AUG 10 1998
STATION 30

ENGINEERING DATA TRANSMITTAL

1. EDT 622272

2. To: (Receiving Organization) Distribution	3. From: (Originating Organization) TWRS Projects/SST Retrieval	4. Related EDT No.: n/a
5. Proj./Prog./Dept./Div.: W-320 TWRS/TCPN # D2991	6. Design Authority/ Design Agent/Cog. Engr.: JW Bailey, NHC	7. Purchase Order No.: n/a

8. Originator Remarks:
For approval and release of a new supporting document. This document has been generated to ensure retrievability of the Project W-320 "Department of Health Documentation".

9. Equip./Component No.: n/a

10. System/Bldg./Facility: 241-C-106

11. Receiver Remarks: 11A. Design Baseline Document? [X] Yes [] No

12. Major Assm. Dwg. No.: n/a

13. Permit/Permit Application No.: n/a

14. Required Response Date:

15. DATA TRANSMITTED

(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	(F) Approval Designator	(G) Reason for Transmittal	(H) Originator Disposition	(I) Receiver Disposition
1	HNF-3116	-	0	W-320, Department of Health Documentation	NA			-

16. KEY

Approval Designator (F)	Reason for Transmittal (G)	Disposition (H) & (I)
E, S, Q, D or N/A (see WHC-CM-3-5, Sec.12.7)	1. Approval 2. Release 3. Information 4. Review 5. Post-Review 6. Dist. (Receipt Acknow. Required)	1. Approved 2. Approved w/comment 3. Disapproved w/comment 4. Reviewed no/comment 5. Reviewed w/comment 6. Receipt acknowledged

17. SIGNATURE/DISTRIBUTION
(See Approval Designator for required signatures)

(G) Reason	(H) Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN	(G) Reason	(H) Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN
2	1	Design Authority JW Bailey	[signature]	7/25/98	S2-48						
		Design Agent									
2	1	Cog.Eng. OD Nelson	[signature]	7/25/98	S2-48						
2	1	Cog. Mgr. JW Bailey	[signature]	7/25/98	S2-48						
		QA									
		Safety									
		Env.									

18.	19.	20.	21. DOE APPROVAL (if required)
O.D. Nelson [signature] 7/25/98 Signature of EDT Originator / Date	Authorized Representative for Receiving Organization / Date	J.W. Bailey [signature] 7/25/98 Design Authority/ Cognizant Manager / Date	Ctrl. No. [] Approved [] Approved w/comments [] Disapproved w/comments

BD-7400-172-2 (05/96) GEF097

INSTRUCTIONS FOR COMPLETION OF THE ENGINEERING DATA TRANSMITTAL

(USE BLACK INK OR TYPE)

BLOCK	TITLE	
(1)*	EDT	● Pre-assigned EDT number.
(2)	To: (Receiving Organization)	● Enter the individual's name, title of the organization, or entity (e.g., Distribution) that the EDT is being transmitted to.
(3)	From: (Originating Organization)	● Enter the title of the organization originating and transmitting the EDT.
(4)	Related EDT No.	● Enter EDT numbers which relate to the data being transmitted.
(5)*	Proj./Prog./Dept./Div.	● Enter the Project/Program/Department/Division title or Project/Program acronym or Project Number, Work Order Number or Organization Code.
(6)*	Design Authority (for Design Baseline Documents)/Cognizant Engineer (for all others)/Design Agent	● Enter the name of the individual identified as being responsible for coordinating disposition of the EDT.
(7)	Purchase Order No.	● Enter related Purchase Order (P.O.) Number, if available.
(8)*	Originator Remarks	● Enter special or additional comments concerning transmittal, or "Key" retrieval words may be entered.
(9)	Equipment/Component No.	● Enter equipment/component number of affected item, if appropriate.
(10)	System/Bldg./Facility	● Enter applicable system, building or facility number, if appropriate.
(11)	Receiver Remarks	● Enter special or additional comments concerning transmittal.
(11A)*	Design Baseline Document	● Enter an "X" in the appropriate box. Consult with Design Authority for identification of Design Baseline Documents, if required.
(12)	Major Assm. Dwg. No.	● Enter applicable drawing number of major assembly, if appropriate.
(13)	Permit/Permit Application No.	● Enter applicable permit or permit application number, if appropriate.
(14)	Required Response Date	● Enter the date a response is required from individuals identified in Block 17 (Signature/Distribution).
(15)*	Data Transmitted	
	(A)* Item Number	● Enter sequential number, beginning with 1, of the information listed on EDT.
	(B)* Document/Drawing No.	● Enter the unique identification number assigned to the document or drawing being transmitted.
	(C)* Sheet No.	● Enter the sheet number of the information being transmitted. If no sheet number, leave blank.
	(D)* Rev. No.	● Enter the revision number of the information being transmitted. If no revision number, leave blank.
	(E) Title or Description of Data Transmitted	● Enter the title of the document or drawing or a brief description of the subject if no title is identified.
	(F)* Approval Designator	● Enter the appropriate Approval Designator (Block 15). Also, indicate the appropriate approvals for each item listed, i.e., SQ, ESQ, etc.
	(G) Reason for Transmittal	● Enter the appropriate code to identify the purpose of the data transmittal (see Block 16).
	(H) Originator Disposition	● Enter the appropriate disposition code (see Block 16).
	(I) Receiver Disposition	● Enter the appropriate disposition code (see Block 16).
(16)	Key	● Number codes used in completion of Blocks 15 (G), (H), and (I), and 17 (G), (H) (Signature/Distribution).
(17)	Signature/Distribution	
	(G) Reason	● Enter the code of the reason for transmittal (Block 16).
	(H) Disposition	● Enter the code for the disposition (Block 16).
	(J) Name	● Enter the signature of the individual completing the Disposition 17 (H) and the Transmittal.
	(K)* Signature	● Obtain appropriate signature(s).
	(L)* Date	● Enter date signature is obtained.
	(M)* MSIN	● Enter MSIN. Note: If Distribution Sheet is used, show entire distribution (including that indicated on Page 1 of the EDT) on the Distribution Sheet.
(18)	Signature of EDT Originator	● Enter the signature and date of the individual originating the EDT (entered prior to transmittal to Receiving Organization). If the EDT originator is the Design Authority (for Design Baseline Documents)/Cognizant Engineer (for all others) or Design Agent, sign both Blocks 17 and 18.
(19)	Authorized Representative for Receiving Organization	● Enter the signature and date of the individual identified by the Receiving Organization Design Authority (for Design Baseline Documents)/Cognizant Engineer (for all others) as authorized to approve disposition of the EDT and acceptance of the data transmitted, as applicable.
(20)*	Design Authority/Cognizant Manager	● Enter the signature and date of the Design Authority/Cognizant Manager. (This signature is authorization for release.)
(21)*	DOE Approval	● Enter DOE approval (if required) by signature or control number that tracks the approval to a signature, and indicate DOE action.

*Asterisk denote the required minimum items check by Configuration Documentation prior to release; these are the minimum release requirements.

S

W-320 Department of Health Documentation

Owen D. Nelson
Numatec Hanford Co., Richland, WA 99352
U.S. Department of Energy Contract DE-AC09-96RL13200

EDT/ECN: 622272 UC: 506
Org Code: 8C452 Charge Code: D2991/HANA0600
B&R Code: EW3130010 Total Pages: 327

Key Words: W-320, Department of Health, Documentation.

Abstract: This supporting document contains project specific information relative to compliance with Department of Health Notice of Construction Compliance.

AUG 10 1998
DATE: HANFORD RELEASE
STA: 30
ID: 25

Kara L Broz 8/7/98
Release Approval Date

Release Stamp

Approved for Public Release

Supporting Document Coversheet page 1 of 3

A-6400-073 (01/97) GEF321

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Signature: for O.D. Nelson per telecon Beth Dickstrom

Credit line (if required):

Application approved by:

Name: Thomas P Hamilton **Date:** 7/30/98

Company Name: NEW YORK BLOWER **Signatory's Position:** NAT'L SALES MGR

Signature: Thomas P Hamilton **(on behalf of)** NYB

A-6000-237 (05/97) WEF220

Cover Sheet
page 2 of 3

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Signature: for O. D. Nelson per telecon [signature]

Credit line (if required):

Application approved by:

Name: ALBERT T. ALGAR **Date:** 7-30-98

Company Name: FLANDERS FILTERS INC. **Signatory's Position:** SALES MGR

Signature: Albert T Algar **(on behalf of)**

TABLE OF CONTENTS

1.0 INTRODUCTION

The purpose of this document is to gather information required to show that Project W-320 is in compliance with Washington State Department of Health requirements as specified in Radioactive Air Emissions Notice of Construction Project W-320, Tank 241-C-106 Sluicing, DOE/RL-95-45. Specifically, that W-320 is in compliance with ASME N509-1989 (Nuclear Power Plant Air-Cleaning Units and Components) and ASME N510-1989 (Testing of Nuclear Air Treatment Systems) for the 296-C-006 exhaust system..

2.0 CODE COMPLIANCE

In order to verify that the HVAC System/components listed in Radioactive Air Emissions Notice of Construction Project W-320, Tank 241-C-106 Sluicing, DOE/RL-95-45 are in compliance with ASME N509/N510, Section 8.2 (Summary of Required Documentation) of ASME N509 was used. The following sections describe how W-320 is in compliance with Section 8.2 of ASME N509. All code sections referenced below (unless otherwise stated) with document sections are from ASME N509.

2.1 Design Parameters (Section 4.2)

Reference documents:

- H-2-818478 Rev 1, Sheets 1-3 (Environmental Tank 241-C-106 Ventilation Process Flow Diagram.

- W-320-P1, Procurement Specification Exhaust Skid Ventilation Air Cleanup Trains, Section 3.0.

This data is given in Appendix - A.

2.2 Maximum Operating Pressure (Section 4.6.3)

Reference documents:

- W-320 Calculation 28-001, Exhaust Airflow Sizing for Tank 241-C-106.

- W-320 Calculation 28-011, Exhaust Skid stack Sizing and Fan Sizing.

- W-320 Calculation 28-018, Pressure Loss Upstream of the Exhaust Skid.

- Ellis & Watts Fan Curve

These documents give the pressure loss up through the exhaust fan and show that the fan is capable of only producing -42" wg while the filter train was tested to -50"wg.

This information can be found in Appendix - B

2.3 Test Pressure (Section 4.6.4)

The test pressure usually equals or exceeds the highest operating pressure. Again, the exhaust fan can only produce -42" wg of pressure, while Ellis & Watts leak tested the filter train at -50" wg.

Reference documents:

- Ellis & Watts fan curve

- Ellis & Watts pressure decay report

This information can be found in Appendix - C

2.4 Structural Capability Pressure (Section 4.6.6)

Per 4.6.6 "The structural design capability pressure shall equal or exceed the maximum design pressure and shall be the static pressure to which the air cleaning unit can be safely loaded without permanent distortion". Section 4.6.5.1 defines the Maximum Design Pressure as that produced due to normal operating pressure, test pressure or transient pressure conditions due to rapid closure of dampers. If the inlet damper to the ventilation train is closed, the maximum pressure that could be produced with the current fan/electric motor combination is -42" wg. The ventilation train was leak tested at -50" wg, which exceeds -42" wg.

Reference documents:

- Ellis & Watts fan curve

- Ellis & Watts pressure decay report

This information can be found in Appendix - D

2.5 Test Cannister Qualification (4.11)

Not applicable, no test cannisters.

2.6 Basis and Quantity for Maximum Allowable Leakage (4.14.2)

Reference documents:

- W-320-P1, Procurement Specification Exhaust Skid Ventilation Air Cleanup Trains, Section 3.0.

- W-320 Calculation W320-28-034

This information can be found in Appendix - E

2.7 HEPA Filter Qualification report (5.1.3)

Reference documents:

Flanders Filters Bulletin Number 935

This information can be found in Appendix - F

2.8 Adsorber Drawings and Qualification Report (5.2.4/5.2.5)

Not applicable, no adsorber.

2.9 Prefilter and Postfilter (5.4.1)

Not applicable, no prefilters or postfilters in filter train.

2.10 Moisture Separator Drawings and Qualification Report (5.4.1 & 5.4.2)

Reference documents:

- Vendor manufacture bulletin

- Vendor seismic analysis report

This information can be found in Appendix - G

2.11 Heater Drawings and Qualification Report (5.5.2)

Reference documents:

- Ellis & Watts Electric heating coil functional test report

This information can be found in Appendix - H

2.12 Housing Drawings (5.6.2 (g))

Reference document:

- Ellis & Watts Filter train Ventilation Exhaust Air Drawing, K0701-010, Sheet 1, Rev D

This information can be found in Appendix - I

2.13 HEPA and Adsorber Clamping Device Drawings (Section 5.6.3)

Ellis & Watts has informed project W-320 that details for the HEPA filter Clamping Device is propierty information and will not submit any detailed information. Ellis & Watts has supplied W-320 with a letter stating this.

Reference document:

- Ellis & Watts Letter

This information can be found in Appendix - J

2.14 Manifold Drawings (5.6.5.1)

Ellis & Watts has informed project W-320 that details for the aerosol manifold is propierty information and will not submit any detailed information. Ellis & Watts has supplied W-320 with a letter stating this.

Reference document

- Ellis & Watts letter

This information can be found in Appendix - K

2.15 Factory Visual Inspection Report (5.6.5.2)

Reference document

- Ellis & Watt visual inspection report

This information can be found in Appendix - L

2.16 Factory Housing Leak Test Results (5.6.5.4)

Reference document:

- Ellis & Watts leak test report

This information can be found in Appendix - M

2.17 Factory Airflow Distribution Test (5.6.5.5)

Per ASME N510 Section 8.5.2 (Airflow Distribution Test), "Note: Aiflow distribution tests are not required for a filter bank containing a single HEPA filter". W-320 filter train is consists of two stages of single HEPA filter banks. Airflow distribution test is not required.

2.18 Factory Air-Aerosol Mixing Uniformity Test (5.6.5.6)

Per ASME N510 Section 9.1 (Purpose), "Note: "The air-aerosol mixing uniformity test is not necessary for a single HEPA filter in a bank filter". W-320 filter train is consists of two stages of single HEPA filter banks. Airflow distribution test is not required.

2.19 Fan Drawings and Qualification Test Report (5.7.4/5.7.5)

Reference document:

- Ellis & Watts fan data

This information can be found in Appendix - N

2.20 Fan Motor Drawings and Data Sheets (5.8.3)

Reference document:

- Ellis & Watts fan data

This information can be found in Appendix - O

2.21 Damper Drawings and Reports (5.9.8)

Reference document:

- Ellis & Watts damper data

This information can be found in Appendix - P

2.22 Test Acceptance Data (Table 9-1)

See Section 3.0 for this information.

2.23 System Layout Drawings (7.1)

Reference document:

- Ellis & Watts Filter Train Drawing, K0701-0101, Sheet 1, Rev D

This information can be found in Appendix - Q

3.0 SUMMARY OF CRITERIA FOR ACCEPTANCE TESTING

The following sections summarize acceptance criteria as presented in Table 9-1 of ASME N509.

3.1 Visual Inspection (5.0)

Reference document:

- 241-C-006 Acceptance Test Report, HNF-SD-W320-ATR-012, Rev 0.

This information can be found in Appendix - R

3.2 Housing Leak Test (6.0)

Reference document:

- 241-C-006 Acceptance Test Report, HNF-SD-W320-ATR-012, Rev 0.

This information can be found in Appendix - S

3.3 Mounting frame Leak Test (7.0)

This test is listed as optional in Section 7.0. The note in Section 7.1 provides the following, "Presence of these leaks will be evident when performing Sections 10 and 11 of this Standard. A good visual verification per Section 5 is usually adequate. This test method is provided for use when leakage needs to be located or qualified". This filter train will have a in-place aerosol test performed per Section 10 and any leaks associated with the mounting frame will be detected with this method.

3.4 Duct Leak Test (6)

Reference Document:

- 241-C-006 Acceptance Test Report, HNF-SD-W320-ATR-012, Rev 0.

This information can be found in Appendix - T

3.5 Airflow Capacity and Distribution (8)

Per the note listed below Section 8.5.2 (Airflow Distribution Test), "Airflow distribution tests are not required for a filter bank containing a single HEPA filter". The 241-C-006 filter train consists of two stages consisting of single HEPA filters. The Airflow distribution test does not apply. However, the airflow capacity test was achieved per the following:

- 241-C-006 Acceptance Test Report, HNF-SD-W320-ATR-012, Rev 0.

