. Specialty fibers for high-temperature use such as Teflon, Ryton, P84, and carbon fibers have been developed; however, the synthetic fiber most used for high-temperature applications is glass.

The properties of glass fiber, such as good acid resistance, good heat resistance, and high tensile strength, solve many of the problems inherent in baghouses.

Fiberglass has the following characteristics.

- It is noncombustible because it is completely inorganic.
- It has zero moisture absorption; therefore, it is not subject to hydrolysis.
- It has dimensional stability (low coefficient of linear expansion).
- It has very high tensile strength, but poor resistance to flex and abrasion. There are some chemical surface treatments (e.g., silicone, graphite, Teflon B) that improve the flex–abrasion characteristics of glass.
- It has good resistance to acids, but is attacked by hydrofluoric, concentrated sulfuric, and hot phosphoric acids.
- It has poor resistance to alkalis; hot solutions of weak alkalis attack glass.
- It has poor resistance to acid anhydrides and metallic oxides (e.g., fluorides and sulfur oxides). For this reason, glass baghouses should not be operated at or below the dew point.

Table 1 lists the major fiber alternatives for gas filtration and gives some of the important properties of these fibers.

The first, and probably the key, inlet condition that must be identified prior to selecting a filtration medium is the temperature the fabric will experience. Figure 6 compares the recommended operating temperatures for the most often used filtration fabrics. Note that as temperature increases, the fabric choices become fewer and fewer. In 1991, the maximum temperature for which economical filter media were commercially available was about 500°F (260°C), although this may have changed with the advent of ceramic and metallic filters. When confronted with higher temperatures, the usual approach has been to cool the gas down, at least to the vicinity of 500°F (260°C). Once a preliminary selection of filtering fabric has been made, the media supplier can usually provide additional information that should be considered in finalizing the fabric choice.

Important Fiber Characteristics

When selecting a fiber for gas filtration, attention must be paid to the following factors that interact and thus must be considered together.

TABLE 1. Fabric Selection Chart

Fabric	Maximum Temperature, °F	Acid Resistance	Fluoride Resistance	Alkali Resistance	Flex Abrasion Resistance
Cotton	180	Poor	Poor	Good	Very Good
Polypropylene	200	Excellent	Poor	Excellent	Very good
Polyester	275	Good	Poor to fair	Good	Very good
Nomex	400	Poor to fair	Good	Excellent	Excellent
Teflon	450	Excellent	Poor to fair	Excellent	Fair
Fiberglass	500	Fair to good	Poor	Fair to good	Fair

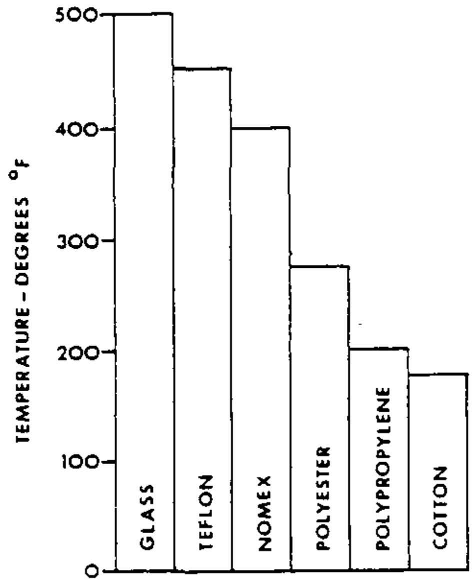


FIGURE 6. Recommended Maximum Operating Temperatures for Fabrics

1. Temperature. The fiber must have a maximum continuous service temperature higher than the normal temperature of the application. If temperature surges above the normal range occur, the ability of the fiber to withstand the expected conditions of surge temperature and duration must be considered.
2. Corrosiveness. The ability of the fiber to resist physical degradation from the expected application levels of acids, alkalies, solvents, or oxidizing agents must be considered.
3. Hydrolysis. Effects of the expected level of humidity must be taken into account.
4. Dimensional stability. If the fiber is expected to shrink or stretch in the application environment, the effects of such a change must be tolerable.
5. Cost. As with any engineering product, the least costly selection that will meet overall requirements is usually the best selection.

Media Selection

Baghouse operating costs are reduced if the baghouse has a high gas-to-cloth ratio, a low pressure drop, and a long life. In each case, the key to operation at minimum cost is the media selected for bag construction. This selection is crucial, but not easy, because many, often conflicting, requirements must be met.

The primary media selection criteria are the compatibility of the selected fiber with the gaseous environment and the physical configuration of the fiber and resulting fabric as it affects filtration performance. Usually, the selection criteria interact so much, or are not well enough understood, that the best selection is not apparent without long-term testing, except for bag-life determination, where experimental bag tests can provide specification data. Sometimes it is possible to equip complete baghouse compartments with various media[9] and observe the results for future selections. In 1985, ETS, Inc., introduced an individual bag flow monitor that is useful in making side-by-side comparisons of alternative media.[10]

The satisfactory performance of a fabric filter in a specific application requires the selection not only of a fiber material that is compatible with the gas–particle environment, but also that is of a fabric design appropriate to the dust collector geometry and collector cleaning requirements. *Fiber, yarn, and fabric parameters all influence the filtration process.*

Fabric strength, stability, and flexibility all are important parameters in determining the ability of the fabric to resist wear caused by abrasion. The term "abrasion" is defined as an eroding of fabric fibers or fiber surface material as a result of moving contact between the fiber and dust particles or between adjacent fibers. The flexibility of a filtration fabric is important for at least two reasons: cleanability and durability. Removal of the dust deposit may be improved by flexing of the fabric substrate, but such flexure may degrade the fabric. Thus fabric flexibility may be both necessary and harmful.

Permeability of the fabric must be considered when selecting a filter media. It must be understood, however, that permeability of filtration fabrics is so reduced by a residual dust deposit that the permeability of clean fabric appears to have little relationship to permeability during use. The objective in fabric design is to maintain a highly permeable combination of residual dust and fabric while allowing a minimal amount of dust to pass through. To meet this objective, the pores through a fabric must be closely controlled. They must not exceed a certain bridging diameter, but if they are too small, they will either plug or pass too little gas. In an ideal filtration fabric, probably all the fabric pores should be of the same size, that size depending on properties of the dust and gas, fabric characteristics, and so on. Yarn texturizing and the postweave surface treatments contribute greatly to the permeability of clean fabric, and perhaps also to the permeability of residual dust deposit.

The last, but certainly not least, criterion for media selection is the ability of the fabric to *release* collected dust during the cleaning cycle. This ability depends largely on the mode and intensity of cleaning, but also on the adhesive character of the fabric. The way in which fabric construction relates to deposit release has not been completely determined, but it is known that a smooth fabric surface releases dust more readily than does a fuzzy surface. Dust may agglomerate on loose fibers and move away from the surface during cleaning, only to return once filtration resumes. This action, whose outcome is sometimes referred to as "dingleberries," can result in poor cleaning. Some fabric surface treatments are specifically intended to enhance cake release. Dust release also depends on the electrical resistances of selected fibers. Electrical resistance is known to depend on humidity, which itself has a marked effect on filtration fabric performance.[11] An extensive table of electrical properties for a variety of fabrics is given by Frederick.[12] "Electrical effects" is a factor that has rarely been quantified, but is known to influence pressure drop and efficiency. This is one of the factors that can cause major variations in baghouse performance.

In about 90% of the baghouses currently operating on coal-fired boilers, the bags are fabricated from glass fibers. Glass fibers are tiny filaments as small as 0.00015 inches (4 μm) in diameter that are extremely flexible and thus may be woven into fabric. Before 1930, discontinuous "glass wool" fibers were the only form produced commercially. The new technology was first used to develop continuous fibers for high-temperature insulation of fine electrical wires, designated "E"-glass because of its unique electrical insulation properties, and which was industrially practical because an effective lubricating finish protects the filaments. Today, E-glass is used in nearly all glass-fiber applications, ranging from printed circuit boards to boat hulls and filtration fabrics. Other formulations were also developed by altering percentages of the glass composition to obtain special performance characteristics. "C"-glass is particularly resistant to chemical attack; "S"-glass possesses outstanding strength characteristics. Thus far, production constraints and economics have limited glass filtration fabrics to E-glass.