This information can be found in Appendix - U

3.6 Air-Aerosol Mixing Uniformity (9)

Per ASME N510 Section 9.1 (Purpose), "Note: "The air-aerosol mixing uniformity test is not necessary for a single HEPA filter in a bank filter". W-320 filter train is consists of two stages of single HEPA filter banks. Airflow distribution test is not required.

3.7 In-Place HEPA Filter Test (10)

In-place HEPA filter test will be performed prior to connecting 241-C-006 to 241-C-106 per the following document:

- In-Place HEPA Filter Test, 6-TF-156TT

This information can be found in Appendix - V

3.8 In-Place Adsorber Leak Test (11)

Test not applicable to 241-C-006, no adsorbers.

3.9 Duct Damper Bypass Test (12)

Test not applicable to 241-C-006, no duct damper bypass.

3.10 System Bypass Test (13)

Test not applicable to 241-C-006, no system bypass.

3.11 Air Heater Performance Test (14)

Reference document:

- 241-C-006 Acceptance Test Report, HNF-SD-W320-ATR-012, Rev 0.

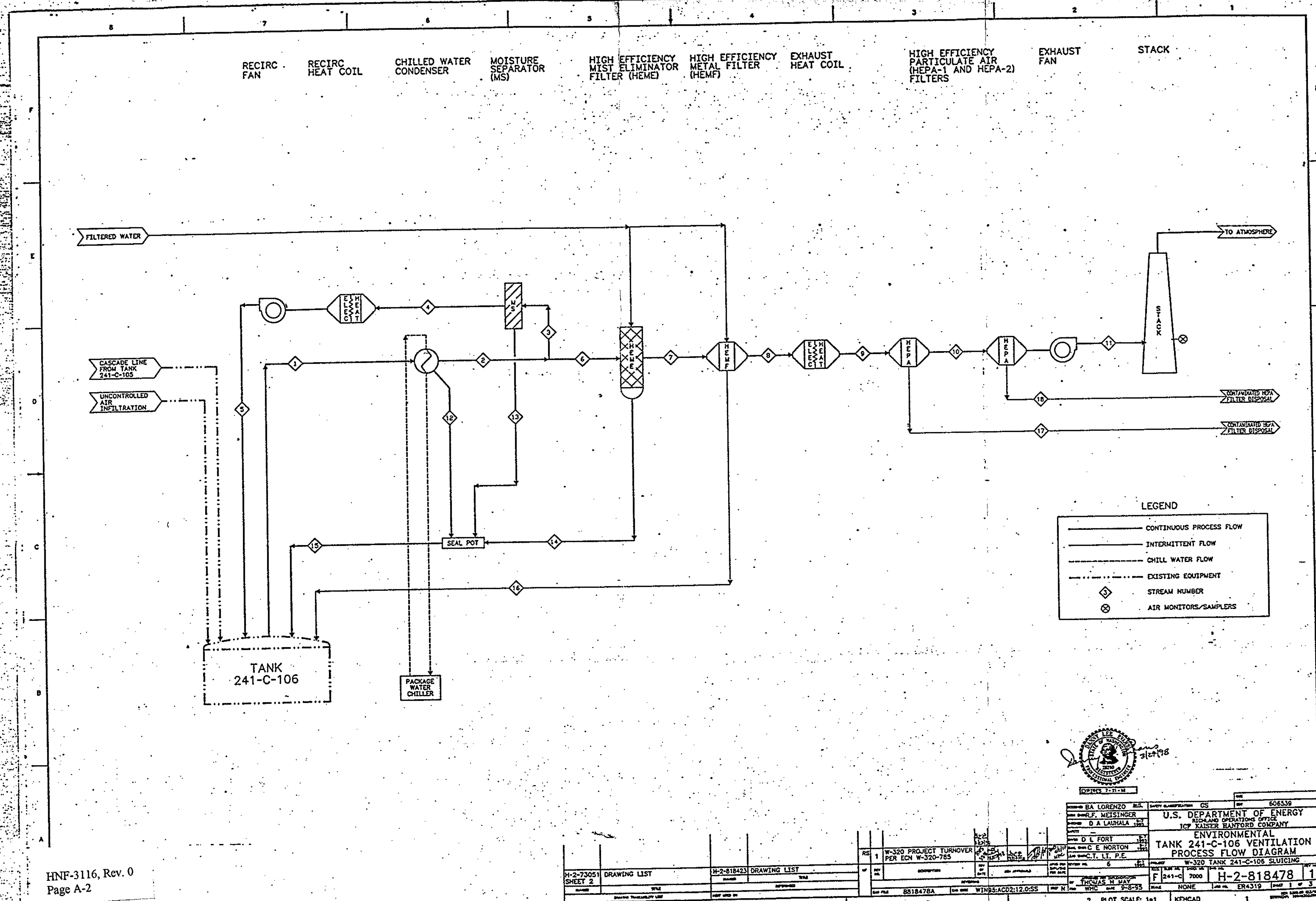
This information can be found in Appendix - W

3.12 Laboratory Testing of Adsorber

Test not applicable to 21-C-006, no adsorber.

APPENDIX - A

Design Parameter



RECIRC FAN
RECIRC HEAT COIL
CHILLED WATER CONDENSER
MOISTURE SEPARATOR (MS)
HIGH EFFICIENCY MIST ELIMINATOR FILTER (HEME)
HIGH EFFICIENCY METAL FILTER (HEMF)
EXHAUST HEAT COIL
HIGH EFFICIENCY PARTICULATE AIR (HEPA-1 AND HEPA-2) FILTERS
EXHAUST FAN
STACK
FILTERED WATER
CASCADE LINE FROM TANK 241-C-105
UNCONTROLLED AIR INFILTRATION
TANK 241-C-106
PACKAGE WATER CHILLER
SEAL POT
TO ATMOSPHERE
CONTAMINATED HEPA FILTER DISPOSAL
CONTAMINATED HEPA FILTER DISPOSAL
LEGEND
CONTINUOUS PROCESS FLOW
INTERMITTENT FLOW
CHILL WATER FLOW
EXISTING EQUIPMENT
STREAM NUMBER
AIR MONITORS/SAMPLERS
U.S. DEPARTMENT OF ENERGY
RICHLAND OPERATIONS OFFICE
ICF KAISER HANFORD COMPANY
ENVIRONMENTAL
TANK 241-C-106 VENTILATION
PROCESS FLOW DIAGRAM
W-320 TANK 241-C-106 SLUICING
H-2-818478
W-320 PROJECT TURNOVER PER ECN W-320-785
H-2-73051 SHEET 2 DRAWING LIST
H-2-818423 DRAWING LIST
PLOT SCALE: 1=1

TANK 241-C-106 VENTILATION MASS BALANCE

Tank Ventilation Flowrate is 1090 scfm
Recirculation Flowrate is 860 scfm
Stack Exhaust Flowrate is 230 scfm

ABBREVIATIONS
acfm = actual cubic feet per minute
scfm = standard cubic feet per minute
DA = dry air (0.0% humidity)
DAC = derived air concentration
DCG = derived concentration guide
I/F = intermittent flushing
N/A = not applicable

STREAM #	1	2	3	4	5	6	7	8	9	10	11
SOURCE	C-106 Tank	Condenser	Flow Split	MS	Recirc Fan	Flow Split	HEME	HEMF	Exh Heat	HEPA-1	Exh Fan
SINK	Condenser	Flow Split	MS	Heat Coil	C-106 Tank	HEME	HEMF	Exh Heat	HEPA-1	HEPA-2	Stack
TEMPERATURE (deg F)	95	40	40	40	77	40	40	40	55	55	55
ESTIMATED WATER GAUGE (in)	-2	-13	-13	-19	-2	-13	-23	-28	-29	-31	2
SYSTEM PRESSURE (psia)	14.3	13.9	13.9	13.7	14.3	13.9	13.6	13.4	13.4	13.3	14.5
RELATIVE HUMIDITY	100%	100%	100%	100%	35%	100%	100%	100%	61%	60%	66%
ABS. HUMIDITY (lb H2O/lb DA)	0.037	0.011	0.011	0.007	0.007	0.011	0.006	0.006	0.006	0.006	0.006
SAT'N VAPOR PRESSURE (in Hg)	1.66	0.25	0.25	0.25	0.94	0.25	0.25	0.25	0.44	0.44	0.44
SP. VOL. (wet ft-3/lb DA)	15.2	13.5	13.5	13.6	14	13.5	13.8	13.8	14.4	14.5	13.3
WET GAS FLOW AT T & P (acfm)	1,240	1,104	871	880	904	233	237	241	248	250	229
STANDARD OFF-GAS FLOW (scfm)	1090	1090	860	860	860	230	230	230	230	230	230
WASH WATER/CONDENSATE (kg/min)		0.17	0.13	0.03		0.04	0	0			
AEROSOL MASS FLOW (mg/min)	4.80E+02	1.20E+02	9.60E+01	6.40E+01	6.40E+01	2.60E+01	1.80E+00	9.20E-04	9.20E-04	4.60E-07	2.30E-10
AEROSOLS, SOLIDS (mg/m-3 DA)	1.50E+01	3.90E+00	3.90E+00	2.60E+00	2.60E+00	3.90E+00	2.80E-01	1.40E-04	1.40E-04	7.00E-08	3.50E-11
AEROSOLS, WATER (mg/m-3 DA)	3.00E+02	5.60E+03	5.60E+03	1.20E+03	0.00E+00	5.60E+03	1.90E+01	1.40E-01	0.00E+00	0.00E+00	0.00E+00
TOTAL AEROSOL (mg/m-3 DA)	3.10E+02	5.60E+03	5.60E+03	1.20E+03	2.60E+00	5.60E+03	2.00E+01	1.10E-01	1.40E-04	7.00E-08	3.50E-11
NON-RADIOACTIVE CONTAMINANTS	(mg/min)	(mg/min)	(mg/min)	(mg/min)	(mg/min)	(mg/min)	(mg/min)	(mg/min)	(mg/min)	(mg/min)	(mg/min)
Aluminum	1.25E+02	3.23E+01	2.55E+01	1.70E+01	1.70E+01	6.82E+00	4.87E-01	2.44E-04	2.44E-04	1.22E-07	6.09E-11
Antimony	3.27E+00	1.09E+00	8.60E-01	5.74E-01	5.74E-01	2.30E-01	1.64E-02	8.22E-06	8.22E-06	4.11E-09	2.05E-12
Arsenic	4.38E-01	1.10E-01	8.65E-02	5.76E-02	5.76E-02	2.31E-02	1.65E-03	8.26E-07	8.26E-07	4.13E-10	2.06E-13
Barium	3.95E-01	9.88E-02	7.79E-02	5.20E-02	5.20E-02	2.08E-02	1.49E-03	7.44E-07	7.44E-07	3.72E-10	1.86E-13
Boron	3.95E-01	9.88E-02	7.79E-02	5.20E-02	5.20E-02	2.08E-02	1.49E-03	7.44E-07	7.44E-07	3.72E-10	1.86E-13
Calcium	2.14E+00	7.12E-01	5.62E-01	3.74E-01	3.74E-01	1.50E-01	1.07E-02	5.37E-06	5.37E-06	2.68E-09	1.34E-12
Cerium	5.52E-01	1.84E-01	1.45E-01	9.69E-02	9.69E-02	3.89E-02	2.78E-03	1.39E-06	1.39E-06	6.94E-10	3.47E-13
Chromium	1.97E+00	4.92E-01	3.88E-01	2.59E-01	2.59E-01	1.04E-01	7.42E-03	3.71E-06	3.71E-06	1.86E-09	9.28E-13
Copper	3.36E-01	8.41E-02	6.64E-02	4.42E-02	4.42E-02	1.77E-02	1.27E-03	6.34E-07	6.34E-07	3.17E-10	1.58E-13
Iron	9.26E+01	2.31E+01	1.83E+01	1.22E+01	1.22E+01	4.88E+00	3.49E-01	1.74E-04	1.74E-04	8.72E-08	4.36E-11
Lead	2.81E+00	9.37E-01	7.40E-01	4.93E-01	4.93E-01	1.98E-01	1.41E-02	7.06E-06	7.06E-06	3.53E-09	1.77E-12
Magnesium	4.72E-01	1.57E-01	1.24E-01	8.28E-02	8.28E-02	3.32E-02	2.37E-03	1.19E-06	1.19E-06	5.93E-10	2.97E-13
Manganese	5.06E+00	1.27E+00	9.98E-01	6.66E-01	6.66E-01	2.67E-01	1.91E-02	9.54E-06	9.54E-06	4.77E-09	2.38E-12
Neodymium	6.30E-01	1.57E-01	1.24E-01	8.28E-02	8.28E-02	3.32E-02	2.37E-03	1.19E-06	1.19E-06	5.93E-10	2.97E-13
Phosphorus	8.21E+00	2.74E+00	2.16E+00	1.44E+00	1.44E+00	5.77E-01	4.12E-02	2.06E-05	2.06E-05	1.03E-08	5.16E-12
Selenium	1.57E+00	3.94E-01	3.10E-01	2.07E-01	2.07E-01	8.30E-02	5.93E-03	2.97E-06	2.97E-06	1.48E-09	7.41E-13
Silicon	2.93E+01	7.32E+00	5.77E+00	3.85E+00	3.85E+00	1.54E+00	1.10E-01	5.51E-05	5.51E-05	2.76E-08	1.38E-11
Silver	2.36E+00	5.90E-01	4.66E-01	3.10E-01	3.10E-01	1.25E-01	8.90E-03	4.45E-06	4.45E-06	2.22E-09	1.11E-12
Sodium	1.76E+02	4.39E+01	3.46E+01	2.31E+01	2.31E+01	9.26E+00	6.62E-01	3.31E-04	3.31E-04	1.65E-07	8.27E-11
Strontium	1.24E-01	4.13E-02	3.26E-02	2.17E-02	2.17E-02	8.71E-03	6.22E-04	3.11E-07	3.11E-07	1.55E-10	7.77E-14
Thallium	1.35E+00	3.37E-01	2.66E-01	1.77E-01	1.77E-01	7.12E-02	5.08E-03	2.54E-06	2.54E-06	1.27E-09	6.35E-13
Titanium	3.70E-01	1.23E-01	9.74E-02	6.49E-02	6.49E-02	2.61E-02	1.86E-03	9.30E-07	9.30E-07	4.65E-10	2.33E-13
Uranium	4.60E-01	1.53E-01	1.21E-01	8.06E-02	8.06E-02	3.23E-02	2.31E-03	1.16E-06	1.16E-06	5.78E-10	2.89E-13
Zirconium	6.76E-01	2.25E-01	1.78E-01	1.19E-01	1.19E-01	4.75E-02	3.40E-03	1.70E-06	1.70E-06	8.49E-10	4.24E-13
Hydroxide (OH-)	6.57E-06	1.64E-06	1.30E-06	8.65E-07	8.65E-07	3.47E-07	2.48E-08	1.24E-11	1.24E-11	6.19E-15	3.10E-18
Nitrite (NO2-)	3.95E-06	9.88E-07	7.79E-07	5.20E-07	5.20E-07	2.08E-07	1.49E-08	7.44E-12	7.44E-12	3.72E-15	1.86E-18
EDTA(-4)	6.79E-01	2.26E-01	1.79E-01	1.19E-01	1.19E-01	4.78E-02	3.41E-03	1.71E-06	1.71E-06	8.53E-10	4.26E-13
HEDTA(-3)	5.34E-01	1.78E-01	1.40E-01	9.36E-02	9.36E-02	3.76E-02	2.68E-03	1.34E-06	1.34E-06	6.71E-10	3.35E-13
Citric(-3)	3.48E+00	1.16E+00	9.15E-01	6.10E-01	6.10E-01	2.45E-01	1.75E-02	8.74E-06	8.74E-06	4.37E-09	2.18E-12
Oxalic(-2)	4.86E+00	1.62E+00	1.28E+00	8.52E-01	8.52E-01	3.42E-01	2.44E-02	1.22E-05	1.22E-05	6.10E-09	3.05E-12
Formic(-)	4.97E+00	1.66E+00	1.31E+00	8.71E-01	8.71E-01	3.50E-01	2.50E-02	1.25E-05	1.25E-05	6.24E-09	3.12E-12
Ammonia	2.11E+02	2.11E+02	1.66E+02	1.66E+02	1.66E+02	4.45E+01	4.45E+01	4.45E+01	4.45E+01	4.45E+01	4.45E+01
RADIOACTIVE CONTAMINANTS	(pCi/min)	(pCi/min)	(pCi/min)	(pCi/min)	(pCi/min)	(pCi/min)	(pCi/min)	(pCi/min)	(pCi/min)	(pCi/min)	(pCi/min)
C-14	6.27E+02	1.57E+02	1.24E+02	8.24E+01	8.24E+01	3.31E+01	2.36E+00	1.18E-03	1.18E-03	5.90E-07	2.95E-10
Co-60	2.40E+06	7.99E+05	6.31E+05	4.20E+05	4.20E+05	1.69E+05	1.20E+04	6.02E+00	6.02E+00	3.01E-03	1.51E-06
Sr-90	5.34E+09	1.78E+09	1.40E+09	9.36E+08	9.36E+08	3.76E+08	2.68E+07	1.34E+04	1.34E+04	6.71E+00	3.35E-03
Y-90	5.34E+09	1.78E+09	1.40E+09	9.36E+08	9.36E+08	3.76E+08	2.68E+07	1.34E+04	1.34E+04	6.71E+00	3.35E-03
Tc-99	5.93E+05	1.48E+05	1.17E+05	7.79E+04	7.79E+04	3.13E+04	2.23E+03	1.12E+00	1.12E+00	5.58E-04	2.79E-07
I-129	2.19E+02	1.75E+02	1.38E+02	1.38E+02	1.38E+02	3.69E+01	3.69E+01	3.69E+01	3.69E+01	3.69E+01	3.69E+01
Cs-137	8.92E+08	2.23E+08	1.76E+08	1.17E+08	1.17E+08	4.71E+07	3.36E+06	1.68E+03	1.68E+03	8.40E-01	4.20E-04
mBa-137	8.44E+08	2.11E+08	1.66E+08	1.11E+08	1.11E+08	4.45E+07	3.18E+06	1.59E+03	1.59E+03	7.95E-01	3.97E-04
Pu-239	7.25E+06	2.42E+06	1.91E+06	1.27E+06	1.27E+06	5.10E+05	3.64E+04	1.82E+01	1.82E+01	9.11E-03	4.56E-06
Pu-240	7.25E+06	2.42E+06	1.91E+06	1.27E+06	1.27E+06	5.10E+05	3.64E+04	1.82E+01	1.82E+01	9.11E-03	4.56E-06
Am-241	2.83E+06	9.44E+05	7.45E+05	4.97E+05	4.97E+05	1.99E+05	1.42E+04	7.12E+00	7.12E+00	3.56E-03	1.78E-06

EQUIPMENT PERFORMANCE CRITERIA

1. The condenser cools the tank ventilation off-gas to 40°F.
2. Following decontamination factors (DF) are used:

	DF
Entrained condensate mist in moisture separator (MS)	5
Aqua soluble and insoluble aerosols in moisture separator	1.5
Aerosol-aqua soluble solids in condenser	4
Aerosol-aqua insoluble solids in condenser	3
I-129 vapor in condenser	1.25
Entrained condensate mist in HEME	400
Aqua soluble and insoluble aerosol in HEME	14
I-129 vapor in HEME	1
Entrained condensate mist in HEMF	100
Dry particulate in HEMF and HEPA	2000
Ammonia in all equipment	1

3. Recirculated ventilation off-gas is heated to 77°F by the recirculation heat coil.
4. The ventilation off-gas exhaust is heated to 55°F by the exhaust heater.

MATERIAL BALANCE ASSUMPTIONS

1. Standard state conditions are dry air at 14.7 psia and 70°F. The off-gas characterization concentrations are given at the standard conditions.
2. Atmospheric pressure is 14.4 psia.
3. Air and water are the dominant species in the tank ventilation off-gas.
4. Specific contaminant concentrations and total aerosol density in the tank ventilation off-gas are presented in Attachment 3 of PROJECT W-320 REVISED HEADSPACE CHARACTERIZATION (Internal Memo 71320-94-056), Dec. 6. 1994 of PROJECT 93L-EWW-320. TANK 241-C-106 SLUICING, LETTER OF INSTRUCTION, DEFINITIVE DESIGN, ADDENDUM 7. Following modifications of the reported characterization are made (also see DSI's from Li to Bradshaw on June 19, 1995):
   a. Sr-89 is taken out from the original table.
   b. The added transient decay daughter of Sr-90 and Cs-137 are Y-90 and Ba-137m respectively.
   c. Activities of Pu-239 and Pu-240 are assumed equal and have the value as listed in the original table for 239/240 Pu.
   d. Ammonia with a concentration of 9 ppm(v) is added.
   e. Organic compounds, sodium salts of EDTA, HEDTA, citric acid, oxalic acid and formic acid are added.
5. Ammonia is not removed by any of pollutant removal equipment in the system.
6. I-129 exists entirely as a non-condensable gas and is only partially removed from the system in the condenser.
7. Although most of the sodium organic salts are aqua soluble, dried and aerosol suspended particles of organic sodium salts are considered as insoluble particles, and the respective DF's are applied for different pollutant removal equipment.
8. The HEME fiber element will be periodically cleaned by using a wash water sprayer at a flow of 10 gallons per hour.
9. The HEMF will be back flushed no less than once a year.
10. Stack discharges of boron, calcium, chromium, lead, magnesium, zinc, potassium, sodium, and hydroxide will be reported as the following regulated toxic air pollutants: $Na_2B_4O_7*5H_2O$, $Ca(OH)_2$, Na_2CrO_4, $Pb(OH)_2$, MgO, ZnO, KOH, and NaOH for Na and OH.

EXPIRES 7-21-96

BA LORENZO	CS	606539	
R.F. MEISINGER	U.S. DEPARTMENT OF ENERGY RICHLAND OPERATIONS OFFICE ICF KAISER HANFORD COMPANY		
D A LAUHALA			
D L FORT	ENVIRONMENTAL TANK 241-C-106 VENTILATION MASS BALANCE		
C E NORTON			
C.T. LI, P.E.			
6	W-320 TANK 241-C-106 SLUICING		
THOMAS H MAY	F 241-C 7000	H-2-818478	1
WHC 9-8-95	NONE	ER4319	2 of 3

RS 1 W-320 PROJECT TURNOVER PER ECN W-320-785

B8184788 WIN95:AC02:12.0:SS N

2 PLOT SCALE: 1=1 KEHCAD

TANK 241-C-106 VENTILATION MASS BALANCE

Tank Ventilation Flowrate is 1090 scfm
Recirculation Flowrate is 860 scfm
Stack Exhaust Flowrate is 230 scfm

Refer to Sheet 2 for Equipment Performance Criteria and Material Balance Assumptions

STREAM #	12	13	14	15		16	17	18
SOURCE	Condenser	MS	HEME	Seal Pot	Liquid in	HEMF	HEPA-1	HEPA-2
SINK	Seal Pot	Seal Pot	Seal Pot	C-106 Tank	Seal Pot	C-106 Tank	Disposal	Disposal
TEMPERATURE [deg F]	40	40	40	40	40	40	55	55
ESTIMATED WATER GAUGE [in]								
SYSTEM PRESSURE [psia]								
RELATIVE HUMIDITY								
ABS. HUMIDITY [lb H2O/lb DA]								
SAT'N VAPOR PRESSURE [in Hg]								
SP. VOL. [vol ft^3/lb DA]								
WET GAS FLOW AT T & P [acfm]								
STANDARD OFF-GAS FLOW [scfm]								
WASH WATER/CONDENSATE [kg/min]	0.96	0.11	0.05	1.1		I/F		
AEROSOL MASS FLOW [mg/min]	3.50E+02	3.20E+01	2.40E+01	4.10E+02	3.60E+02	1.80E+00	9.20E-04	4.60E-07
AEROSOLS, SOLIDS [mg/m^3 DA]								
AEROSOLS, WATER [mg/m^3 DA]								
TOTAL AEROSOL [mg/m^3 DA]	-							
NON-RADIOACTIVE CONTAMINANTS	[mg/min]	[mg/min]	[mg/min]	[mg/min]	[mg/L]	[mg/min]	[mg/min]	[mg/min]
Aluminum	9.70E+01	8.50E+00	6.33E+00	1.12E+02	9.90E+01	4.87E-01	2.44E-04	1.22E-07
Antimony	2.18E+00	2.87E-01	2.14E-01	2.68E+00	2.40E+00	1.64E-02	8.21E-06	4.11E-09
Arsenic	3.29E-01	2.88E-02	2.15E-02	3.79E-01	3.40E-01	1.65E-03	8.25E-07	4.13E-10
Barium	2.96E-01	2.60E-02	1.94E-02	3.42E-01	3.00E-01	1.49E-03	7.44E-07	3.72E-10
Boron	2.96E-01	2.60E-02	1.94E-02	3.42E-01	3.00E-01	1.49E-03	7.44E-07	3.72E-10
Calcium	1.42E+00	1.87E-01	1.39E-01	1.75E+00	1.60E+00	1.07E-02	5.36E-06	2.68E-09
Cerium	3.68E-01	4.84E-02	3.61E-02	4.53E-01	4.00E-01	2.77E-03	1.39E-06	6.94E-10
Chromium	1.48E+00	1.29E-01	9.65E-02	1.70E+00	1.50E+00	7.42E-03	3.71E-06	1.85E-09
Copper	2.52E-01	2.21E-02	1.65E-02	2.91E-01	2.60E-01	1.27E-03	6.34E-07	3.17E-10
Iron	6.94E+01	6.09E+00	4.54E+00	8.01E+01	7.10E+01	3.49E-01	1.74E-04	8.72E-08
Lead	1.87E+00	2.47E-01	1.84E-01	2.30E+00	2.00E+00	1.41E-02	7.06E-06	3.53E-09
Magnesium	3.15E-01	4.14E-02	3.08E-02	3.87E-01	3.40E-01	2.37E-03	1.19E-06	5.93E-10
Manganese	3.80E+00	3.33E-01	2.48E-01	4.38E+00	3.90E+00	1.91E-02	9.53E-06	4.77E-09
Neodymium	4.72E-01	4.14E-02	3.08E-02	5.44E-01	4.80E-01	2.37E-03	1.19E-06	5.93E-10
Phosphorus	5.47E+00	7.20E-01	5.36E-01	6.73E+00	6.00E+00	4.12E-02	2.06E-05	1.03E-08
Selenium	1.18E+00	1.03E-01	7.71E-02	1.36E+00	1.20E+00	5.93E-03	2.96E-06	1.48E-09
Silicon	2.19E+01	1.92E+00	1.43E+00	2.53E+01	2.20E+01	1.10E-01	5.51E-05	2.75E-08
Silver	1.77E+00	1.55E-01	1.16E-01	2.04E+00	1.80E+00	8.89E-03	4.45E-06	2.22E-09
Sodium	1.32E+02	1.15E+01	8.60E+00	1.52E+02	1.30E+02	6.61E-01	3.31E-04	1.65E-07
Strontium	8.25E-02	1.09E-02	8.09E-03	1.01E-01	9.00E-02	6.22E-04	3.11E-07	1.55E-10
Thallium	1.01E+00	8.87E-02	6.61E-02	1.17E+00	1.00E+00	5.08E-03	2.54E-06	1.27E-09
Titanium	2.47E-01	3.25E-02	2.42E-02	3.04E-01	2.70E-01	1.86E-03	9.30E-07	4.65E-10
Uranium	3.07E-01	4.03E-02	3.00E-02	3.77E-01	3.30E-01	2.31E-03	1.15E-06	5.77E-10
Zirconium	4.51E-01	5.93E-02	4.41E-02	5.54E-01	4.90E-01	3.39E-03	1.70E-06	8.49E-10
Hydroxide (OH-)	4.93E-06	4.32E-07	3.22E-07	5.69E-06	5.00E-06	2.48E-08	1.24E-11	6.19E-15
Nitrite (NO2-)	2.96E-06	2.60E-07	1.94E-07	3.42E-06	3.00E-06	1.49E-08	7.44E-12	3.72E-15
EDTA(-4)	4.53E-01	5.95E-02	4.43E-02	5.57E-01	4.90E-01	3.41E-03	1.70E-06	8.52E-10
HEDTA(-3)	3.56E-01	4.68E-02	3.49E-02	4.38E-01	3.90E-01	2.68E-03	1.34E-06	6.70E-10
Citric(-3)	2.32E+00	3.05E-01	2.27E-01	2.85E+00	2.50E+00	1.75E-02	8.73E-06	4.37E-09
Oxalic(-2)	3.24E+00	4.26E-01	3.17E-01	3.98E+00	3.50E+00	2.44E-02	1.22E-05	6.10E-09
Formic(-)	3.31E+00	4.35E-01	3.25E-01	4.07E+00	3.60E+00	2.50E-02	1.25E-05	6.24E-09
Ammonia	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RADIOACTIVE CONTAMINANTS	[nCi/min]	[nCi/min]	[nCi/min]	[nCi/min]	[nCi/L]	[nCi/min]	[nCi/min]	[nCi/min]
C-14	4.70E+02	4.12E+01	3.07E+01	5.42E+02	4.80E+02	2.36E+00	1.18E-03	5.90E-07
Co-60	1.60E+06	2.10E+05	1.57E+05	1.97E+06	1.70E+06	1.20E+04	6.02E+00	3.01E-03
Sr-90	3.56E+09	4.68E+08	3.49E+08	4.38E+09	3.90E+09	2.68E+07	1.34E+04	6.70E+00
Y-90	3.56E+09	4.68E+08	3.49E+08	4.38E+09	3.90E+09	2.68E+07	1.34E+04	6.70E+00
Tc-99	4.44E+05	3.90E+04	2.90E+04	5.12E+05	4.50E+05	2.23E+03	1.12E+00	5.58E-04
I-129	4.38E+01	0.00E+00	0.00E+00	4.38E+01	3.90E+01	0.00E+00	0.00E+00	0.00E+00
Cs-137	6.69E+08	5.86E+07	4.37E+07	7.71E+08	6.80E+08	3.36E+06	1.68E+03	8.40E-01
mBa-137	6.33E+08	5.55E+07	4.13E+07	7.30E+08	6.50E+08	3.18E+06	1.59E+03	7.95E-01
Pu-239	4.84E+06	6.36E+05	4.74E+05	5.95E+06	5.30E+06	3.64E+04	1.82E+01	9.11E-03
Pu-240	4.84E+06	6.36E+05	4.74E+05	5.95E+06	5.30E+06	3.64E+04	1.82E+01	9.11E-03
Am-241	1.89E+06	2.48E+05	1.85E+05	2.37E+06	2.10E+06	1.47E+04	7.11E+00	3.56E-03

TOXIC AIR POLLUTANT (TAP) EMISSIONS

	Acceptable Source Impact Level (ASIL)	WAC 173-460 Small Quantity Emission Rates	Unabated emissions by mass flow	W-320 abated emissions by mass flow	W-320 abated emissions by concentration
	[µg/m^3]	[lb/yr]	[lb/hr]	[lb/hr]	[µg/m^3]
Aluminum	6.7	0.02	9.07E-04	8.06E-15	9.35E-09
Antimony	1.7	0.02	3.04E-05	2.72E-16	3.15E-10
Arsenic	0.00023	N/A	3.06E-06	2.73E-17	3.17E-11
Barium	1.7	0.02	2.76E-06	2.46E-17	2.86E-11
Boron	3.3	0.02	2.76E-06	2.46E-17	2.86E-11
Calcium	17	0.2	1.99E-05	1.77E-16	2.06E-10
Cerium	N/A	N/A	5.14E-06	4.59E-17	5.33E-11
Chromium	0.000083	N/A	1.37E-05	1.23E-16	1.42E-10
Copper	3.3	0.02	2.35E-06	2.10E-17	2.43E-11
Iron	3.3	0.02	6.46E-04	5.77E-15	6.70E-09
Lead	0.5	N/A	2.62E-05	2.34E-16	2.71E-10
Magnesium	33	0.6	4.39E-06	3.92E-17	4.55E-11
Manganese	0.4	0.02	3.53E-05	3.15E-16	3.66E-10
Neodymium	N/A	N/A	4.39E-06	3.92E-17	4.55E-11
Phosphorus	N/A	N/A	7.64E-05	6.82E-16	7.92E-10
Selenium	0.67	0.02	1.10E-05	9.81E-17	1.14E-10
Silicon	N/A	N/A	2.04E-04	1.82E-15	2.12E-09
Silver	0.033	0.02	1.65E-05	1.47E-16	1.71E-10
Sodium	6.7	0.02	1.23E-03	1.09E-14	1.27E-08
Strontium	N/A	N/A	1.15E-06	1.03E-17	1.19E-11
Thallium	0.33	0.02	9.41E-06	8.40E-17	9.75E-11
Titanium	N/A	N/A	3.45E-06	3.08E-17	3.57E-11
Uranium	0.67	0.02	4.28E-06	3.82E-17	4.43E-11
Zirconium	17	0.2	6.29E-06	5.62E-17	6.52E-11
Hydroxide (OH-)	6.7	0.02	4.59E-11	4.10E-22	4.75E-16
Nitrite (NO2-)					
EDTA(-4)	N/A	N/A	6.32E-06	5.64E-17	6.55E-11
HEDTA(-3)	N/A	N/A	4.97E-06	4.44E-17	5.15E-11
Citric(-3)	N/A	N/A	3.24E-05	2.89E-16	3.35E-10
Oxalic(-2)	N/A	N/A	4.52E-05	4.04E-16	4.68E-10
Formic(-)	N/A	N/A	4.62E-05	4.13E-16	4.79E-10
Ammonia	1.00E+02	2	5.88E-03	5.88E-03	6.83E+03