Woven Fabric

Most filtration fabrics are either completely or partially made by weaving. Even felted or so-called "nonwoven" fabrics include a base (scrim) of woven fabric. Baghouses in which the gas flow is from the inside of the bags to the outside, such as reverse-air and shaker-cleaned baghouses, use woven fabrics almost exclusively. These baghouses generally operate at lower gas flow rates where the flow restriction of the fabric is not so significant. Woven fabrics usually have greater flow restriction but greater strength (for a given fabric weight) than do comparable nonwoven fabrics and thus are usually chosen for reverse-air and shaker applications.

Pulse-jet–cleaned baghouse designs offer increased cleaning energy and operate at higher gas flow rates. The tendency of woven fabrics to "bleed," resulting in low filtration efficiency when clean, usually restricts the use of woven fabrics for pulse-cleaned applications. Woven fabrics made with texturized yarn or with membrane films applied to the upstream surface offset the tendency to bleed when cleaned, and these types of fabrics are used in pulse-cleaned applications.

Woven fabric is manufactured by weaving together fibers that previously had been made into yarns. During weaving, longitudinal yarns (the warp) are interlaced at right angles with transverse yarns (the fill) by means of a loom.

Woven fabrics are formed by interlacing yarns at right angles on the loom, after which the raw (greige) fabric may be further treated. While there are many patterns of interlac-

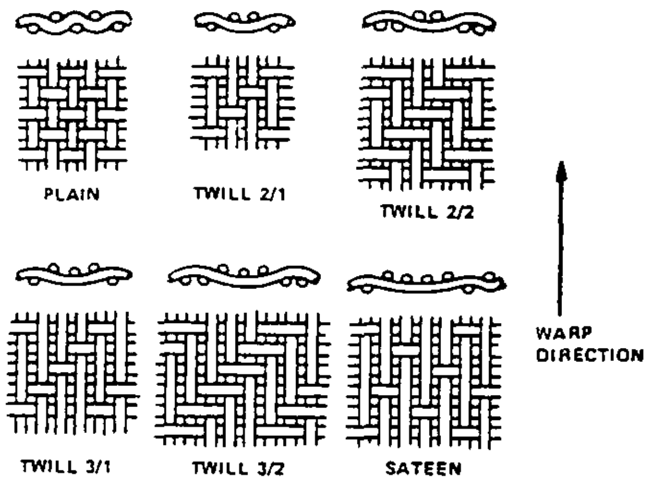


FIGURE 7. Typical Filter Cloth Weaves

ing, the fabrics most commonly used in gaseous filtration are twill, satin, or plain weaves. These three weave patterns are depicted in Figure 7. Both the twill and the satin weaves have fabric sides where warp or fill yarns predominate, and those sides are referred to as warp face or filling face.

In its basic construction, satin weave is similar to twill, but generally uses a pattern of fill yarns going under one, then over four to 12 warp yarns. Satin differs in appearance from twill because the diagonal of satin weave is not visible; it is purposely interrupted in order to contribute to the flat, smooth, lustrous surface desired. There is no visible design on the face of the fabric because the yarns that are to be thrown to the surface are greater in number and finer in count than the yarns that form the reverse of the fabric.

Plain weave is sometimes referred to as tabby, homespun, or taffeta weave. It is the simplest type of construction and consequently the least expensive. Each fill yarn goes alternately under and then over the warp yarns across the width of the fabric. On its return, the yarn alternates the pattern of interlacing. If the yarns are close together, plain weave has a high thread count, often a requirement for suitable efficiency.

Nonwoven Fabrics

Nonwoven fabrics generally are defined as sheet or web structures made by bonding and/or interlocking fibers, yarns, or filaments by mechanical, thermal, chemical, or solvent means.

The International Non-woven and Disposables Association (INDA), a trade association of the nonwoven fabrics industry, has given this definition:

> A non-woven is any fabric made directly from a web of fiber without the yarn preparation required for weaving or knitting. Natural or synthetic fibers can range in length from 0.5–15 cm from crimped staple products, up to continuous filaments for spunbonded products. The fibers may be oriented in one direc-

yarn producer applies and the warp sizing (starch and mineral oil) applied to facilitate weaving, must be removed before a finish is applied to the fabric. This is necessary because these organic lubricants would not be stable at the process temperature, and also because they would interfere with the application of the desired finish. It is desirable that the applied finish have as close a contact as possible with the bare glass filaments, penetrating the yarn bundle and encapsulating individual filaments.

Organic sizings are removed thermally by a process called coronizing, which also sets the crimp in the glass yarns. Crimp is the bend in a yarn caused by interlacing during weaving. The yarn is heated to the softening point and the crimp is set as the yarn cools. It is believed that setting the crimp in the yarn maximizes the flex life of the fabric.

The finish used for glass fabrics must be thermally stable at process temperatures (500–550°F or 260–290°C) and chemically resistant to the gas environments found in fiberglass filter bag applications. The basic purpose of the finish is to protect the glass fibers from abrading themselves, but it can also enhance dust-release characteristics.

In addition to providing lubricity to extend bag life, glass fabric finishes also help to promote dust release from the fabric and offer varying degrees of protection from chemical attack. The success of glass fabric as a viable filter medium depends to a large degree on the quality of the finish. Finish development has occurred in roughly three stages, with finishes making up primarily three groups:

I. Silicones. A glass-to-silicone coupler is the basic prefinish required before subsequent organic finishes are applied. These "couplers" insure the complete individual fiber envelopment needed for effective protection.
II. Silicones and graphite with small amounts of fluorocarbons.
III. Fluorocarbon compounds.

All three groups are still in use, although Group I, the second-stage silicone finish, has largely faded from the scene. Group II finishes are divided into tricomponent and acid-resistant groups.[13]

- Tricomponent
  - Graphite (natural or synthetic)
  - Teflon
  - Silicones
  - Agents to assist application
- Acid-resistant
  - Graphite (natural or synthetic)
  - Polymers
  - Binders
  - Silicone
  - Teflon
  - Agents to assist application

Teflon is used in both Group II and III finishes. Group III finishes consist of Teflon, binders, and agents to assist application.

Most of the experience to date with Group III finishes has been at 10% loading; for example, 10% of the finished fabric weight is Teflon B. Amounts of finish vary greatly, but, in general, the Teflon finish is 7–10% weight added per weight of cloth, the acid-resistant finish is 4–6%, and the tricomponent finish is 1–2%.[14] Some experience indicates that Group II finishes are more resistant to chemical attack, while other experience favors the use of Group III finishes. There has been progress in using Group II finishes to protect Nomex fabrics from acid exposure in coal-fired boiler applications.

A special surface treatment gaining increased use in gaseous filtration is the application of a Gore-Tex® membrane to the fabric surface.[14] The Gore-Tex membrane is expanded polytetrafluoroethylene (PTFE) deposited as a thin, fibrillated film. Figure 9 shows a photomicrograph of the fibrillated film of PTFE on the fabric surface. A cross section through the fabric is shown in Figure 10. The coarse woven fibers are seen on the right and a thin PTFE film covers the left side. Gore-Tex membranes have been applied to many available backing materials, including woven polyester, Nomex, glass, and Teflon. Usually, the backing fabric is quite porous. Gore-Tex filter bags are constructed for pulse-jet, reverse-air, and shaker collectors. Gore-Tex membrane filter cartridges are also available.

The measured properties of fabric finished with a Gore-Tex membrane show the tensile and burst strengths characteristic of the woven fabric, but permeability is lower. Although lower permeability might suggest higher-than-desirable pressure drops and drags, that often is not the case, because the membrane improves cleanability and reduces residual dust buildup in the fabric.

CLEANING TECHNIQUES

The primary way to categorize a fabric filter is by the method used to clean it. In general, accumulated dust is separated from the fabric by some combination of the following effects.

1. Deflection of the fabric/dust cake, tending to fracture the cake and separate it from the fabric.
2. Acceleration of the fabric/dust cake, yielding separation forces.
3. Gas flow in the reverse direction, yielding aerodynamic forces that separate the dust from the fabric and subsequently move the dust toward the collecting hopper.

Four cleaning methods have evolved, each of which generates some combination of these fabric–dust-cake separation effects. The majority of baghouses currently in use employ one or more of these cleaning methods.

tion or may be deposited randomly. This web is given structural integrity by 1) mechanical fiber intertangling, 2) thermal or chemically induced fusing of the fibers, or 3) application of any of several adhesives or resins.

Perhaps the most significant feature underlying all nonwoven fabric production, and the one that contributes most to its economic appeal, is the speed at which the fabric is produced. Many nonwoven production units in place today can produce fabric at speeds of 400 fpm (200 cm/s) or more. Some advanced units operate at speeds over 1000 fpm (500 cm/s). These rates may be compared with knitting machine speeds of about 5.0 fpm (2.5 cm/s) and the even slower rates of weaving machines.

A needlepunched fabric is produced by introducing a fibrous web already formed by carding or air-laying into a machine equipped with groups of specially designed, barbed needles (see Figure 8). While the web is trapped between a bed plate and a stripper plate, the needles punch through it and reorient the fibers so that mechanical bonding is achieved among the individual fibers. The needlepunching process is generally used to produce fabrics that have high density and yet retain some bulk. Fabric weights usually range from 1.7 to 10 oz/yd^2 (58–340 g/m^2) and thicknesses from 15 to 160 mils (0.38–4.1 mm).

Needlepunching is often used to combine two or more layers of fiber into a feltlike fabric. Usually one layer is a woven fabric, called a *scrim*, for strength, while the other(s) may consist of fibers of almost any description or combination. Thus considerable control over separate properties of the finished material is possible. For example, the scrim may contribute to desired dimensional stability, while the top, or batting layer, contributes appropriate properties for filtration. Needlepunching is accomplished by punching needles with forward barbs from the batting side into or through the scrim, and the batting fibers thus laced into the scrim remain behind when the needles are withdrawn. Variations on the needling process include changing the needle angle or number of repetitions or using two-sided needling. When a shrinkable scrim is used, the needled material may later be felted in various ways to produce a denser and more uniform material.

To improve the filtration characteristics, primarily the collection efficiency of the fabric surface, the surface may be napped. This is done by teasels (woody, thistlelike parts of weed plants), whose barbs pluck fibers from the surface

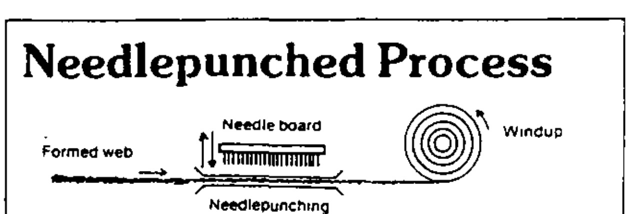


FIGURE 8. Needlepunched Process (From Reference 12)

of the felt. When enough nap has been raised in this manner, it may be singed or otherwise trimmed to the desired thickness.

Needlepunched fabrics, sometimes called needlefelts, are employed in many filtration applications. Modification of the basic structure produced by the needling process determines filtration performance. When punch density is increased during needling, one of the results is an increase in fabric density. Eventually, an optimum punch level is attained above which the density falls off. The maximum density possible from needlepunching alone would be insufficient to produce an efficient filtration medium. Additional processes are required to give the necessary densification and closing-up of the structure. Heat treatments are normally employed at temperatures suited to the thermal characteristics of the particular fiber in use. Suitable processes include the squeezing of the fabric between rollers or a roller and a stationary bed. An increase in fabric density increases filtration efficiency, up to a point.

Successful fabrics are also required to provide good discharge of the dust cake. Good discharge is usually achieved by means of a surface modification in the form of singeing to remove individual fibers protruding from the surface. Good cake release surfaces can also be formed by heating the fabric surface to such an extent that fiber melting and fusion occur, although this will also increase the flow resistance of the fabric.

Relaxation of tensions built into the fabric structure by the needling operation can be brought about by passage through an oven. Such treatment is insurance against dimensional changes occurring when the fabric first encounters operating conditions.

Knitted fabrics, both plain and bulk, are being used (especially the latter) in high-ratio collectors.

Treatments and Finishes

"Finishing" includes those processes that improve the appearance or serviceability of the fabric after it leaves the weaving machine. Greige (unfinished) fabrics intended for use as filtration fabrics are treated and/or finished after weaving to improve their filtration characteristics and cleaning (release) characteristics. Fabric life and strength may also be affected. Treatments are defined as postweaving processes that affect the entire fabric, whereas finishes are postweaving processes that affect only the surface of the fabric.

One fabric treatment of significance for filtration fabrics is heat setting. In the process of heat setting, the fabric is exposed to temperatures exceeding those experienced in service. This treatment is done on a machine known as a pin tenter. The fabric is held under tension in both the warp and fill directions and passed through a heated oven.

Special finishes have been developed for the glass fabrics used in high-temperature filtration. For glass filter bags, organic materials, such as the starch binder that the

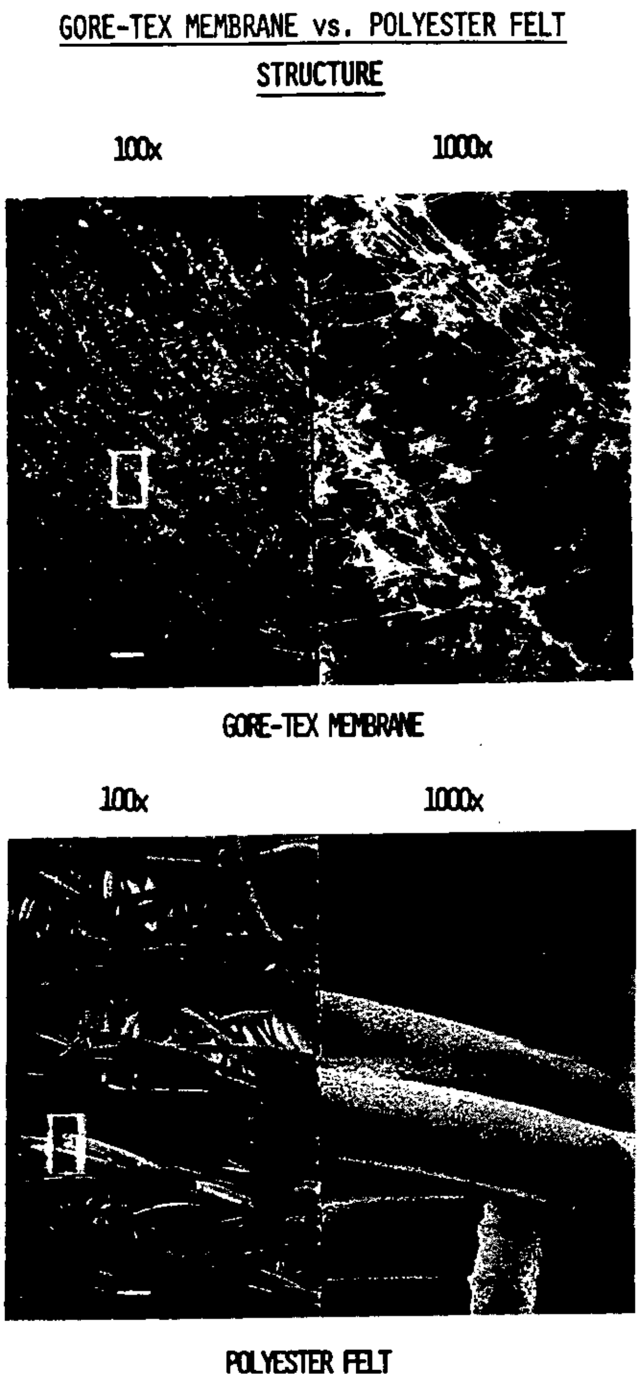


FIGURE 9. Gore-Tex® Membrane Compared with Polyester Felt

1. Shaker-cleaned baghouses. In shake cleaning, the tops of the bags are shaken, preferably horizontally, resulting in deflections and acceleration forces throughout the bag. Zero or reverse flow is normally combined with the shaking.
2. Reverse-air–cleaned baghouses. In reverse-air cleaning, a combination of bag deflection (inward collapse) and reverse flow is used to remove dust from the fabric. This process, which results in very low stresses on the fabric, was developed specifically for easily damaged fabrics such as fiberglass.
3. Pulse-jet–cleaned baghouses. Pulse-cleaned baghouses use outside–in flow, where the fabric collapses against a wire cage during filtration. During cleaning, a pulse of high-pressure air is directed into the bag (the reverse flow direction), inflating the bag and causing fabric/cake deflection and high inertial forces that separate the dust from the bag. Although reverse-airflow is involved, it is thought to have a minor effect on cleaning.
4. Sonic cleaning. Sonic cleaning, if used, usually augments another cleaning method. Sonic energy is normally introduced into the baghouse by air-powered horns. Although the process is not well understood, the sonic air shock waves apparently generate acceleration forces that tend to separate the dust from the fabric.

The significant parameters of shaker, reverse-air, and pulse-jet cleaning are given in Tables 2, 3, and 4.