RADIONUCLIDE EMISSIONS

	Unabated emissions by activity	W-320 abated emissions by activity	W-320 abated emissions by concentration	DCG values given in DOE Order 5400.5	W-320 abated emissions as a DCG ratio	DAC values given in DOE Order 5480.11	W-320 abated emissions as a DAC ratio
	[Ci/yr]	[Ci/yr]	[µCi/m^3]	[µCi/ml]		[µCi/ml]	
C-14	1.74E-05	1.55E-16	4.53E-17	5.00E-07	0	9.00E-05	0
Co-60	8.87E-02	7.92E-13	2.31E-13	8.00E-11	0	1.00E-08	0
Sr-90	1.98E+02	1.76E-09	5.15E-10	9.00E-12	0	2.00E-09	0
Y-90	1.98E+02	1.76E-09	5.15E-10	1.00E-09	0	2.00E-07	0
Tc-99	1.64E-02	1.47E-13	4.29E-14	2.00E-09	0	3.00E-07	0
I-129	1.94E-05	1.94E-05	5.67E-06	7.00E-11	0.08	4.00E-09	0.0014
Cs-137	2.47E+01	2.21E-10	6.45E-11	4.00E-10	0	7.00E-08	0
mBa-137	2.34E+01	2.09E-10	6.10E-11	3.00E-08	0	7.00E-08	0
Pu-239	2.68E-01	2.40E-12	6.99E-13	2.00E-14	0	2.00E-12	0
Pu-240	2.68E-01	2.40E-12	6.99E-13	2.00E-14	0	2.00E-12	0
Am-241	1.05E-01	9.36E-13	2.73E-13	2.00E-14	0	2.00E-12	0
				DCG total =	0.08	DAC total =	0.0014

EXPIRES 7-21-98

1 W-320 PROJECT TURNOVER PER ECN W-320-785

BA LORENZO
R.F. MEISINGER
D A LAUHALA
D L FORT
C E NORTON
C.T. LI, P.E.

U.S. DEPARTMENT OF ENERGY
RICHLAND OPERATIONS OFFICE
ICF KAISER HANFORD COMPANY

ENVIRONMENTAL
TANK 241-C-106 VENTILATION
MASS BALANCE

W-320 TANK 241-C-106 SLUICING

F 241-C 7000 H-2-818478 1

NONE ER4319 SHEET 3 OF 3

B818478C WIN95:ACD2:12.0:SS

PLOT SCALE: 1=1 KENCAD

3 REQUIREMENTS

3.1 Equipment Description: The skid mounted ACT shall include an electric heating system, 2 stages of HEPA filters, 3 HEPA filter test sections, exhaust fan and motor, variable speed drive (the variable speed drive will be mounted at a separate location), and associated housings, dampers, valves, instruments, insulation, jackets, supports, and controls, etc, to form a working unit. The skid shall have a main electrical supply (fed from the Buyer's 480 V ac, 3-phase source), via a main disconnect switch. The power shall then be distributed to supply the heater circuit (see 3.1.1) and the minipower center (see 3.1.13). A separate Buyer's 480 V ac source will supply power to the variable speed drive. The ACT shall meet the design requirements of ASME N509 (non-ESF) as detailed in the following paragraphs and the pressure decay test and in-place DOP test requirements of ASME N510, Sections 7 and 10. Interpretations and clarifications to ASME N509 are as given in Table A. Total leakage rate of ACT including fan shaft seal shall not exceed 10 ft^3/min at -50 inH_2O test pressure. The equipment configuration and dimensional requirements shall be as shown in Sketch ES-1. The equipment must be capable of supporting the stack and monitoring components provided by the Buyer as shown on Sketch ES-1.

3.1.1 Electric Heater: Heating elements shall be staggered to prevent thermal and moisture stratification. The electric heating system will normally operate with a constant inlet condition of 40°F air saturated with water vapor, and shall be required to provide a continuous minimum leaving temperature of 53°F at 60% relative humidity. The normal range of airflow will be 180 to 360 standard ft^3/min. Abnormal operating conditions may result in an inlet condition of 120°F air saturated with water vapor at a flow of 360 standard ft^3/min. Under these conditions, the leaving air temperature must be raised to 139°F in order to reduce the relative humidity to 60%. The air temperature shall not be continuously above 150°F. The heater coil shall have a zero-crossover fired silicon controlled rectifier (SCR) power controller to modulate heating capacity to reduce the relative humidity below 100% (see Sketch ES-3). A disconnecting means shall be provided for the electric heater. Heater shall be 480 V, 3-phase, 60 Hz supplied from the skid main electrical supply. Electrical design and installation work shall be in accordance with NFPA 70. The heater shall contain an internal high-high temperature switch, manual cutout switch, pneumatic type low flow switch (sail type not acceptable), and contactors. The heater shall be designed for outside use. The heater shall be shut down automatically when the fan FN-1362 is not running or trips off (interlock #14). See Data Sheet Y-324 for the associated temperature controller.

3.1.2 HEPA Filter Housings: Housings shall be bag-in, bag-out style, constructed of ASTM A 240, Type 304 Series stainless steel. Filter elements shall have 180 to 1000 ft^3/min capacity, and shall be in accordance with DOE/DP/STD-0005-91. Frame material shall be ASTM A 240, Type 304 Series stainless steel. Filters shall have neoprene gaskets, and be suitable for continuous service at 150°F, in high humidity. Pre-filters are not required. Seller shall provide filters for testing at Seller's facility. Owner will provide filters for installed operation. Service shall be from the right hand side (facing downstream).

3.1.3 HEPA Filter Test Sections: Test sections shall be installed upstream and downstream of each stage of HEPA filters to allow in-place efficiency testing of each stage as well as both stages combined in accordance with ASME N510. Material shall be ASTM A 240, Type 304 stainless steel. Service shall be from the right hand side (facing downstream).

3.1.4 Centrifugal Exhaust Fan: Construction and descriptive nomenclature shall be in accordance with AMCA 99. Performance shall be certified, and in accordance with AMCA 210. The fan shall bear the AMCA certified ratings seal or label. Design features and documentation shall be in accordance with ASME N509, Section 4.2 and 4.14. Fan design conditions are as follows:

3.1.4.1 Normal operation: 230 ft^3/min air flow at 53°F and 60% relative humidity, with a range of 180 standard ft^3/min at 19 inH_2O to 360 standard ft^3/min at 42 inH_2O.

3.1.4.2 Abnormal operation: 360 standard ft^3/min at 139°F and 60% relative humidity, maximum temperature could reach 150°F.

3.1.4.3 Fan material shall be 300 series stainless steel.

3.1.4.4 The shaft seal shall limit leakage to 1 ft^3/min maximum at operating conditions. Provide fan with plugged drain connection and bolt-on cleanout panel. Bearings shall be grease lubricated, anti-friction type with grease extension fittings. Bearing shall have 100,000 hour L10 minimum life in accordance with AFBMA 9 or 11. The fan shall be furnished complete with belt drive or coupling drive, motor, and vibration isolators, and shall have protective guards. Electric motor shall be TEFC, and be suitable for electronic variable speed control, and shall meet the requirements of Motor Data Sheet M-01.

3.1.4.5 The fan wheel shall be statically and dynamically balanced as an assembly.

3.1.4.6 The shaft shall be sized so that the first critical speed of the shaft and impeller assembly is 125% minimum of the maximum fan operating speed.

3.1.5 Insulation and Jacket: The unit shall be insulated in accordance with Sketch ES-1 with a 1-inch thick material having a "k" factor of 0.5 $Btu \cdot in/hr \cdot ft^2 \cdot °F$ maximum. Insulation shall have a stainless steel or aluminum weatherproof jacket on housings, ductwork, and test sections. Other insulated surfaces may be covered with the weatherproof jacket or may have a closed-cell, nonporous, weatherproof exterior surface. Insulation shall be free of chlorinated halogenated hydrocarbons as required for compatibility with stainless steels.

3.1.6 Variable Speed Drive: A solid-state, high performance variable speed drive (VSD) for use with the electric motor specified in 3.1.7 shall be provided. The VSD shall provide a continuous duty variable 3-phase output at rated power. The VSD shall vary the frequency and voltage at the input to the motor in order to obtain the desired fan speed. The VSD shall include a NEMA contactor in series with the VSD output to remove power from the drive motor.

3.1.6.1 The VSD shall be furnished by a reliable supplier who has been actively manufacturing VSDs for 2 years minimum. The VSD shall be from the Westinghouse Accutrol series, General Electric AF-300 series, Allen Bradley 1300 series, an Eaton Corporation Dynamatic Model AF-5000+, or a Buyer approved substitute. Drive unit shall conform to applicable NFPA 70 requirements and be labelled in accordance with NFPA 70, article 430-8 and NEMA MG-1.

3.1.6.2 The VSD shall be controlled by a 4 to 20 mA signal that delivers pressure information. Four milliamps corresponds to -5.9 inH_2O. Twenty milliamps corresponds to -0.3 inH_2O. The fan speed will vary to maintain pressure within this range.

3.1.6.3 Minimum VSD efficiency at 100% speed and 100% torque shall be 95%.

3.1.6.4 VSD input power will be 480 V, 3-phase, 60 Hz from a separate power source than the rest of the skid. Input power factor shall be limited to 0.95 or higher. Drive shall be able to operate with input voltage variations of ±10% of nominal. Drive shall provide "soft start" capabilities. Drive shall have a minimum of a 3-cycle "ride through" in the case of momentary power interruptions. Surge suppression shall be provided to protect drive from power fluctuations.

3.1.6.5 Operation will be inside a climate controlled secondary enclosure provided by the Buyer, that will maintain ambient air temperature within a range of 30 to 100°F.

3.1.6.6 The VSD shall be enclosed in a NEMA ICS 6, Type 12 free-standing enclosure with hinged front doors for front access only. The enclosure shall be constructed of a minimum of 12-gage steel. Maximum enclosure dimensions shall be 92 inches high by 37 inches wide by 24 inches deep. The VSD enclosure will be mounted by the Buyer, separate from the exhaust skid, approximately 300 feet away in a small, climate controlled, Buyer supplied secondary enclosure. A light shall be included in the enclosure cabinet for maintenance purposes. Adequate conduit space shall be provided, in accordance with NFPA 70, for bottom entry installation of power, control and instrument conduits. Physical and electrical isolation shall be provided between power, control and instrument circuits. The enclosure shall have lifting lugs or rings.

3.1.6.7 The VSD shall include the following minimum protection features (ANSI device numbers are shown in parenthesis). VSD trips on any of these functions shall be indicated locally, and it shall be possible to determine the type of drive trip.

a. Static instantaneous overcurrent (50) and overvoltage trip (59).

b. Thermal overload relays (49).

c. Motor inverse time overload protection (51).

d. Phase sequence (46), open conductor (46), phase balance (46), and undervoltage protection (27). The VSD shall be protected from component failure if phases are improperly connected at the input or output power terminals.

e. Line to Line, or line to ground faults (64).

f. Sustained overfrequency at drive output (81).

g. Circuit breaker (3 phase) on line input (52).

3.1.6.8 Diagnostics and fault conditions: The following conditions shall cause an orderly VSD shutdown. It shall be possible to determine the cause of shutdown after the event.

a. Loss of input power.

b. Control power failure.

c. Undervoltage/sustained overvoltage.

d. Electronic overtemperature.

e. Sustained torque overload.

A set of Form "C" contacts shall be available for Buyer's use to remotely deliver "drive failure" status.

3.1.6.9 Control and monitoring: The control of the fan motor shall be available both locally (at the VSD) and at a remote control panel located approximately 1100 feet from the drive unit. Provide transmitters, local switches, and local indication. Remote switches, annunciators, and displays will be provided by the Buyer. A common area of termination within the drive enclosure shall be provided for Buyer's connections for control and monitoring features. A single indicator to display more than one of the listed items is acceptable. Terminal blocks shall be Allen Bradley series 1492-CA1 or a Buyer approved substitute. Physical and electrical isolation shall be provided between power terminals, control terminals and instrument signal terminals. Terminals shall be labeled for their functions. The following are minimal acceptable monitoring and control functions:

a. Local and remote smooth, continuous speed control to within ±3% of maximum rev/min via a 4 to 20 mA loop. Local control shall be by rotary potentiometer.

b. Local and remote drive output frequency via a 4 to 20 mA loop.

c. Drive shall be capable of starting and operating without a motor connected.

d. Local and remote drive running indication (drive in run mode).

e. Local and remote "Drive Power Available" indication.

f. Local and remote drive failure indication.

g. Local and remote start/stop control. A red oiltight mushroom head pushbutton shall be provided to locally shut down the drive.

h. Local display of motor voltage and motor current and access for remote display of motor current for Buyer's use, via a 4 to 20 mA current loop.

i. Thermal overloads shall be provided to remove current from the motor in the event of overtemperature. The thermal overloads shall be installed near the motor.

j. Provide terminals for an external trip signal to the drive unit. The trip signal shall open the series contactor, interrupting power to the drive motor.

k. One normally open and one normally closed auxiliary contact are required to indicate status of the series contactor ("motor power available").

l. Frequency accuracy shall be maintained to within 0.5% of setpoint.

m. Drive unit shall be able to start onto a rotating motor (any speed or direction) and accelerate to the selected motor speed without tripping or component loss.

n. Parameters used for drive setup stored within VSD memory shall be retained in this memory in the event of drive power loss. It shall not be necessary to reconfigure the VSD.

o. Adjustable timed deceleration and acceleration.

p. Include an RS232 or RS422 communications port for use in control, troubleshooting, and reconfiguration of the drive. It shall be possible to read and write drive parameters through the port. This communication shall be with ASCII commands from an IBM compatible personal computer. A listing of the command set shall be provided.

q. The following equipment shall be locally mounted at the drive cabinet door:

1) A light to indicate that the drive is in run mode.

2) Input circuit breaker switch with lock-off provision.

3) VSD fault reset button.

4) Local/remote keylock selector switch.

5) Fan motor run time hour meter.

6) Local alphanumeric display to monitor motor parameters including troubleshooting parameters.

7) Push-to-test button for indicating lights.

8) Rotary potentiometer for speed control.

3.1.6.10 Harmonic distortion: Harmonic distortion introduced to the power system from the drive units shall be limited to no more than 3% total harmonic distortion (THD) as measured on the 480 V ac supply bus as defined in IEEE 519. Include an isolation transformer (dry type) or other means, if necessary, to limit distortion and prevent damage to Buyer's equipment.

3.1.6.11 Startup: Materials shall be provided to enable the Buyer or Buyer's agent to startup the VSD without the presence of a manufacturer's representative. However, if the assistance of a manufacturer's representative is necessary for initial startup of the VSD, these services shall be included with the package.

3.1.7 Electric Motor: Motor shall meet NEMA MG 1 requirements and shall be suitable for the characteristics specified on Data Sheet M-01. Motor horsepower shall be determined so that the motor is non-overloading when operating at any point on the system performance curve. Motor size shall be selected to give the required horsepower and starting torque with a sufficient factor of safety to prevent overloading. Motor leads (pigtails) shall be adequately sized in accordance with NFPA 70. The motor shall include grounding provision within the terminal box.