Shaker

Although shaker-type baghouses are generally considered to be the oldest known form of fabric filter, they still have a significant place in present-day technology. It is known that in the smelter industry, when bag filters were developed in the mid-1800s and during the early 1900s, filter bags were cleaned by hand shaking. Shake cleaning has subsequently

TABLE 2. Shake Cleaning—Parameters

Frequency	Usually several cycles/second; adjustable
Motion type	Simple harmonic or sinusoidal
Peak acceleration	1–10 *g*
Amplitude	Fraction of an inch to few inches
Mode	Off-stream
Duration	10–100 cycles, 30 seconds to few minutes
Common bag diameters	5, 8, 12 inches

Source: Reference 16

TABLE 3. Reverse-Air Cleaning—Parameters

Frequency	Cleaned one compartment at a time, sequencing one compartment after another; can be continuous or initiated by a maximum-pressure-drop switch
Motion	Gentle collapse of bag (concave inward) upon deflation; slowly repressurize a compartment after completion of a back-flush
Mode	Off-stream
Duration	1–2 minutes, including valve opening and closing and dust settling periods; reverse-air flow itself normally 10–30 seconds.
Common bag diameter	8, 12 inches; length 22, 30 feet
Bag tension	50–75 pounds typical, optimum varies; adjusted after on-stream

Source: Reference 17

TABLE 4. Pulse-Jet Cleaning—Parameters

Frequency	Usually, a row of bags at a time, sequenced one row after another; can sequence such that no adjacent rows clean one after another; initiation of cleaning can be triggered by maximum-pressure-drop switch or may be continuous
Motion	Shock wave passes down bag; bag distends from cage momentarily
Mode	On-stream: in difficult-to-clean applications such as coal-fired boilers, off-stream compartment cleaning being studied
Duration	Compressed-air (100 psi) pulse duration 0.1 second; bag row effectively off-line
Common bag diameter	5–6 inches

progressed through stages, from manually operated racks to today's devices that are automated for either motor or air operation. Many mechanisms have been developed to impart motion to the filter bags to clean them. The motion has been either vertical, horizontal, or some combination of the two, although shakers have been developed that twist or otherwise move the bags. In essence, all of the mechanisms impart energy to the filter fabric in such a way that a change of direction allows inertial forces to remove the collected filter cake from the bags. The important parameters affecting the efficiency of cleaning are frequency, oscillation, and amplitude.

The one constant that must be provided in all shaker-type baghouses, regardless of the type of action imparted to the

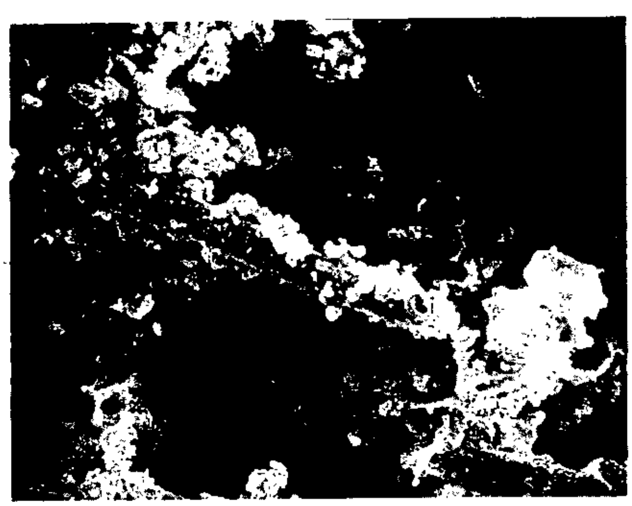


FIGURE 10. Cross Sections of a Gore-Tex® Membrane Filter Bag and a Typical Polyester Felt Filter Bag in Alumina Dust Collection

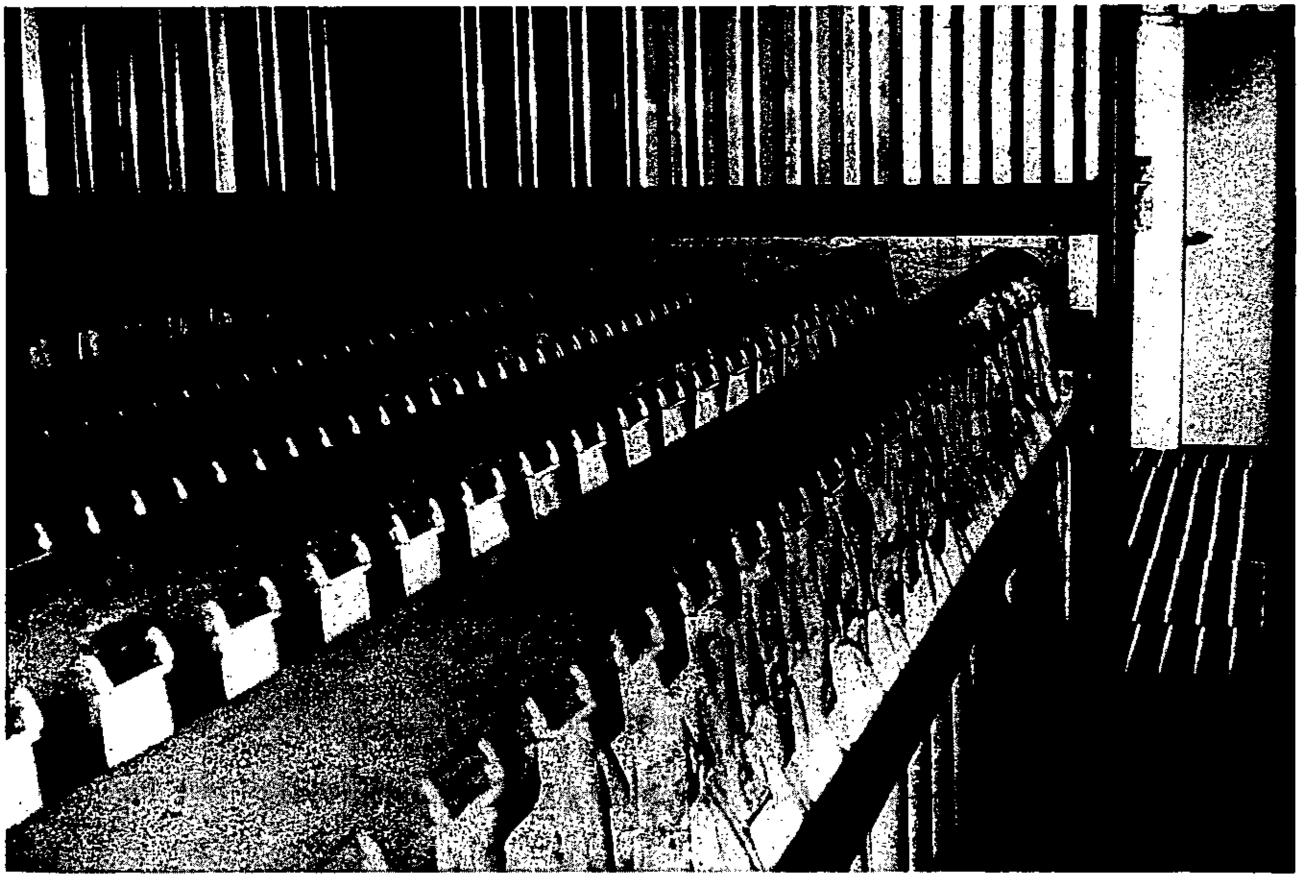


FIGURE 11. AAF's Shaker Support Logs (Photos Courtesy Snyder General Corp., Manufacturer and Marketer of American Air Filter Products)

fabric, is that flow in the positive direction must be absent during cleaning. Forward differential pressure across the bags of less than 0.05 inch (12 Pa) has been observed to retard bag cleaning significantly.[15] Conversely, a slight reverse flow through the bags during shaking can be beneficial.

Shaking is usually accomplished by the use of a motor driving an eccentric (Figure 11), which, in turn, moves a rod connected to the bags. This bag cleaning technique is currently employed over the full range of baghouse capacities, from very small off-the-shelf units to extremely large structural design units.

The bag is generally open at the bottom and closed at the top, fixed in the tube sheet at the bottom and attached to the shaking mechanism at the top (Figure 12). With this configuration, dust is collected on the inside of the bag. The bag normally contains no rings or cages. The flow of dirty gas to the bags is stopped during the cleaning process.

In the United States, shakers normally employ woven cloth at gas-to-cloth ratios below 4 : 1. Attempts thus far to use shaker cleaning in combination with domestic felts have led either to ineffective cleaning, and thus high-pressure drop, or to the filter medium being shaken apart.

Reverse Air

Reverse-air cleaning is the gentlest cleaning method. Dust is removed from the bags by back-flushing with low-pressure (a few inches water gauge) reversed flow. In high-temperature applications, the just-cleaned hot gas is employed for back-flush, rather than ambient-temperature air. Woven filter media are generally employed with reverse-air cleaning.

Cleaning airflow is provided by a separate cleaning fan that is normally much smaller than the main system fan, since only a fraction of the total system is cleaned at any one time. In the case of a negative-pressure system, one often can clean without a reverse-flow fan. The flow rate of cleaning gas is normally about equal to that of the dirty gas (see Table 3).

Reverse-flow systems most often include a number of isolatable compartments, or modules. The gas-to-cloth ratios usually employed are less than 4 : 1. Dust is normally collected on the inside of the bag, the bag being open at the bottom and closed at the top. The bag contains rings to keep it from collapsing completely during flow reversal. Complete collapse would, of course, prohibit cleaning because

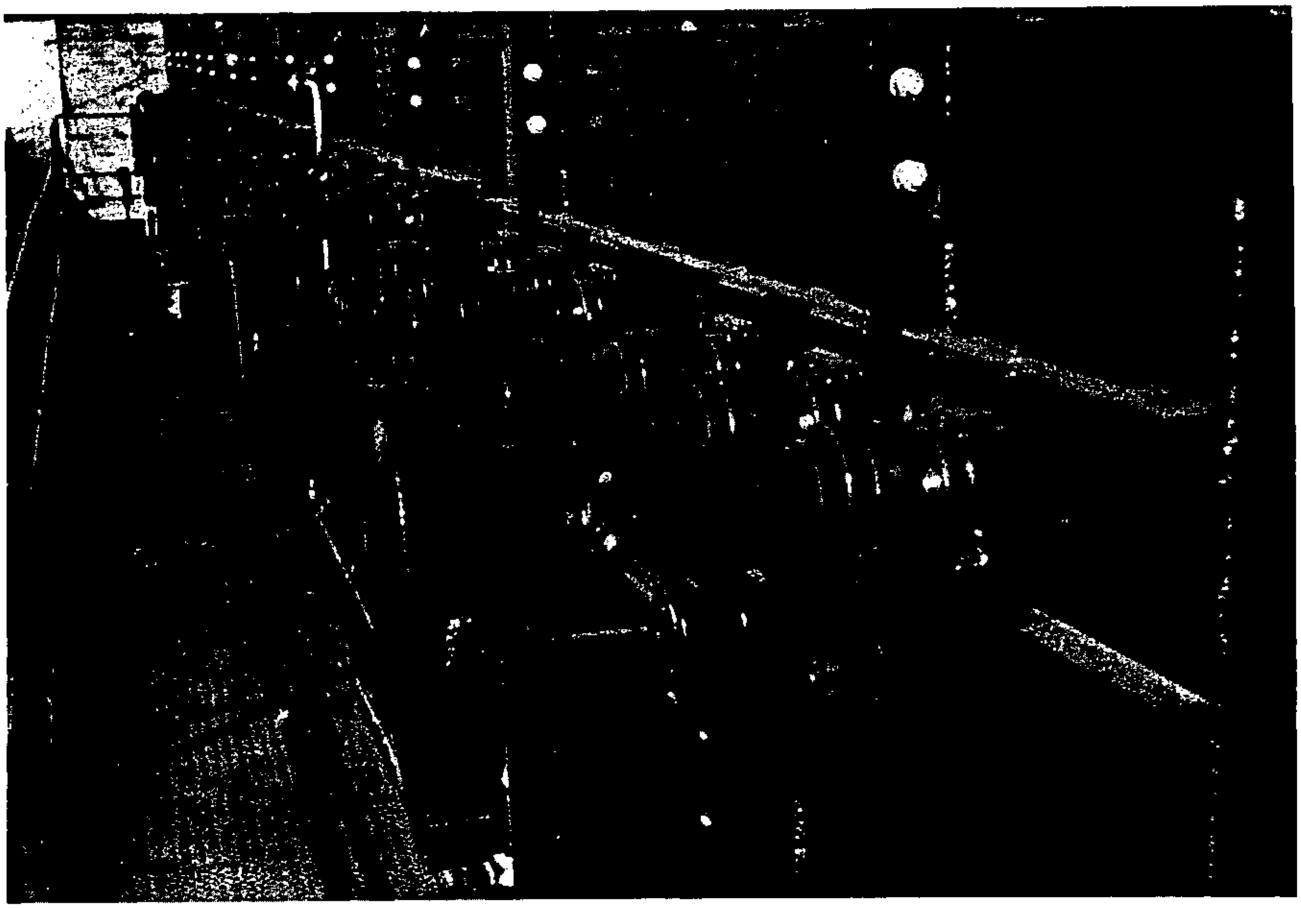


FIGURE 12. AAF's Rugged Shaker Mechanism (Photos Courtesy Snyder General Corp., Manufacturer and Marketer of America American Air Filter Products)

the dust particles could not fall down within the bag to the hopper. Cleaning is accomplished both with and without flexing (partial collapsing) of the bag. Reverse flow without flexing can be employed when the dust is very easily dislodged from the bag surface. Figure 13 shows a typical reverse-air cleaning cycle. In the on-stream gas filtering mode, the compartment and outlet dampers are open and dirty gas enters the bag at the bottom. Dust collects on the inside of the bag and the cleaned gas exits the outlet damper. During the bag cleaning cycle, the flow is reversed by closing the outlet plenum and opening a third damper that allows cleaned gas to enter the compartment on the clean side of the bags, thus back-flushing the bags and exiting the compartment through the inlet damper. This now-dirty gas progresses to the balance of the on-stream compartments. It should be noted that this process increases the system gas-to-cloth ratio by adding to the total gas volume the volume of gas employed in the back-flushing process.

One baghouse manufacturer studied the reverse-air cleaning process both analytically and experimentally[18] and concluded that the improved cleaning frequently observed when a thick dust cake is allowed to build up can be attributed to the pistonlike action of a falling plug of dust cake. The manufacturer theorizes that the cascading dust cake plug both scours that cake ahead of it and causes significant evacuation, and hence additional reverse flow behind it. The concept is shown in Figure 14.

Reverse-airflow can serve to flush out loosened particles from fabric interstices and carry the dislodged agglomerates toward the collecting hopper. Based on gravimetric measurements of the filter resistance characteristics, there is, however, little evidence to suggest any significant removal of dust particles by aerodynamic action alone. The above findings are in agreement with those of Larson,[19] who states that air velocities of the order of 200 fpm (102 cm/s) are required to remove a single 20-μm particle from a fiber; and with Zimon,[20] who indicates that air velocities sweeping tangentially over a layer of dust must be in the range of 400 fpm (203 cm/s) before any appreciable dust removal is accomplished. Because significant dust removal is attained in reverse-flow systems, one must conclude that separating forces other than aerodynamic drag are involved. According to the drag theory, the adhesive forces between adjacent particles are actually increased as dirty gas moves

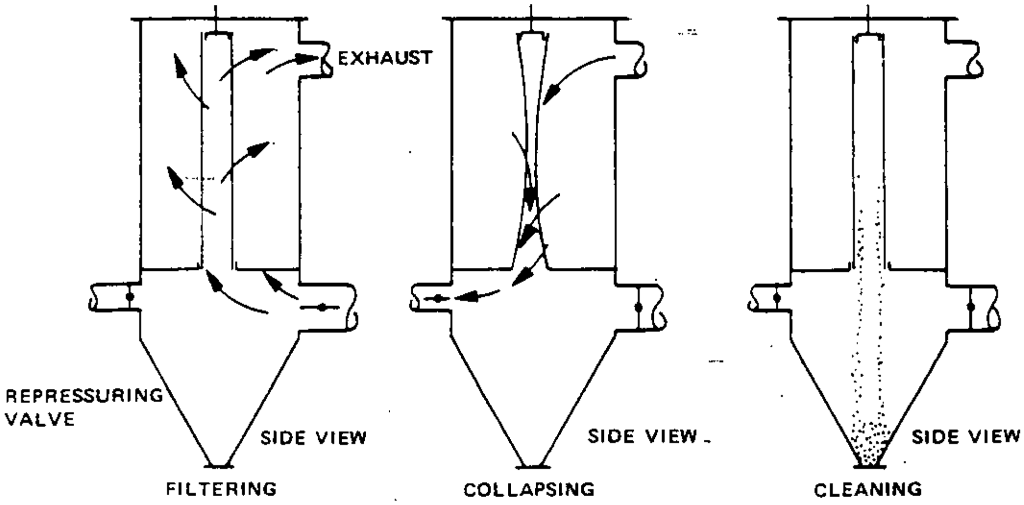


FIGURE 13. Reverse-Air Cleaning (From Reference 17)