3.1.7.1 Derating for variable speed drive use shall be a consideration in determining motor size in accordance with NEMA MG-1. Select a motor size sufficient to meet the above conditions.

3.1.7.2 The duty rating, shaft rotation, and frame size shall be in accordance with NEMA standards.

3.1.7.3 Label motor terminals for their designated function. Label motor phase conductors A, B, and C.

3.1.7.4 Seller shall provide the recommended size for the feeder cable that the Buyer will furnish for the feeder from the VSD to the motor. Recommendation shall include considerations for length, frequency, and ampacity.

3.1.7.5 Motor shall include lifting lugs or eye bolts.

3.1.8 Valves: Valves shall be a bubble tight, isolation type, constructed of 300 Series stainless steel, all-welded design. Blades shall have closed cell EPR or Viton gaskets. Valves shall have locking quadrants.

3.1.9 Flexible Connections: Flexible connections shall be molded, reinforced synthetic rubber, capable of withstanding the full fan static pressure. Connections shall be flanged, ASME B16.5, with gaskets to minimize leakage.

3.1.10 Instrumentation: See Sketches ES-2 and ES-3, and the Data Sheets.

3.1.10.1 Instruments shall be mounted in a manner that is accessible to maintenance personnel without obstruction and without the need for secondary platforms. Installed instruments shall not obstruct access/ removal of ACT equipment.

3.1.10.2 Instruments which must be protected from the environment shall be mounted within a NEMA Type 3R enclosure with ventilation louvers and dust filters. Enclosure maximum envelope dimensions shall be 72 inches high by 48 inches wide by 18 inches deep.

3.1.10.3 Instrument taps and isolation valves for temperature elements, and pressure differential indicators and transmitters, shall be installed on the ACT, as shown on Sketch ES-2. They shall be installed in a manner to permit removal of thermowells and valves without removal of, or damage to, ACT insulation. Pressure differential indicators and transmitters shall have 5-valve manifolds for calibration.

3.1.10.4 Pneumatic sensing lines shall be installed without traps in the lines. Lines that slope down from instrument to process tap.

3.1.10.5 Instruments shall be suitable for the environment to which they are subjected, or be protected by being mounted within a suitable enclosure.

3.1.11 Terminations: Provide a minimum of 2 separate terminal blocks for 4 to 20 mA signals and switched signal lines in a NEMA ICS 6, Type 4 enclosure that is accessible to customer interface wiring. Required power to instrumentation shall be routed to a Seller supplied NEMA ICS 6, Type 4 termination box.

3.1.12 Wiring Access and Separation: Conduits shall enter the skid from below. Provide adequate openings for required power, control and instrumentation conduits. Electrical and physical separation of power, control and instrumentation wiring shall be maintained throughout wiring on the skid.

3.1.13 Mini-Power Center: Provide a skid mounted mini-power center to supply lighting, outlets, and miscellaneous loads. Equipment shall receive 480 V ac from the skid main electrical supply, and deliver 120/240 V ac single-phase power for skid use. The estimate of required capacity is 5 kVA. This equipment shall be mounted on the skid near the disconnect switches and shall be furnished by a manufacturer which has been supplying this type of equipment for at least 2 years. Equipment shall be suitable for indoor or outdoor use. Equipment shall be Westinghouse Style No. P48G11S05P, Square D Catalog No. MPZ5S40F or a Buyer approved substitute.

3.1.14 Circuit Interrupt: Provide an outdoor ground fault circuit interrupt protected duplex outlet mounted on the skid for Buyer's maintenance use. This outlet shall be supplied power from the skid's mini-power center. This outlet shall be on it's own circuit to isolate it from other skid loads in the event of a fault.

3.1.15 Skid Lighting: Provide outdoor lighting on the skid to provide visibility for operation of disconnect switches and mini-power center breakers. Lighting shall be supplied from the skid's mini-power center. Overcurrent protection shall isolate lighting from other loads in the event of a fault.

3.1.16 Disconnect Switches: Provide for the fan motor, 480 V ac main power supply, and heating elements located on the skid. Switches shall be grouped in a common area for ready access by maintenance personnel, and have provisions for padlocking. Switches shall be installed within NEMA ICS-6 Type 3 or 4 enclosures.

3.1.17 Label electrical and instrument wires, terminals, terminal strips, and terminal boxes. Labels shall match designations on drawings.

3.1.18 Electrical components shall be listed in the UL Electrical Appliance and Utilization Equipment Directory, and labelled for the intended purpose, where such products are available. When UL listed components are not available, products tested and certified by another agency are acceptable, provided that the agency has been qualified for product testing in accordance with a National Code or Standard, and provided that the testing is also accomplished in accordance with a National Code or Standard.

3.1.19 Design life shall be 2 years minimum of continuous operation. Materials that have a standard design life greater than 2 years shall not be degraded to meet these minimum requirements. Design life is exclusive of Seller testing, shipping, and storage.

3.1.20 Electrical Heat Tracing: Install freeze protection type electrical heat tracing on pipes and tubing, as shown on Sketch ES-2, in accordance with the following:

a. Power source shall be 120 V ac, 1 phase from the Seller furnished Mini-Power Center. Heat trace branch circuit breakers shall be 20 amp maximum.

b. Seller is responsible for performing calculations necessary to determine heating cable power output rating consistent with the insulation type and thickness to be furnished. Submit the calculations for Buyer's vendor information files.

c. Provide and install thermal insulation and suitable outer protective jacket on all pipes and/or tubing.

d. Provide self-limiting electrical heat tracing cable, ambient sensing thermostat(s), power connection kits, voltage indication lights, end termination kits, plus all other accessories and materials necessary to install complete, functional electrical heat tracing systems.

e. Self-limiting heating cable shall be of high quality and shall have an outer tinned copper braid shield with polyolefin outer jacket.

f. Thermostat shall be variable type and set to turn on at 40°F.

3.2 Environmental Conditions: The Air Cleanup Train will be located outside at an elevation of 700 feet above sea level. Equipment must operate without failure at ambient conditions of -20 to 115°F, and 0 to 100% relative humidity, in rain, sleet, snow, extreme blowing dust, and intense solar radiation.

3.3 Structural Criteria

3.3.1 Structural steel supports and components shall be fabricated in accordance with the AISC ASD, S329 and S335, and the ICBO UBC.

3.3.1.1 The skid shall have a heavy duty, structural steel base that provides structural integrity for the entire ACT system assembly. The arrangement of longitudinal and cross beams shall provide the required strength and stiffness for the base, and support for equipment installed.

3.3.1.2 Deflection of the entire base shall be minimized so as not to cause damage to container elements or equipment installed. Base construction shall take into account loads imposed on the structure during seismic, lifting, shipping, etc. Permanent deformations to the base shall not impair performance of the structure.

3.3.1.3 Lifting attachments for the skid shall be engineered with a safety factor of 5. The manufacturers' name or identification mark shall be forged in raised letters on the lifting attachment. Include any special instructions needed for a safe lift along with manufacturers' data on lifting attachment.

3.3.1.4 The base shall be constructed and detailed for attachment to a concrete pad. Anchorage locations shall be provided.

3.3.1.5 The base and stack support shall be fabricated to handle static and dynamic loads imposed by the Buyer provided 14-foot long upper stack and rain cap assembly. The Buyer provided upper stack section shall be subjected to the loading stated in 3.3.2 and shall transmit those loads to the Seller's lower stack section. Thus, the lower stack section shall be fabricated to support the loads imposed by the upper section. See Sketch ES-1.

3.3.2 Structural Loads: Loads shall include live, dead, wind, snow, sleet, and seismic loads, including normal, operating loads. Other loads, either static or dynamic shall be considered auxiliary loads. Equipment function shall be maintained during load conditions.

3.3.2.1 Wind loads: Loads shall be in accordance with ASCE 7, Section 6, with wind assumed to come from any horizontal direction. Fabrication of the structure and components shall be based on the following:

a. Basic wind speed: 70 mi/h.

b. Importance factor: I = 1.07.

c. Exposure category: C.

3.3.2.2 Snow loads: In accordance with ASCE 7, Section 7. Use 20 lb/ft^2.

3.3.2.3 Seismic loads: Seismic loads shall be in accordance with the ICBO UBC, Sections 2336 and 2337 (Zone 2B), where Fp = 0.375 Wp.

a. The lateral force, Fp shall be distributed in proportion to the mass distribution of the element or component. The distributed forces shall be applied so that the most critical loadings result. These loadings shall be used in the fabrication of the elements or components and anchorages.

b. Orthogonal effects, as described in the ICBO UBC, shall be satisfied by designing such elements for 100% of the seismic forces in one horizontal direction plus 30% of the seismic forces in the perpendicular horizontal direction.

3.4 Material

3.4.1 Materials shall be new, and conform to a national standard such as ASTM or ASME. Pressure boundary material shall be in accordance with ASME N509, Sections 5.6 and 5.10, as applicable.

3.4.1.1 Structural steel shapes, plate, and bars: ASTM A 36.

3.4.1.2 Stainless steel sheet: ASTM A 240.

3.4.1.3 Floor plate for skid base: ASTM A 786, using ASTM A 36 material. Diamond Tread.

3.4.1.4 Bolts: ASTM A 325, Type 1 or 2, plain (noncoated), or ASTM A 193, as applicable.

3.4.1.5 Nuts: ASTM A 563, Grade C, or ASTM A 194, Grade 8F, plain, heavy hex, as applicable.

3.4.1.6 Washers: ASTM F 436, circular.

3.4.1.7 Metal Grating: FS RR-G-661, Type I, Class 1, Material S, hot-dip galvanized. Grating shall be plain surface type with end banding bars. Provide manufacturer's standard clips for attachment to framing.

3.4.2 Pressure boundary materials in contact with the air stream shall be 300 series stainless steel unless noted otherwise in this Specification.

3.4.3 Tape and adhesives leachable chloride content shall not exceed 15 ppm, and leachable fluoride content 10 ppm; 3M Company preservation sealing tape No. 481, 9 mil thick, or Kendall Company Polyken Division No. 226. In addition, materials which contact stainless steel during fabrication and shipping shall not exceed these limits.

3.5 Fabrication and Assembly

3.5.1 Base Construction: The base shall be constructed from fabricated hot or cold rolled or cold formed steel shapes, welded on suitable jigs or alignment beds. Welding shall be in accordance with AWS D1.1.

3.5.2 Exhaust Skid Ventilation Air Clean-up Train: Pressure boundary and structural welding shall be in accordance with ASME N509, Section 7.3. Sheet metal welding shall be in accordance with AWS D9.1 (as referenced by ASME AG-1).

3.5.3 Color Coding and Marking

3.5.3.1 Provide equipment numbering, flow arrows, and other labeling and color coding in accordance with WAC 296-24, Part B-2.

3.5.3.2 Safety Color Coding for Marking Physical Hazards:

a. Safety color coding shall be used to ensure ready identification of physical hazards, signs and markers.

b. Safety signs, objects and locations shall be adequately illuminated to permit positive identification of the color and hazard or situation. Illumination provided shall not distort the color and therefore the message the color identification signifies.

c. The following major colors and color combinations shall be used for safety color code marking of physical hazards and piping systems.

1) Orange - Designates parts of equipment that may cut, crush or otherwise injure.

2) Yellow or Yellow-Black combinations - Designate caution for hazards such as striking against, tripping, bumping, and "CAUTION" tags.

3.5.3.3 Provide caution signs for automatic start equipment, hot surfaces and other similar dangerous conditions.

3.5.4 Painting and Corrosion Protection

3.5.4.1 Surface Preparation: Suitable surface preparation, avoidance of electromechanical corrosion and coating procedures shall be given special consideration.

3.5.4.2 Provide general corrosion protection for dissimilar metal connections.

3.5.4.3 Following skid assembly apply one coat of Primer Amerlock No. 400, beige and a finish coat 2-3 mils thick of Amercoat 450 HS, beige in accordance with manufacturer's instructions.

3.5.4.4 Structural steelwork and miscellaneous metal: Fabricated parts shall be blast cleaned and painted with an inorganic zinc-based primer to a dry film thickness of 2 mils minimum. Particular care shall be taken to completely clean and protect voids and inner corners of the structure which become inaccessible after assembly.

3.5.4.5 Drill holes and welds: Welds and holes made during assembly or installation of equipment shall be carefully cleaned, primed, and painted before shipment. Bare material shall not be left in either the structure or equipment when the skid is finished.

3.5.4.6 Base underside: Paint the underside of the structure.

3.5.4.7 Do not paint stainless steels.

3.5.5 Grinding or machining of stainless steel shall be accomplished with tools specifically allocated for use on stainless steel only. Use of grinding compounds containing halogens is strictly prohibited. Wire brushing of stainless steel shall be done with stainless steel brushes that are new or have not been used on material other than stainless steel.

3.6 Nameplates

3.6.1 Provide separate, permanent stainless steel nameplates for the exhaust skid system, the fan and motor drive assembly, and the HEPA filter housings. The exhaust skid nameplate shall be installed near a lifting attachment point. The fan assembly nameplate shall be installed in a location where it is accessible. The HEPA filter housing nameplates shall be installed so that they are visible with the insulation and weather jackets in place. The motor nameplate shall be in accordance with NEMA MG-1. Nameplate characters shall be 1/4-inch high, etched or stamped.

3.6.2 The skid system nameplate shall show the following:

a. Name: VENTILATION EXHAUST SKID

b. Purchase order number

c. Project number

d. Total weight (in pounds)

3.6.3 The fan assembly nameplate shall show the following:

a. Equipment number (as shown on the motor data sheet)

b. Fan serial number

c. Air flow range in ft^3/min

d. Fan total dynamic head in inH_2O

e. Fan materials (scroll, wheel, housing, shaft)

f. Direction of rotation

3.6.4 Provide a plastic nameplate in accordance with 3.6.5 for the VSD which shall show:

a. VARIABLE SPEED DRIVE.

b. Equipment number (as shown on the sketches).

3.6.5 Other equipment and instrument nameplates shall be provided for equipment, instruments, sample ports, and injection ports.

3.6.5.1 Permanent laminated plastic, 1/16-inch thick with white surface and black core.

3.6.5.2 Manufacturer's standard equipment nameplates may be used instead of those specified herein, if they display the required information, and are equivalent in quality and legibility. They need not be of the same material, or have the same form of imprinting.

3.6.5.3 Nameplate features

a. Blanks: Select sizes appropriate for required characters and legends. Smooth edges and bevel 1/32-inch at 45 degrees.

b. Characters: Use 3/16 to 5/16-inch characters for equipment names, and 3/32 to 3/16-inch characters for other information. Engrave sharp and clear.

c. Legends: Provide the following information. For equipment names use the generic/functional designations shown on the Drawings.

1) Equipment name.

2) Manufacturer's identification.

3) Manufacturer's model or assembly number.

4) Serial number.

3.6.5.4 Make stainless sheet steel nameplates for equipment items that do not have surfaces suitable for attachment of permanent plastic nameplates. Make nameplates when cylindrical surfaces of adequate size are available. When not, make nametags and attach with 20 gage stainless steel wire. Provide the information required in 3.6.5.3c.

3.7 Inspection

3.7.1 Perform weld inspection in accordance with AWS D1.1 or ASME N509 as applicable.

3.7.2 Welding procedure specifications, procedure qualification records, and welder performance qualifications shall be made available to the Buyer on request.

3.7.3 Welds for lifting attachments shall be 100% visually inspected and 100% magnetic particle inspected. Document results of inspection.

3.7.4 Inspect the skid assembly before shipment for external identification as specified in 3.6.

3.8 Testing

3.8.1 After final assembly and adjustment, the skid assembly shall be subjected to a series of tests using air with characteristics similar to the normal operating conditions specified in 3.1.1. Minimum data recorded for each test shall be as specified in 3.8.2.3. Certain tests will be witnessed by the Buyer. Notify the Buyer 2 weeks before testing.

3.8.2 The variable frequency drive shall be tested as specified and shall be given complete factory tests to simulate operation including verifying acceptable load torque availability at starting. The Seller shall provide certified tests results documenting the following tests.