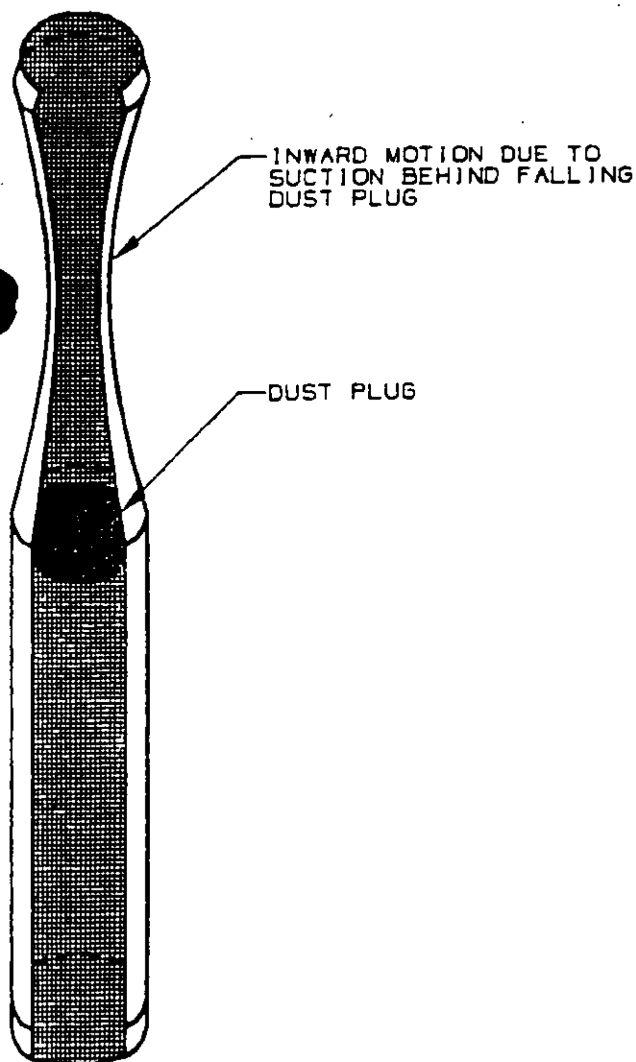


FIGURE 14. Idealization of the Falling Dust Coke upon Cleaning

radially through the dust cake. During reverse-airflow, any dust dislodgement is more likely to follow a spallation process, with the adhesive bond failure probably occurring close to the dirty face of the filter. Aerodynamic drag can be expected to flush out loosened particles.

Another adjunct to dust separation is the flexure produced in the fabric when the flow is reversed. In most systems, sufficient bending of the fabric surface occurs to cause a significant spallation at the dust–fabric interface. This effect is most pronounced for reverse-air–cleaned systems because, with the low gas-to-cloth ratios normally used, a large fraction of the collected dust appears as a superficial layer on the surface of the fabric.

If dust releases readily from the fabric, a reversal of flow alone may suffice for adequate cleaning. Because of its structural depth, and hence greater dust retentivity, a felted fabric is not usually cleaned by reverse flow. When reverse flow is used as the sole method of cleaning, the rate of flexure is probably the controlling factor with respect to fabric (or fiber) failure. Thus a gradual inflation or deflation process is unlikely to cause any serious fabric damage. Increased bag tension and reduced reverse flow rates also minimize the degree of flexure, as well as prevent a complete flattening of the bag. If the bag is flattened, there is no opportunity for loosened dust to fall to the hopper nor is there a pathway for the reverse-flow air. The insertion of restraining rings or a supporting cage eliminates complete bag collapse, but introduces a potential problem of fabric chafing. Sewing the rings to the bag minimizes the problem of chafing or attrition.

Pulse Jet

Pulse-jet cleaning employs high-pressure (60–120-psi) compressed air, with or without a venturi, to back-flush the bags vigorously. This cleaning method creates a shock

TABLE 5. Typical[a] Gas-to-Cloth Ratios for Various Industries

	Shaker/Woven Reverse-Air/Woven	Pulse-Jet/Fest Reverse-Air/Felt
Alumina	2.5	8
Asbestos	3.0	10
Bauxite	2.5	8
Carbon black	1.5	5
Cement	2.0	8
Clay	2.5	9
Coal	2.5	8
Cocoa, chocolate	2.8	12
Cosmetics	1.5	10
Enamel frit	2.5	9
Feeds, grain	3.5	14
Feldspar	2.2	9
Fertilizer	3.0	8
Flour	3.0	12
Fly ash	2.5	5
Graphite	2.0	5
Gypsum	2.0	10
Iron ore	3.0	11
Iron oxide	2.5	7
Iron sulfate	2.0	6
Lead oxide	2.0	6
Leather dust	3.5	12
Lime	2.5	10
Limestone	2.7	8
Mica	2.7	9
Paint pigments	2.5	7
Paper	3.5	10
Plastics	2.5	7
Quartz	2.8	9
Rock dust	3.0	9
Sand	2.5	10
Sawdust (wood)	3.5	12
Silica	2.5	7
Slate	3.5	12
Soap, detergents	2.0	5
Spices	2.7	10
Starch	3.0	8
Sugar	2.0	7
Talc	2.5	10
Tobacco	3.5	13
Zinc oxide	2.0	5

[a]Generally safe design values; application requires consideration of particle size and grain loading.

wave that travels down the bag, knocking dust away from the fabric. Normally, this method is employed in conjunction with felted or bulk knitted filter media and the gas-to-cloth ratio is generally higher than in shake and reverse-air cleaning methods. Typical gas-to-cloth ratios are given in Table 5. The duration of cleaning is shorter than for the other two methods; generally, the pulse lasts only a fraction of a second. The baghouse is often not subdivided when pulse-jet cleaning is employed.

The usual pulse-jet configuration has the bag closed at the bottom and open at the top, as shown in Figure 15. A metal cage is used inside the bag to keep it from collapsing. In the normal mode of operation, dirty gas enters the hopper and proceeds to the bags. Dust collects on the outside of the bags and cleaned gas exits through the top of the bags and baghouse. Usually, a row of bags is cleaned simultaneously by introducing compressed air briefly at the top of each bag. The shock wave created drives the dust off the outside of the bag and down into the hopper. Continuous discharge of dust from the hopper is often employed. Cleaning parameters are given in Table 4. It is noteworthy that this system allows for removal of the bags from the clean side of the house, since they are usually connected only at the top.

The pulsed jets of compressed air commonly used to clean nonwoven fabrics are relatively inefficient at removing deposited dust. Measurements on a pilot-scale pulse-jet fabric filter using fly ash test dust indicate that typically less than 1% of the dust on a bag is removed to the hopper by a cleaning pulse.[18]

The following factors are important to the design and/or operation of a pulse-cleaned baghouse.

1. The location of the pulse-jet nozzle must be considered.
2. Bag material should be flexible, lightweight, and inelastic to obtain maximum acceleration for dust removal during the pulse. The fabric should have sufficient weight (i.e., number of fibers per unit area) to present many targets for dust collection. The pore structure should be as uniform as possible.
3. A large housing and hopper volume on the dirty side of the filter bag will minimize the pressure buildup in this region during the pulse and thus enlarge the magnitude of the pulse differential.
4. The pulse delivered to the bag should begin as abruptly as possible, with sufficient inflating flow to subject the entire bag length to a sudden pressure differential.
5. The back flow of air through the filter that accompanies the pulse assists cleaning in several ways. It flushes from the pore structure agglomerates loosened by the acceleration. It can itself loosen agglomerates if the shock alone was insufficient, although this appears to be a very inefficient use of compressed air. It also accelerates agglomerates that have already left the felt surface, helping to convey them to the hopper.
6. Pulse intensity should be as low as can be tolerated to save on compressed air (and reduce power needs) but sufficiently high to maintain equilibrium in the cleaning process.
7. Pulse duration should ordinarily be as short as possible.
8. Dry, clean (oil-free) air must be used.