3.8.2.1 Run in Test: A 24 hour continuous run test of the fan assembly and the variable speed drive shall be made at maximum required flow, at the highest temperature specified in 3.1.1. Data shall be recorded at one hour intervals. A test report shall be prepared and certified.

a. The vibration limit shall be a peak velocity of 0.10 in/s. The double amplitude radial displacement, measured on the bearing caps at design speed, shall be 0.5 mills maximum, as measured with a meter filtered to the fan rotational speed.

b. Before taking measurements, the fan shall be operated at design speed until the bearings reach a stable equilibrium temperature.

c. The residual unbalance shall be documented in accordance with ANSI S2.19.

3.8.2.2 Performance Test of Fan and VSD: Eight tests shall be made to plot the performance curves at equal intervals from 20 to 100% of fan rated speed. The test report shall be provided with final data submittal. The test report shall contain fan performance curves, which shall include suction pressure at shut off. Include tests of supplied instrumentation. Transmitters shall be calibrated and tested for operating conditions. Tests shall be conducted over the temperature range specified in 3.1.1. A test report shall be prepared and certified.

3.8.2.3 The minimum test data to be recorded for the continuous run test and the performance tests is:

<u>Fan</u>

r/min
actual ft^3/min
Static pressure differential across the fan (inH_2O)
Efficiency
BHP
Bearing temperature (°F)
Vibration at bearing caps

Motor & VSD
- Input Voltage (VA-B, VB-C, VC-A)
- Output Voltage (VA-B, VB-C, VC-A)
- Motor input frequency
- Input Amperage (IA, IB, IC)
- Output Amperage (IA, IB, IC)
- Motor Insulation temperature (°F)
- Input Power factor
- Output Power factor
- Input voltage (VA-B, VB-C, VC-A)
- Input current (IA, IB, IC)
- Input kW

Inlet to Skid, Outlet of Heater, and Outlet of Fan
- Temperature (°F)
- Relative Humidity (%)

3.8.3 In addition, a functional test shall be made of monitoring and control functions included with the variable speed drive.

3.8.4 The motor manufacturer's test data and certification shall be obtained. Motor tests shall have been performed in accordance with NEMA MG 1. Tests shall have included:

a. Measurement of winding resistance

b. No-load readings of current, power and nominal speed at rated voltage and at the anticipated operating frequency.

c. Measurement of open circuit voltage ratio if wound rotor motors.

d. Megger test of motor windings and power leads.

e. Vibration on testing with baseline plots.

f. Percent slip

3.8.5 The Air Cleanup Train shall be tested for pressure decay leakage rate and shall be DOP penetration tested in accordance with ASME N510, section 10. Total leakage rate between unit inlet and fan outlet (including fan shaft seal) shall not exceed 10 ft^3/min at -50 inH_2O test pressure. All thermowells, pressure sensors and other instrumentation shall be installed prior to testing. Test will be witnessed by the Buyer. Notify the Buyer 2 weeks before testing. A test report shall be prepared and certified.

3.9 Cleaning: Demineralized water used for cleaning or flushing shall be limited to a maximum chloride content of 25 ppm. Cleaning solutions shall not contain halogenated compounds.

APPENDIX - B

Maximim Operating Pressure

CALCULATION IDENTIFICATION AND INDEX

Date 3-28-95

This sheet shows the status and description of the attached Design Analysis sheets.

Discipline 28/HVAC WO/Job No. ER4319 Calculation No. W320-28-001

Project No. & Name W-320 Tank 241-C-106 Waste Retrieval

Calculation Item Exhaust Airflow Sizing for Tank 241-C-106

These calculations apply to:

Dwg. No. H-2-818468 HVAC Overall Flow Diagram C-106 Rev. No. draft 21, 3-17-95

Dwg. No. H-2-818479 HVAC Energy Balance Rev. No. draft 2, 3-21-94

Other (Study, CDR) N/A Rev. No. N/A

The status of these calculations is:

[] Preliminary Calculations

[x] Final Calculations

[] Check Calculations (On Calculation Dated)

[] Void Calculation (Reason Voided)

Incorporated in Final Drawings? [] Yes [x] No

This calculation verified by independent "check" calculations? [] Yes [x] No

Original and Revised Calculation Approvals:

	Rev. 0 Signature/Date	Rev. 1 Signature/Date	Rev. 2 Signature/Date
Originator	superceeded by revision 1. 11/29/93 PH LANGOWSKI	PH Langowski 3-28-95	
Checked by	T.O. LOONEY 12/1/93	[signature] 3/31/95	
Approved by	RW DAVIDSON 12/8/93	PH Langowski 4-3-95	
Checked Against Approved Vendor Data		Charles T. Li 4/10/98	

INDEX

KEH 0378.00 (06/92) KEF072

DESIGN ANALYSIS

Client WHC
Subject W-320 Exhaust Airflow Sizing for Tank 241-C-106
Location 241-C Farm, 200 East

WO/Job No. ER4319
Date 3/28/95 By PH Langowski
Checked 3/31/95 By R. Pina
Revised By

1.0 OBJECTIVE

The objective of this calculation is to determine the range of exhaust airflow design values required for Tank 241-C-106 during active sluicing retrieval operations.

2.0 DESIGN INPUTS

2.1 CRITERIA AND SOURCE

DOE General Order 6430.1A
Functional Design Criteria WHC-SD-W320-FDC-001, rev. 2, 1-18-94

2.2 GIVEN DATA

- none

2.3 ASSUMPTIONS

- Assumed C-106 tank minimum operating pressure of -2.00" water gauge (w.g.). This assumes that the operating pressure setpoint will be approximately -1.50" w.g. with a range of control that would limit the minimum pressure to -2.00" w.g. under normal operating conditions. Operating pressure setpoint is stated as -1.50" w.g. on ref. 6.

- Assumed the C-105 airspace temperature is equal to 80F and a vaporspace pressure of -1.00" water gauge due to continuing radiolytic heat input. C-105 was formerly designated a high-heat watchlist tank and is estimated to have between 20,000 and 25,000 Btu/h of radiolytic heat generation in January, 1991 per Figure 12 of ref. 3 (see Appendix A). The thermal analysis shows that the temperature in C-105 may reach 120F if the ventilation is ceased. With a C-105 ventilation rate of approximately 1,000 cfm at a tank pressure of -1.0" water gauge (similar to actual conditions on 2/5/91 data), the tank average annual air temperature should be approximately 80F.

- Assumed a maximum infiltration rate of 250 scfm into tank C-106 through the three existing pits with cover blocks and the additional riser flanges. Actual infiltration will be less with the installation of the sealing tape from the W-030 project and proper operating procedures. This assumes that the three cover blocks currently in place on C-106 are replaced with new cover blocks which will have covers for all penetrations (2" valve handle holes and others) through the cover blocks. The design of new, low-infiltration cover blocks is the current design assumption and design philosophy. Psychrometric data from DST's AW, AN, and AP (see Appendix A) shows that 250 scfm is a reasonable assumption for the maximum infiltration through the three existing cover blocks.

2.4 METHODS

Hand calculations and Excel spreadsheet using ASHRAE formulae.

DESIGN ANALYSIS

Client WHC | WO/Job No. ER4319
Subject W-320 Exhaust Airflow Sizing for Tank 241-C-106 | Date 3/28/95 | By PH Langowski
Checked 3/31/95 | By R. Pirio
Location 241-C Farm, 200 East | Revised | By

2.5 REFERENCES

1. WHC-SD-WM-ANAL-012, Rev. 1, "Flow Analysis for Single Shell Tanks", p. 2
2. W320ER1.TD.395, "Tank 241-C-106 Sluicing Tank Farm Riser Usage and Pit Modifications," 9/93.
3. WHC-SD-WM-ER-189, Rev. 0, "Thermal Analysis of Tank 241-C-105 in Support of Process Test," Figure 12, January 1993.
4. WHC-EP-0651, Rev. 0, "Barometric Pressure Variations," June 1993.
5. W320-H-011, Rev. 0, "Exhaust Skid Stack Sizing and Fan Sizing"
6. H-2-818468, draft 21, 3-17-95, "Overall Flow Diagram C-106"
7. HW-72743, Rev. 19, "75'-0" Dia Storage Tanks Arrangements"
8. ASHRAE Fundamentals 1993

3.0 CALCULATIONS

The total airflow into Tank 241-C-106, and hence, the total exhaust flowrate from C-106 is estimated to be made of two components: 1) the infiltration through the three pit cover blocks and into the pit drains and infiltration through riser flanges outside of the pits on Tank C-106, and; 2) the inflow through the 3" cascade line which connects tank C-106 to tank C-105.

3.1 Infiltration

Riser Study ref. 2 (see Appendix A) details the current existing risers on Tank C-106. There are fourteen risers listed on the summary, seven of which are located inside the three pits. Of the remaining seven, one is covered with dirt and could be assumed sealed airtight. Of the remaining six, there are four 4" and two 12" risers. It is expected that all three existing pits on C-106 will have large openings into the tank and that the pit cover blocks will be the limiting infiltration path. No new risers are currently planned to be constructed under W-320. The existing 3" floor drains in the three existing pits are not planned to be used after W-320 construction. The risers through which the pumps are inserted are planned to have perforated spacer rings which will provide a large drain opening to the tank. This large opening is thought to be required based on the accident scenario of 350 gpm spilling into the pit.

A calculation of infiltration into the C-106 tank with the equipment installed in the risers is severely dependent on the crack width assumptions used on each riser flange and on the pit cover blocks. This calculation was not undertaken due to it's inherent low reliability. The maximum 250 scfm infiltration rate for a 75' diameter tank with three pits is based on psychrometric data from existing DST's (see Appendix A) which showed a wide range of airflows, generally in the 100 to 200 cfm range, but with a few big exceptions. DST's generally have at least twice as many risers as SST's. The high end of the general range of the DST infiltration data was used.

The W-320 design assumes that the pit cover blocks are sealed so that the size of the drains in the pits is unimportant. This would yield infiltration rates near zero with only the purge air used for the FIC, purge air for the pressure transmitter PIT-1361 at Hatchway Riser R-15, the CCTV purge air, and the infiltration through the riser flanges on risers located outside of the pits or through penetrations in the pit cover blocks as contributors. This is a partially unrealistic assumption. Even if the pits are

DESIGN ANALYSIS

Client WHC	WO/Job No. ER4319	
Subject W-320 Exhaust Airflow Sizing for Tank 241-C-106	Date 3/28/95	By PH Langowski
	Checked 3/31/95	By R. Pina
Location 241-C Farm, 200 East	Revised	By

sealed there will be times when the seals are broken for maintenance of items in the pits, or infiltration due to lack of maintenance of the seals themselves. The 250 scfm maximum infiltration assumption should prove conservative. For calculations where a normal operating flow rate is specified, 170 scfm shall be used.

The ref. 1 flow analysis report (see Appendix A) discusses infiltration rates into single shell tanks for various combinations of risers, pit drains, and pressures. For 2" w.g. pressure drop, the following infiltration rates were calculated: 23 cfm for a tank with sealed pits; 425 cfm for a tank with cover blocks off and pit drains sealed 50%; 819 cfm for a tank with cover blocks off and pit drains 100% open; and, 2819 cfm for a tank with an open inlet filter and 100% open pit drains. Pit drains are the standard 3" drains in the flow analysis report. The 250 scfm maximum infiltration assumption is reasonable in this context.

3.2 Inflow Through Cascade Line

The airflow through the 3" (ref. HW-72743 see Appendix B) cascade line of approximately 30' length from C-105 is calculated by assuming a delta pressure drop along the cascade line. Thirty feet of pipe with a 2" w.g. delta pressure drop would require a pressure drop of approximately (2")(100'/30')=6.67" w.g. per 100' of pipe and require a substantial velocity. The entrance and exit losses should not be neglected at these high velocities.

The C-105 entrance is a 4" schedule 80 pipe on the OD with the 3" cascade line inside overhanging the sidewall of the tank by 12". The C-106 exit side is the 3" cascade line overhanging the tank by 4' (see ref. 7). ASHRAE Fundamentals 1993 fitting ED1-1 was assumed to model the entrance in C-105(See Appendix B). Using Schedule 80 pipe data (see Appendix B), For C-105: 2t=4.5"-2.9"=1.6", so t=0.8"; L=12"; D=2.9"; t/D=0.8/2.9=0.276; L/D=12/2.9=4.14; from the table C_o=0.50. The exit in C-106 can use C_o=1.00 since the airstream decelerates to zero velocity.

Appendix B contains a simple Excel spreadsheet which proved useful in iterating in on an airflow with a given delta pressure. ASHRAE Fundamentals (ref. 8) equations as listed on the spreadsheet were used to calculate friction factors and pressure loss through the piping. The entrance and exit losses which are dependent on velocity pressure are also included. The spreadsheet shows that a normally expected cascade airflow of 60 scfm of 80F air can be expected at 0.5" w.g. total pressure drop between the two tanks. The same spreadsheet yielded 103 scfm of 120F air and 108 scfm of 80F air at 1.5" w.g. total pressure drop simulating the case of C-105 not being ventilated. 110 scfm shall be used as the maximum cascade line airflow.

3.4 Minimum Airflow

DOE Order 6430.1A, para. 1550-99.0.3 "Offgas Systems", states that "the design of process confinement off-gas treatment systems shall preclude the accumulation of potentially flammable quantities of hydrogen generated by radiolysis or chemical reactions within process equipment." Review of SY-101 hydrogen generation was undertaken to investigate an assumed worst case. Scaling down an estimated 241-SY-101 steady-state hydrogen generation rate of 2.24 scfh based on total mass yields a C-106 steady-state hydrogen generation rate of 0.33 scfh. To operate safely below the lower explosive limit only 1 scfm need be exhausted. The W-030 flammability calculations yielded a 3 scfm fresh air sweep requirement. The W-320 airstream characterization lists no flammable components.

Minimum airflow for infiltration should address the tank breathing rate due to changes in atmospheric pressure. Barometric Pressure Variation Report ref. 4 (see Appendix A) analyzes data for 1988-1991 as measured at the Hanford Weather Station located between 200E and 200W. The report presents the average breathing rate as 0.005639 inches of mercury per hour. It also presents hourly swing data. The largest value which occurred through the four year data collection is 0.12 inches of mercury per hour. The report presents annual average barometric pressures ranging from 29.22 to 29.26 inches mercury. The thirty year average for 1950 to 1980 is presented as 29.21 inches of mercury.

Assuming ideal conditions, the % volume change in one hour would be:

0.005639/29.21 = 0.0193% volume change per hour (average)
0.12/29.21 = 0.41% volume change per hour (maximum)

A 530,000 gallon single shell tank consists of a 75' diameter cylinder which is 18' tall, a 12' tall dome, and a 1' deep dished bottom. The total tank volume would be:

cylinder: (pi*75*75/4)(18) = 79,522 cubic feet
dish: approximately (pi*75*75/4)(0.5) = 2,209 cubic feet
dome: approximately pi*75*75*12/8 = 26,507 cubic feet (paraboloid)

The total tank volume (neglecting any waste in the tank) is approximately:

79,522 + 2,209 + 26,507 = 108,238 cubic feet

At the average hourly volume change this yields:

(0.000193 volume/hour)(108,238 cubic feet)(1 hour/60 minutes) = 0.35 cfm

At the maximum hourly volume change this yields:

(0.00411 volume/hour)(108,238 cubic feet)(1 hour/60 minutes) = 7.4 cfm

The maximum flowrate of 7.4 cfm is the most that could be expected through infiltration due to pressure variations.

The minimum airflow requirement to properly operate the high pressure blower exhaust fan may prove to be a concern when detailed selection of fan and controls is undertaken. Calculation ref. 5, lists a potential fan for consideration. The fan should be able to operate down at any reduced airflows below the 180 scfm minimum sizing range since a radial high pressure blower can function down to shut-off routinely.

DESIGN ANALYSIS

Client WHC
WO/Job No. ER4319
Subject W-320 Exhaust Airflow Sizing for Tank 241-C-106
Date 3/28/95 By PH Langowski
Checked 3/31/95 By R. [signature]
Location 241-C Farm, 200 East
Revised By

4.0 FINDINGS & CONCLUSIONS

The total maximum exhaust airflow is the sum of the 250 scfm infiltration airflow, and the 110 scfm cascade line flow. This yields a total maximum exhaust design airflow of 360 scfm. 360 scfm should be used for maximum exhaust design airflow purposes. Normal operating design airflow would be 60 scfm cascade flow, plus 170 scfm infiltration flow for a total of 230 scfm.

The proposed 360 scfm maximum exhaust air system can maintain the tank vapor space pressure at -1.50" water gauge under the worst case assumptions. 360 scfm should be used for maximum exhaust airflow sizing of equipment. The minimum absolute total exhaust airflow if Tank C-105 were actively ventilated to an equal or more negative pressure than C-106 (or the cascade line is plugged) and infiltration is extremely small should be considered to be 70 scfm infiltration (assumed). Neither of these two scenarios are deemed likely. For design purposes, the minimum exhaust airflow should be considered to be 60 scfm cascade flow (0.5" w.g. cascade line pressure drop) plus 120 scfm infiltration for 180 scfm total.

APPENDIX A

T Pim 3/31/95
W320-28-001 rev 1 PHK
4-3-95

Figure 12. Calculated Temperatures to Year 2002.
(Level 3 —— Level 4 +++)

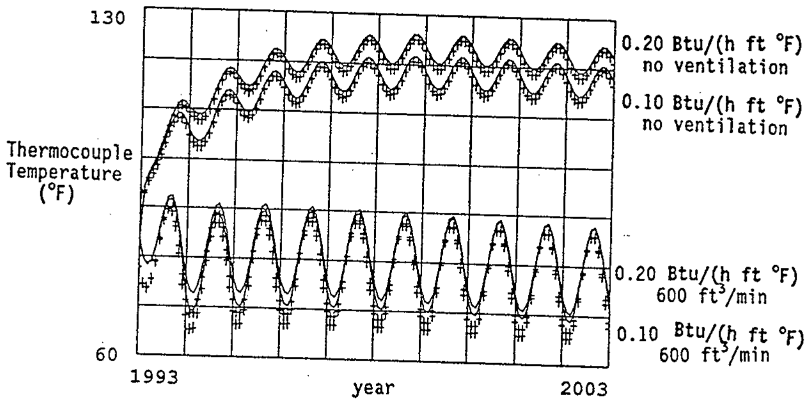


Table 1. Maximum Temperatures for Dry Out Transient.

	Ventilation ($600\ ft^3/min$)		Ventilation off	
Minimum Waste Conductivity (Btu/(h ft °F))	0.2	0.1	0.2	0.1
Maximum Waste Temperature (°F)	137	163	166	189
Maximum Concrete Temperature (°F)	133	151	162	175

R. Pait 3/31/95
W320-28-001 rev 1 PHK 4-3-95

Vent & Balance Data

PSYCHROMETRIC SURVEY

DATE: 6-13-89

TO: ~~A. ALSTAB~~ Dan Saide R1-51
~~Jim A~~

FROM: ~~H. Richie~~ T. Johnson
2101M bldg. Rm. 138
200 East (S2-70)
3-1657

Psychrometric Tank Farm Survey 241-AP , TANK EXH.

Taken by: RUGGLES, WARD KINZEL

The following airflow and temperature readings were taken on subject tank.

Date: 6-13-89

Weather Tower
Time: 900/Am Wet Bulb 63° °F Dry Bulb 77° °F

Ambient:
Time: 900/Am Wet Bulb 64° °F Dry Bulb 78° °F

Tank No.	Time	Temperature Wet °F	Temperature Dry °F	Flow CFM	Neg. Off Chart %	Exh Duct S/F IN.W.G.	Exh Damp Pos. % OPEN	Neg. Off Tank IN.W.G.
101	900/Am	68°	68°	100	18%	2.37" WG	25	-2.70" WG
102	910/Am	68°	68°	130	26%	2.07" W.G.	25	-2.40" W.G.
103	915/Am	68°	68°	130	18%	2.00" W.G.	25	-2.80" W.G.
104	920/Am	70°	71°	212	17%	2.45" WG	20	-2.60" W.G.
105	925/Am	61°	70°	264	10%	2.91" WG	100	-3.00" WG
106	930/Am	68°	68°	188	15%	2.55" WG	188	-2.70" WG

COMMENTS:

296-A-40 681 CFM

PRE FILTER .10" W.G. D/P
PRIMARY .90" W.G. D/P
SECONDARY .65" WG D/P
DEENTRAINER .68" WG D/P

INLET TEMP 68°
OUTLET TEMP 76°

CC. ~~H. A. ANDERSON~~
Becky Hanlon ~~R1-51~~ R1-40

T. Ann 3/31/95
W320-28-001 reul PHR 4-3

Vent & Balance Data

PSYCHROMETRIC SURVEY

DATE: 7/17/89

TO: ~~J. H. Cleavenger~~ Dan Saile R1-51

FROM: I. T. Johnson
2101M bldg. Rm. ~~XXX~~ 141-D
200 East (S2-70)
3-1887

Psychrometric Tank Farm Survey 241 A.P , TANK EXH.

Taken by: KINZEL KNUTSON Oeltjen

The following airflow and temperature readings were taken on subject tank.

Date: 7/17/89

Weather Tower
Time: 10:00 Wet Bulb 59 °F Dry Bulb 76 °F

Ambient:
Time: 10:00 Wet Bulb 60 °F Dry Bulb 75 °F

Tank No.	Time	Temperature Wet °F	Temperature Dry °F	Flow CFM	Neg. Off Chart %	Exh Duct S/P IN. W.G.	Exh Damp Pos. % OPEN	Neg. Off Tank IN. W.G.
101	9:18	66	73	110	-2.7" w.g.	2.61" w.g.	18	-2.60" w.g.
102	9:22	66	72	99	-2.1" w.g.	2.0[illegible]" w.g.	25	-2.10" w.g.
103	9:27	66	73	99	-2.7" w.g.	2.00" w.g.	22	-2.70" w.g.
104	9:33	66	72	116	-2.7" w.g.	2.4[illegible]" w.g.	20	-2.60" w.g.
105	9:50	64	75	255	-2.7" w.g.	2.90" w.g.	95	-2.10" w.g.
106	10:00	71	73	153	-2.7" w.g.	2.60" w.g.	25	-2.60" w.g.
							Blanked off	
							Blanked off	

COMMENTS:

296-A-40 791 CFM

Pre Filter .10" w.g.
Primary .75" w.g.
Secondary .63" w.g.
Decentrainer .45" w.g.

Inlet Temp. 65 °F
Outlet Temp. 72 °F

CC.

Betty Hanlon R1-50
~~H. Hanners~~

T. Pim 3/31/95
320-28-001 rev 1 AH 4-3-95

Vert & Balance Data

241-AN Tank Farm

DATE: 2-8-90

TO: ____

FROM: 2101-M RM.
200 E (S2-70)
3-1857

Instrument Type micro

Instrument Last Calibration Date 11-8-89

Instrument Code No. WHSL 702-28-09-013

Psychrometric Survey Tank 241, TANK EXH.

Taken By: Carrick, Tiffany + McCinse

The following airflow and temperature readings were taken on subject tank.

DATE: 2-8-90

Weather Tower:
Time: 9:00 AM Wet Bulb 31 °F Dry Bulb 33 °F

Ambient:
Time: N/A Wet Bulb N/A °F Dry Bulb N/A °F

TANK NO. AN	TIME AM	TEMPERATURE WET °F	TEMPERATURE DRY °F	FLOW CFM	NEG. OFF CHART %	EXHAUST DUCT S/P IN. W.G.	EXHAUST DAMP POSITION % OPEN	NEG. OFF TANK IN. W.G.
101	10:10	61°F	66°F	.48	41%	-1.65"w.g.	100%	10/89 -2.0"w.g.
102	10:30	75°F	77°F	34	40%	-1.66"w.g.	100%	10/89 -1.50"w.g.
103	10:20	63°F	78°F	235	43%	-1.65"w.g.	100%	10/89 -1.90"w.g.
104	10:00	66°F	75°F	55	43%	-1.67"w.g.	100%	10/89 -2.0"w.g.
105	9:40	66°F	70°F	34	43%	-1.61"w.g.	60%	10/89 -2.0"w.g.
106	9:30	59°F	63°F	347	45%	-1.55"w.g.	75%	10/89 -1.50"w.g.
107	9:10	61°F	75°F	203	42%	-1.65"w.g.	80%	10/89 -1.90"w.g.

COMMENTS: No Ambient readings due to broken equipment.

Ira Johnson, Manager Ventilation Balance

TEST RECORD SHEET 3.

|---|

T. Pom 3/31/95
W320-28-001 rev 1 AHK 4-3-95

Vent & Balance Data

241-AW Tank Farm

DATE: 2-9-90

TO:

FROM: 2101-M RM.
200 E (S2-70)
3-1857

Instrument Type micro

Instrument Last Calibration Date 11-8-89

Instrument Code No. WHSL 712-28-09-013

Psychrometric Survey Tank 241, TANK EXH.

Taken By: Carrick, McCruse + Tiffany

The following airflow and temperature readings were taken on subject tank.

DATE: 2-8-90

Weather Tower:
Time: 1:45 Wet Bulb 35 °F Dry Bulb 41 °F

Ambient:
Time: N/A Wet Bulb N/A °F Dry Bulb N/A °F

TANK NO.	TIME	TEMPERATURE WET °F	TEMPERATURE DRY °F	FLOW CFM	NEG. OFF CHART %	EXHAUST DUCT S/P IN. W.G.	EXHAUST DAMP POSITION % OPEN	NEG. OFF TANK IN. W.G.
AW	P.m.							
101	1:50	65°F	65°F	.59 X	55%	-1.30"w.g.	15%	9/39 -1.70"w.g.
102	2:30	66°F	66°F	339 X	60%	-1.15"w.g.	50%	9/39 -1.20"w.g.
103	2:00	65°F	65°F	106 X	59%	-.93"w.g.	25%	9/39 -1.20"w.g.
104	2:40	67°F	67°F	243 X	59%	-1.19"w.g.	25%	9/39 -1.30"w.g.
105	2:20	52°F	59°F	270 X	55%	-1.27"w.g.	100%	9/39 -1.40"w.g.
106	2:10	68°F	72°F	116 X	65%	-.88"w.g.	25%	9/39 -1.0"w.g.

COMMENTS: Ambient inst. broken K1-5-2 Fan inservice.

Ira Johnson, Manager Ventilation Balance

TEST RECORD SHEET 3.

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T. Pratt 3/31/95
320-28-001 Rev 1 PHK 4-3-95

Riser	Existing Use	Proposed Modification
TANK 241-C-106		
R1 - 4 in.	FIC	
R2 - 12 in.	HVAC Outlet	HVAC Outlet
- 42 in. (36 in.)	Dirt Covered Construction Manhole	
TANK 241-C-106 SLUICE PIT		
R3 - 12 in.	Liquid Level Tape Riser blanked, H-2-73346	Install New Sluicer Risers empty and open
R4 - 4 in.	Recirc Dipleg Still there, H-2-73346 Sluice Pit Drain	Dipleg is laying in pit Riser is empty and open
TANK 241-C-106 HEEL PIT		
R13 - 26 in.	Heel Jet Pump Still there, H-2-73346 Heel Pit Drain	Install New Heel Pump Possibly Modify Riser dia. Remove Old Pump
TANK 241-C-106 PUMP PIT		
R5 - 4 in.	Recirc Dipleg Still there, H-2-73346 Pump Pit Drain	Riser is empty and open
R6 - 12 in.	Sluicing Access	New Sluicer
R7 - 12 in.	Observation Port In wall of Pit See H-2-93726 Blind Flange on Riser	Visual System Installation
R-9 - 42 in. (36 in.)	Sludge Pump Still there, H-2-73346	New Submersible Pump
TANK 241-C-106		
R8 - 4 in.	Temp Cont. Still there, H-2-73346 West of Pump Pit	
R11 - 4 in.	Southeast of Heel Pit (below grade)	
R14 - 4 in.	Thermocouple Tree	
TANK 241-C-106 HVAC INTAKE		
R15 - 12 in.	HVAC, HEPA Filtered Intake Intake, Riser plate could be made larger	HVAC Intake

From W320 TN 395 [illegible] 3/31/?? W320-28-001 rev 1 PHA 43-45

1.0 INTRODUCTION

The purpose of this document is to show the analytical results which were reached in determining the minimal flow rate for one air change per day from a single shell tank.[1] Also, what flow rate will be required to maintain a static pressure of -.3" wg to -5.9" wg in the tank (DOE Order 6430.1A page 11-4 paragraph 1161-4, and OSD #113). This flow may be used to size a exhauster for both, before and after stabilization. Please review all the assumptions made during this analysis very carefully. These assumptions are uncontrolled variables (ie.. drains being plugged by dirt and debris), therefore, close attention should be paid to these assumptions.

2.0 SCOPE

The flow rates and static pressures were determined by the following four scenarios:

- 2 - 4" risers and 2 - 6" risers with a crack width of 1/64" each, 3 - 3" drains in the sluice pits (completely open free from debris), and 1 - 4" drain in the pump pit (completely open free from debris). In addition, 50 cfh or .833 cfm[2] is also added due to purge air used by the FIC.

- 2 - 4" risers and 2 - 6" risers with a crack width of 1/64" each, 3 - 3" drains in the sluice pits (50% of the drain blocked due to dirt and debris), and 1 - 4" drain in the pump pit (50% of the drain blocked due to dirt and debris). In addition, 50 cfh or .833 cfm[2] is also added due to purge air used by the FIC.

- 1 - inlet filter placed on a 12" riser with flow through both, the inlet filter, and flow going through the above mentioned cracks. In addition, 50 cfh or .833 cfm[2] is also added due to purge air used by the FIC.

- 2 - 4" risers and 2 - 6" risers with a crack width of 1/64" each, and the sluice pits and pump pit are sealed up completely (no in-leakage through pits). In addition, 50 cfh or .833 cfm[2] is also added due to purge air used by the FIC.

The tank which was used for this analysis was 104-AX. This tank had the largest vapor space (gal.) due to the lowest liquid level (gal.) of all single shell tanks. This was determined by using the March 30, 1991 Tank Farm Facilities Chart (see appendix B).

1 = Internal Memo from J.D. Thomson and J.L. Deichman to M.A. Payne, 2-18-92, Single Shell Tank Ventilation Systems
2 = Information supplied by A.T. Alstad and V.D. Maupin

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3.0 RESULTS

All scenarios, which were mentioned above, were evaluated, labeled, and explained in Appendix A. The results were as follows:

PRESSURE DROP in. wg	SCENARIO #1[3] cfm	SCENARIO #2[3] cfm	SCENARIO #3[1,2,3] cfm	SCENARIO #4[3] cfm
.3" wg	317	165	300 + #1 or #2	9
1" wg	579	301	1000 + #1 or #2	16
2" wg	819	425	2000 + #1 or #2	23
3" wg	1003	521	3000 + #1 or #2	28
4" wg	1158	601	4000 + #1 or #2	33
5" wg	1333	672	5000 + #1 or #2	37
5.9" wg	1406	730	5900 + #1 or #2	40

1 = Based on damper being completely open
2 = See page 16 in Appendix A for reasoning of additive flows
3 = .83 cfm needs to be added to these values for the purge air off the FIC

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Table 4. Population of Pressure Changes Every Hour.

Press swing (inches of mercury)	Year			
	1988	1989	1990	1991
-0.13 or lower	0	0	0	0
-0.12	0	0	1	0
-0.11	3	1	1	3
-0.10	0	2	1	0
-0.09	2	0	1	0
-0.08	3	3	3	3
-0.07	1	2	4	4
-0.06	10	5	15	7
-0.05	26	10	27	16
-0.04	130	86	128	110
-0.03	344	238	294	302
-0.02	890	915	990	976
-0.01	1,446	1,583	1,435	1,473
0	2,838	2,934	2,785	2,825
0.01	1,772	1,806	1,674	1,703
0.02	930	888	995	958
0.03	266	181	252	231
0.04	76	71	99	89
0.05	17	14	31	33
0.06	13	8	14	13
0.07	3	2	0	7
0.08	1	0	4	2
0.09	3	2	1	0
0.10	1	0	2	1
0.11	1	3	0	1
0.12	2	1	1	0
0.13 or higher	0	0	1*	0

*One reading was 0.18 but is ascribed to an error, see discussion in Section 1.2, "Raw Data."

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Table 1. Annual Data.