Pulse-jet cleaning is sometimes described as the rapid passage of an air bubble through the bag, a concept depicted in Figure 16. During the pulse's descent, localized fabric distension is assumed to loosen the dust layer while the transient reverse flow completes dust dislodgement from the upstream filtering surface. Although there is some truth to this concept, it overlooks the fact that typical pulse durations (of at least 0.06 second) far exceed the time for the

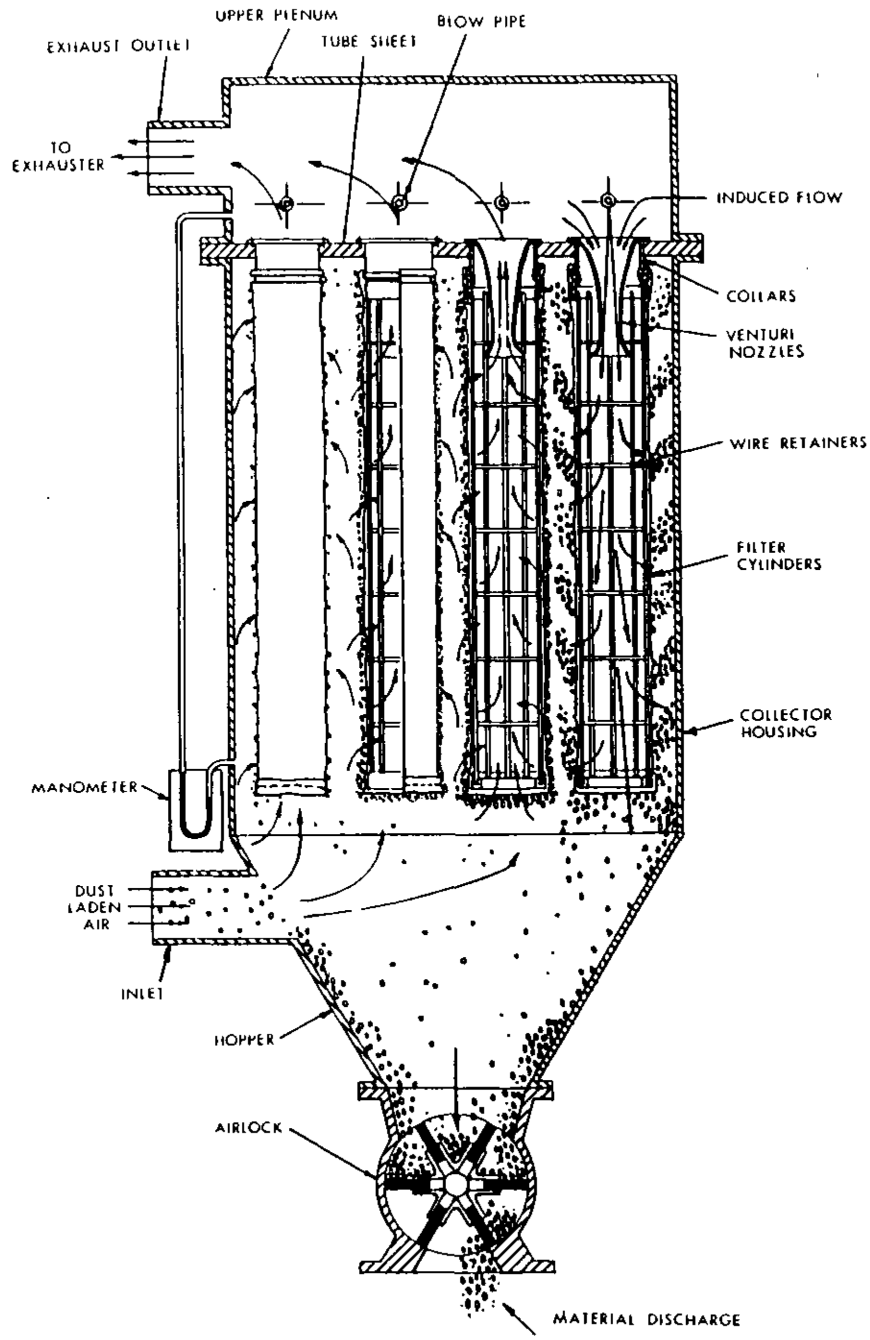


FIGURE 15. Pulse-Air-Jet Type of Bag Filter (From Reference 23)

shock wave to travel to the bottom of a conventional felt bag (roughly 0.01 second for a 10-foot-long bag). Donovan et al.[15] propose that, in reality, while the pressure front is advancing, the continued arrival of pulse air, at successively increasing rates until the solenoid valve is fully open, maintains the inflating pressure behind the front. Because pulse air entry continues well after the bottom of the bag is fully pressurized, the concept of an advancing bubble is questioned. It is suggested that parts (b), (c), and (d) of Figure 16 are more descriptive of the movement of bag fabric during a pulse.

Sonic Horns

Sonic horns are increasingly being used to augment shaker-cleaned and reverse-air–cleaned baghouses. The horns are usually powered by compressed air, and acoustic vibration is introduced by a vibrating metal plate that periodically interrupts the airflow. A cast metal horn bell is normally used for cleaning. Typically, one to four horns are installed in the ceiling of a baghouse compartment containing several hundred bags.

Sonic frequencies of 150–550 Hz have been tested;

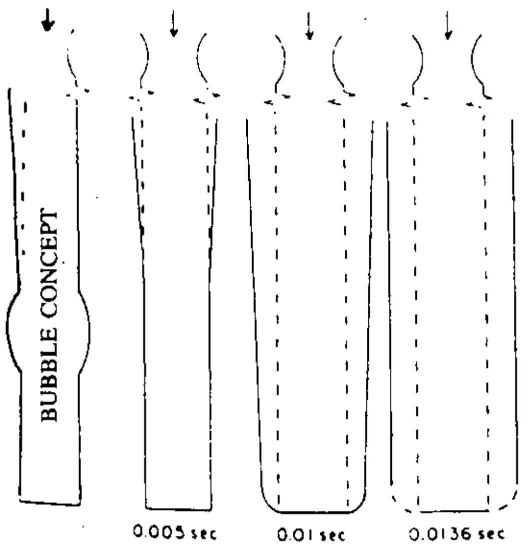


FIGURE 16. Bag Profiles versus Time after Pulse Initiation for a 4-Foot-Long Bag (From Reference 22)

Cushing, Pontius, and Carr[24] got the best results with horns that concentrated most of their energy at the lower frequencies. Relative sound pressure levels of 120–140 dB inside the baghouse are used.

Probably the most significant effect of sonic cleaning is on the weight of residual dust load on the bags. Menard and Richards[25] found that, before the sonic horns were operated, bag weights ranged from 34 to 55 pounds, with an average weight of approximately 46 pounds. After extended use of the sonic horns, bag weights ranged from 12.5 to 25 pounds, with an average weight of approximately 18 pounds. A new bag weighs approximately 9 pounds. The sonic air horns have thus reduced the amount of residual cake on the filtering elements by an average of 76%.

Cushing et al.[24] concluded:

> Sonic horns are an effective method for enhancing fabric filter performance. Their generally low cost and simple construction make them attractive additions to the available methods for cleaning fabric filter bags at coal-fired utility baghouses. Tests of six commercial sonic horns at the EPRI Fabric Filter Pilot Plant have demonstrated that, under appropriate conditions, reverse-air cleaning with sonic assist can be effective in reducing operating pressure losses. The test results have shown that overall sound pressure levels and the output frequency spectrum are important factors in determining whether a particular sonic horn application will enhance baghouse performance. One penalty encountered with sonic assist may be higher particulate penetration due to less residual dust cake on the bag surface. It is possible, however, that less frequent applications of horns will result in low ΔP without a significant increase in emissions.

BAGHOUSE MAINTENANCE

Why Keep Records?

Traditionally, baghouse operators do not keep records of routine baghouse operation. There are several reasons to reconsider this policy, including the following.

1. Records permit the operator to be aware of continuing normal operation.
2. Records permit the operator to be aware of abnormal operation, such as sudden failures or slowly changing parameters (e.g., a slow rise in residual pressure that, if allowed to continue, would limit the ability of the process to reach full load).
3. Records provide a historical record that is useful when troubleshooting problems.

What Records to Keep

Pressure drop is often the only parameter monitored in a baghouse, usually by means of a gauge mounted on the baghouse wall. In multicompartment baghouses, the pressure drops of individual compartments may be monitored along with the total baghouse pressure drop. Unfortunately, over time, the pressure-sensing lines become clogged with dust or the gauge becomes unreadable owing to dust accumulation on the instrument face. An obvious first step in maintenance is to assure that the instrumentation is both functional and accurate.

An instrument reader who routinely records process data should probably also routinely record available baghouse data. A better scheme is to record the data with a strip-chart recorder or as part of a data-logging system. Automated data-recording and parameter alarm systems are becoming more common. If such a system is a part of the process itself, perhaps baghouse data could also be recorded.

Other types of baghouse records, in addition to pressure-drop information, should be considered:

1. Flow rate. Pressure-drop information cannot be interpreted properly unless the flow rate is known. A record of flow rate may be useful in identifying a developing leak in the ducting or in the baghouse itself.
2. Opacity. If a continuous opacity monitor is incorporated into the system, its output should be recorded. If such opacity instrumentation is not available, visual opacity readings recorded manually should still prove useful. The cause of any change in opacity should be pursued and understood.
3. Temperature. The baghouse outlet temperature should certainly be monitored, even if other temperature records are not kept.
4. Dust removal. At least one parameter related to the quantity of dust removed from each baghouse compartment should be monitored and recorded. A change in

dust quantity may be indicative of baghouse failure or of process changes.

The key to baghouse maintenance is frequent and routine inspection. It is essential that a regular program of routine maintenance be established and followed. Records (a log) should be kept of all inspections and maintenance. Inspection intervals will depend on the type of baghouse, the manufacturer's recommendation, and the process on which the unit is installed. The important thing is to be sure that the checks are performed regularly and as frequently as necessary, that no components are neglected, and that all pertinent information is logged for future reference.

When problems are located and isolated during routine or other inspection, it is important that corrections be made as quickly as possible to avoid possible equipment downtime or excess emissions from bypassing the control system. When there is a baghouse failure, the unit is usually shut down and/or bypassed and the malfunction corrected. Plant managers should expect considerable maintenance time to be expended on troubleshooting and correction of baghouse malfunctions. Maintenance personnel must learn to recognize the symptoms that indicate potential problems, and then to determine the cause of the difficulty and remedy it, either by in-plant action or by contact with the manufacturer or some other outside resource. High-pressure drop across the system exemplifies one symptom for which there are many possible causes; for example, difficulties with the bag-cleaning mechanism, low compressed-air pressure, weak shaking action, loose bag tension, or excessive reentrainment of dust. Many other factors can cause excessive pressure drop, and several options are usually available for corrective action. Thus the ability to locate and correct malfunctioning baghouse components requires a thorough understanding of the system. The critical influence of moisture, in the baghouse, in the cleaning air, or with the particulate, should be noted and emphasized.

The operating experience of baghouses in conjunction with electric utility boilers has probably been more extensively documented than any other application. The Electric Power Research Institute (EPRI) currently supports an extensive research program intended to optimize the design, operation, and reliability of baghouse technology for the electric utility industry. Pilot and full-scale evaluations are performed to measure, interpret, and predict baghouse performance. Results show that baghouses routinely achieve a clear stack and particulate matter collection efficiencies well in excess of 99.9%

References

1. J. D. McKenna and J. H. Turner, *Fabric Filter—Baghouses I*, ETS, Inc., Roanoke, VA, 1989.
2. R. Dennis and H. A. Klemm, *Fabric Filter Model Format Change, Vol. I: Detailed Technical Report*, EPA-600/7-79-0432, U.S. Environmental Protection Agency, Research Triangle Park, NC, 1979, National Technical Information Service (NTIS) PB-293-551.
3. C. E. Billings and J. Wilder, *Handbook of Fabric Filter Technology, Vol. I: Fabric Filter Systems Study*, GCA Corp., Bedford, MA.; PB-200-648, NTIS, Springfield, VA, December 1970.
4. R. Dennis, R. W. Cass, D. W. Cooper, et al., *Filtration Model for Coal Flyash with Glass Fabrics*, EPA-600-7-77-084, August 1977.
5. W. T. Davis and R. F. Kurzynske, "The effect of cyclonic precleaners on the pressure drop of fabric filters," *Filtration Separation*, 16(5).
6. W. T. Davis and W. F. Frazier, "A laboratory comparison of the filtration performance of eleven different fabric filter materials filtering resuspended flyash," *Proceedings of the 75th Annual Meeting of the Air Pollution Control Association*, 1982.
7. W. F. Frazier and W. T. Davis, *Effects of Flyash Size Distribution on the Performance of a Fiberglass Filter*, Symposium on the Transfer and Utilization of Particulate Control Technology. Vol. II: *Particulate Control Devices*, EPA-600/9-82-0050c, July 1982, pp 171–180.
8. J. W. Robinson, R. E. Harrington, and P. W. Spaite, "A new method for analysis of multicompartmented fabric filtration," *Atmospheric Environ.*, 1(4):499 (1967).
9. A. A. Reisinger and W. T. Grubb, "Fabric evaluation program at Coyote Unit #1, operating results update," *Proceedings Second EPRI Conference on Fabric Filter Technology for Coal-Fired Power Plants*, Electric Power Research Institute, Palo Alto, CA., EPRI CS03257, November 1983.
10. G. P. Greiner, J. C. Mycock, and D. S. Beachler, "The IBFM, a unique tool for troubleshooting and monitoring baghouses," Paper 85-54.2, Annual Meeting of the Air Pollution Control Association, Detroit, MI, June 1985.
11. J. F. Durham and R. E. Harrington, "Influence of relative humidity on filtration resistance and efficiency of fabric dust filters," *Filtration Separation*, 8:389–393 (July/August 1971).
12. E. R. Frederick, *Electrostatic Effects in Fabric Filtration: Volume II Triboelectric Measurements and Bag Performance* (annotated data), EPA-600/7-78-142b, NTIS PB-287-207, July 1978.
13. International Non-Woven and Disposable Association, New York.
14. C. B. Hotchkiss and L. F. Cox, "Fabric and finish selection, manufacturing techniques and other factors affecting bag life in the coal-fired boiler applications," *Proceedings Second EPRI Conference on Fabric Filter Technology for Coal-Fired Power Plants*, Electric Power Research Institute, Palo Alto, CA, EPRI CS-3257, November 1983.
15. R. P. Donovan, B. E. Daniel, and J. H. Turner, *EPA Fabric Filtration Studies, 3. Performance of Filter—Bags Made From Expended PTFE Laminate*, EPA-600/2-76-168c, U.S. Environmental Protection Agency, Research Triangle Park, NC, December 1976, NTIS PB-263-132.
16. R. L. Adams, "Shaker type filter," *Proceedings APCA Specialty Conference on the User and Fabric Filter Equipment*, Buffalo, NY, October 1973, Air Pollution Control Association, Pittsburgh, PA.

17. *The Fabric Filter Manual*, C. E. Billings, Ed.; McIlvaine Co., Northbrook, IL.
18. M. M. Ketchuk, A. Walsh, O. F. Fortune, et al., "Fundamental strategies for cleaning reverse-air baghouses," *Proceedings Fourth Symposium on the Transfer and Utilization of Particulate Control Technology, Vol. I: Fabric Filtration*, EPA-600/9-84-025a, U.S. Environmental Protection Agency, Research Triangle Park, NC, November 1984.
19. R. I. Larson. "The adhesion and removal of particles attached to air filter surface," *AIHA J.*, 19 (1958).
20. A. D. Zimon, *Adhesion of Dust and Powder*, Plenum Press, New York, 1969, p 112.
21. M J. Ellenbecker and D. Leith, "Dust removal from nonwoven fabrics," Annual Meeting of the Air Pollution Control Association, Montreal, Que., June 22–27, 1980.
22. R. Dennis and L. S. Hovis, "Pulse-jet filtration theory—a state-of-the-art assessment," *Proceedings Fourth Symposium on the Transfer and Utilization of Particulate Control Technology, Vol. I: Fabric Filtration*, EPA-600/9-84-0252, U.S. Environmental Protection Agency, Research Triangle Park, NC, November 1984.
23. C. Orr, *Filtration, Principles, and Particles, Part I*, Marcel Dekker, New York, 1977.
24. K. M. Cushing, D. H. Pontius, and R. C. Carr, "A study of sonic cleaning for enhanced baghouse performance," Annual Meeting of the Air Pollution Control Association, San Francisco, June 1984.
25. A. R. Menard and R. M. Richards, "The use of sonic air horns as an assist to reverse-air cleaning of a fabric filter dust collector," *Proceedings Fourth Symposium on the Transfer and Utilization of Particulate Control Technology, Vol. I: Fabric Filtration*, EPA-600/9-84-025a, U.S. Environmental Protection Agency, Research Traingle Park, NC, November 1984.