Value	Year				
	1988	1989	1990	1991	1950 -1980*
Average (inches of mercury)	29.25	29.26	29.22	29.23	29.21
Standard deviation (inches of mercury)	0.211	0.197	0.193	0.210	-
Number	8779	8756	8760	8758	-
Maximum (inches of mercury)	29.94	29.96	30.02	29.83	30.23
Minimum (inches of mercury)	28.52	28.79	28.50	28.33	28.10
Total increases (inches of mercury)	49.98	46.04	51.46	49.97	-
Total decrease (inches of mercury)	50.50	46.20	51.28	49.78	-

* Source: Stone et al. (1983)

gross outliers. Some years have more storms than others. Further computations would show that the coupling of extremes with the average and standard deviations indicate a well-behaved and normal distribution of values. Finally, 1988 was a leap year.

The total yearly breathing is 49.40 inches of mercury (0.005639 inches of mercury per hour) or about 1.69 atmospheres, which is somewhat lower than previous rates of about 2.2 atmospheres used in other studies (Klem 1991; Garfield 1975). Note that the present data gave breathing rates approaching 3 atmospheres before the few erroneous entries were corrected. Therefore, we believe the 1.69 atmospheres (0.005639 inches of mercury per hour) annual breathing rate to be valid and the best available.

Note that the total hourly barometric movement (upward or downward changes being accumulated as separate accounts) are higher than would be determined from Stone et al. (1983). For example, Table 36 in Stone et al. (1983) gives the annual average station pressure for hours 1 through 24. From this, the average diurnal change from low to high is 0.04 inches of mercury, or about 30% of the movement determined by the present analysis from hourly changes. Although this is a natural rate, one needs to be aware that some tanks are actively being purged (through the Food Instrument Corporation level gauge or other instruments). These purges may be in excess of 0.71 m^3/h (25 ft^3/h), which is similar to the natural breathing rate.

The data were examined on a daily basis to see if variations could be seen that were similar to the sinusoidal temperatures seen during the day. Those results for 1990 are presented (other years are very similar) as Table 2. Figure 1 is a graphical representation of the same data. There really is no trend over the day; in this case, Figure 1 is more enlightening than Table 2. Therefore, it would be impossible to predict that tank pressure would be high or low for any given hour of the day at some time in the future.

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APPENDIX B

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KAISER ENGINEERS HANFORD CO.
DUCT PRESSURE LOSS
CALCULATION SHEET

JOB NO./ W.O. NO. : W-320/ER4319
BLDG NO./ AREA : 241-C-106/200E
DUCT SYSTEM : Cascade Line from C-105 to C-106

PREPARED BY: P.H. LANGOWSKI
DATE: 3/27/95
CHECKED BY:

NOTES:
Calculation W320-28-001.
3" schedule 80, ID=2.90".
Pressure loss per 1993 Fundamentals p.32.4 Darcy Equation (19).
Hydraulic diameter per 1993 Fundamentals p.32.6 Equation (24).
Reynold's Number per 1993 Fundamentals p.32.5 Equation (22).
ASHRAE fitting ED1-1 1993 Fundamentals p.32.29.

NOTE: COLUMNS UNDER SHADED AREAS REQUIRE USER INPUT

AIR STREAM	AIR FLOW	TEMP	AIR FLOW	AIR FLOW TAKEOFF	DUCTSIZE either round or rectangular			EQUIV DUCT LENGTH	DUCT AREA	PERI METER	HYDRAL DIA	REY	FPRIME	F	VEL.	VEL. PRESS. Vp	PRESS. LOSS
					WIDTH	HEIGHT	DIA.										
	SCFM	DEGREE F	ACFM	SCFM	IN.	IN.	IN.	FT.	SQ. IN.	IN.	IN.				FPM	IN. WG	IN. WG
	initial only							duct only									
C-106 gauge pressure																	-0.500
entrance in C-105	60	80	61				2.90		6.61	9.11	2.90	31,790	0.025	0.025	1,334	0.111	0.055
30' of 3" schedule 80	60	80	61				2.90	30	6.61	9.11	2.90	31,790	0.025	0.025	1,334	0.111	0.334
exit in C-106	60	80	61				2.90		6.61	9.11	2.90	31,790	0.025	0.025	1,334	0.111	0.111
																total	0.000

DATA USED ABOVE
roughness = 0.0001
density = 0.074 lbm/ft3 80F, dry air 13.602 ft3/lbm
kinematic viscosity = 0.000169 ft2/s

friction factors		
	galvanized	0.0003
	carbon steel	0.0001

kinematic viscosity	temp(F)	ft2/s
from Mechanical Engineering	0.00	0.000126
Reference Manual Eighth	20.00	0.000136
Edition, p.3-36.	40.00	0.000146
	60.00	0.000158
	68.00	0.000160
	80.00	0.000169
	100.00	0.000180
	120.00	0.000189
	250.00	0.000273

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KAISER ENGINEERS HANFORD CO.
DUCT PRESSURE LOSS
CALCULATION SHEET

JOB NO./ W.O. NO. : W-320/ER4319
BLDG NO./ AREA : 241-C-106/200E
DUCT SYSTEM : Cascade Line from C-105 to C-106

PREPARED BY: P.H. LANGOWSKI
DATE: 3/28/95
CHECKED BY:

NOTES:
Calculation W320-28-001.
3" schedule 80, ID=2.90".
Pressure loss per 1993 Fundamentals p.32.4 Darcy Equation (19).
Hydraulic diameter per 1993 Fundamentals p.32.6 Equation (24).
Reynold's Number per 1993 Fundamentals p.32.5 Equation (22).
ASHRAE fitting ED1-1 1993 Fundamentals p.32.29.

NOTE: COLUMNS UNDER SHADED AREAS REQUIRE USER INPUT

AIR STREAM	AIR FLOW	TEMP	AIR FLOW	AIR FLOW TAKEOFF	DUCTSIZE either round or rectangular			EQUIV DUCT LENGTH	DUCT AREA	PERI METER	HYDRAL DIA	REY	FPRIME	F	VEL.	VEL. PRESS. Vp	PRESS. LOSS
					WIDTH	HEIGHT	DIA.										
	SCFM	DEGREE F	ACFM	SCFM	IN.	IN.	IN.	FT.	SQ. IN.	IN.	IN.				FPM	IN. WG	IN. WG
	initial only							duct only									
C-106 gauge pressure																	-1.500
entrance in C-105	103	120	113				2.90		6.61	9.11	2.90	58,591	0.022	0.022	2,458	0.377	0.188
30' of 3" schedule 80	103	120	113				2.90	30	6.61	9.11	2.90	58,591	0.022	0.022	2,458	0.377	0.935
exit in C-106	103	120	113				2.90		6.61	9.11	2.90	58,591	0.022	0.022	2,458	0.377	0.377
																total	0.000

DATA USED ABOVE

roughness = 0.0001
density = 0.068 lbm/ft3 120F, dry ai 14.613 ft3/lbm
kinematic viscosity = 0.000189 ft2/s

friction factors		
	galvanized	0.0003
	carbon steel	0.0001

kinematic viscosity	temp(F)	ft2/s
from Mechanical Engineering	0.00	0.000126
Reference Manual Eighth	20.00	0.000136
Edition, p.3-36.	40.00	0.000146
	60.00	0.000158
	68.00	0.000160
	80.00	0.000169
	100.00	0.000180
	120.00	0.000189
	250.00	0.000273

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KAISER ENGINEERS HANFORD CO.
DUCT PRESSURE LOSS
CALCULATION SHEET

NOTES: Calculation W320-28-001.
3" schedule 80, ID=2.90".
Pressure loss per 1993 Fundamentals p.32.4 Darcy Equation (19).
Hydraulic diameter per 1993 Fundamentals p.32.6 Equation (24).
Reynold's Number per 1993 Fundamentals p.32.5 Equation (22).
ASHRAE fitting ED1-1 1993 Fundamentals p.32.29.

JOB NO./ W.O. NO. : W-320/ER4319
BLDG NO./ AREA : 241-C-106/200E
DUCT SYSTEM : Cascade Line from C-105 to C-106

PREPARED BY: P.H. LANGOWSKI
DATE: 3/27/95
CHECKED BY:

NOTE: COLUMNS UNDER SHADED AREAS REQUIRE USER INPUT

AIR STREAM	AIR FLOW	TEMP	AIR FLOW	AIR FLOW TAKEOFF	DUCTSIZE either round or rectangular			EQUIV DUCT LENGTH	DUCT AREA	PERI METER	HYDRAL DIA	REY	FPRIME	F	VEL.	VEL. PRESS. Vp	PRESS. LOSS
					WIDTH	HEIGHT	DIA.										
	SCFM	DEGREE F	ACFM	SCFM	IN.	IN.	IN.	FT.	SQ. IN.	IN.	IN.				FPM	IN. WG	IN. WG
	initial only							duct only									
C-106 gauge pressure																	-1.500
entrance in C-105	108	80	110				2.90		6.61	9.11	2.90	57,198	0.022	0.022	2,400	0.359	0.180
30' of 3" schedule 80	108	80	110				2.90	30	6.61	9.11	2.90	57,198	0.022	0.022	2,400	0.359	0.961
exit in C-106	108	80	110				2.90		6.61	9.11	2.90	57,198	0.022	0.022	2,400	0.359	0.359
																total	0.000

DATA USED ABOVE
roughness = 0.0001
density = 0.074 lbm/ft3 80F, dry air 13.602 ft3/lbm
kinematic viscosity = 0.000169 ft2/s

friction factors		
	galvanized	0.0003
	carbon steel	0.0001

kinematic viscosity	temp(F)	ft2/s
from Mechanical Engineering	0.00	0.000126
Reference Manual Eighth	20.00	0.000136
Edition, p.3-36.	40.00	0.000146
	60.00	0.000158
	68.00	0.000160
	80.00	0.000169
	100.00	0.000180
	120.00	0.000189
	250.00	0.000273

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equals the difference between the upstream pressure, which is zero (atmospheric pressure), and the loss through the fitting. The static pressure of the ambient air is zero; several diameters downstream, static pressure is negative, algebraically equal to the total pressure (negative) and the velocity pressure (always positive).

System resistance to airflow is noted by the total pressure grade line in Figure 3. Sections 3 and 4 include fan system effect pressure losses. To obtain the fan static pressure requirement for fan selection where the fan total pressure is known, use:

$$P_s = P_t - p_{v,o} \quad (18)$$

where

P_s = fan static pressure, in. of water
P_t = fan total pressure, in. of water
$p_{v,o}$ = fan outlet velocity pressure, in. of water

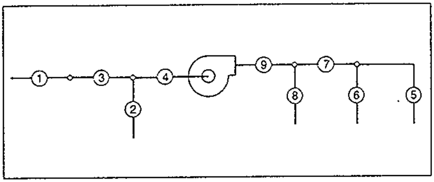

Fig. 2 Illustrative 6-Path, 9-Section System

FLUID RESISTANCE

Duct system losses are the irreversible transformation of mechanical energy into heat. The two types of losses are (1) frictional losses and (2) dynamic losses.

FRICTIONAL LOSSES

Frictional losses are due to fluid viscosity and are a result of momentum exchange between molecules in laminar flow and between particles moving at different velocities in turbulent flow. Frictional losses occur along the entire duct length.

Darcy, Colebrook, and Altshul Equations

For fluid flow in conduits, friction loss can be calculated by the Darcy equation:

$$\Delta p_f = f(12L/D_h)\,\rho\,(V/1097)^2 \quad (19)$$

where

Δp_f = friction losses in terms of total pressure, in. of water
f = friction factor, dimensionless
L = duct length, ft
D_h = hydraulic diameter [Equation (24)], in.
V = velocity, fpm
ρ = density, lb_m/ft^3

Within the region of laminar flow (Reynolds numbers less than 2000), the friction factor is a function of Reynolds number only.

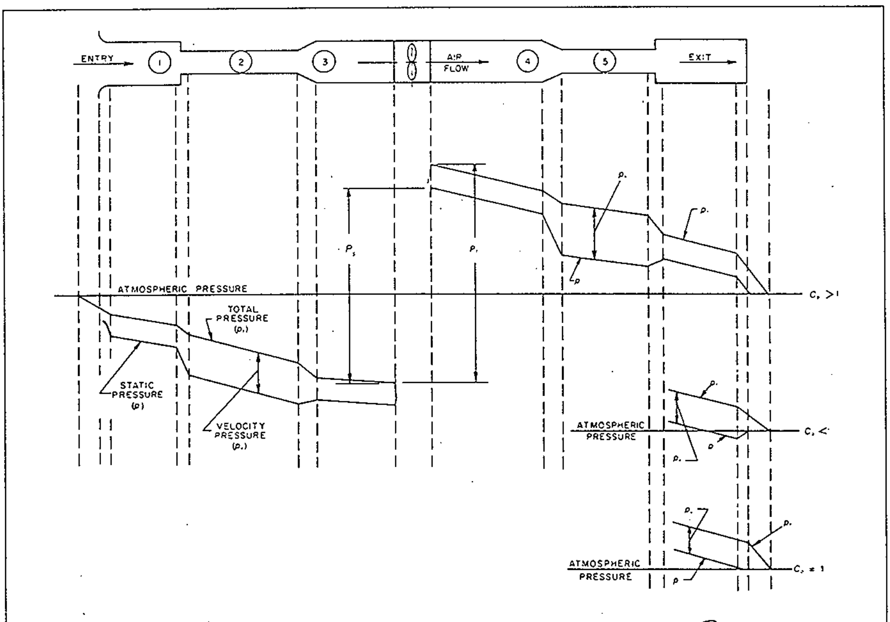

Fig. 3 Pressure Ch[cut off]

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For turbulent flow, the friction factor depends on Reynolds number, duct surface roughness, and internal protuberances such as joints. The traditional Moody chart depicts the behavior for round passages. For hydraulically smooth ducts, the friction factor again depends only on Reynolds number, but the dependence is markedly different from that for laminar flow. In general, for nonsmooth surfaces, the friction factor depends on roughness and Reynolds number; however, for a particular level of roughness beyond a sufficiently large Reynolds number, the friction factor becomes independent of Reynolds number, a flow condition considered as fully rough. Between the bounding limits of hydraulically smooth behavior and fully rough behavior, is a transitional roughness zone where the friction factor depends on both roughness and Reynolds number. In this transitionally rough, turbulent zone, where most cases of airflow occur in air-conditioning applications, the friction factor f is calculated by Colebrook's equation (1938-39). Since this equation cannot be solved explicitly for f, use iterative techniques (Behls 1971).

$$\frac{1}{f^{0.5}} = -2\log\left[\frac{12\epsilon}{3.7D_h} + \frac{2.51}{\text{Re}\,f^{0.5}}\right] \qquad (20)$$

where

ϵ = material absolute roughness factor, ft
Re = Reynolds number

A simplified formula for calculating friction factor, developed by Altshul (1975) and modified by Tsal, is

$$f' = 0.11\left(\frac{12\epsilon}{D_h} + \frac{68}{\text{Re}}\right)^{0.25}$$

$$\text{If } f' \geq 0.018: \quad f = f'$$

$$\text{If } f' < 0.018: \quad f = 0.85f' + 0.0028 \qquad (21)$$

Friction factors obtained from Altshul's modified equation are within 1.6% of those obtained by Colebrook's equation.

Reynolds number (Re) may be calculated by using Equation (22).

$$\text{Re} = \frac{D_h V}{720\,\nu} \qquad (22)$$

where ν = kinematic viscosity, ft^2/s.

For standard air, Re can be calculated by

$$\text{Re} = 8.56\,D_h V \qquad (23)$$

Roughness Factors (ϵ)

The ϵ-values listed in Table 1 are recommended for use with the Colebrook or Altshul-Tsal equation. These values should be interpreted as representing a combination of material, duct construction, joint type, and joint spacing (Griggs and Khodabakhsh-Sharifabad 1992). Roughness factors for other materials are presented in Idelchik *et al.* (1986). Idelchik summarizes roughness factors for 80 materials including metal tubes; conduits made from concrete and cement; and wood, plywood, and glass tubes.

Swim (1978) conducted tests on duct liners of varying densities, surface treatments, transverse joints (workmanship), and methods of attachment to sheet metal ducts. As a result of these tests, Swim recommends for design 0.015 ft for spray-coated liners and 0.005 ft for liners with a facing material cemented onto the air side. In both cases, the roughness factor includes the resistance offered by mechanical fasteners and assumes good joints. Liners cut too long and fastened to the duct cause much more loss than a liner cut too short; therefore, any fabrication error in liner length should be on the short side. Liner density does not significantly influence flow resistance.

Manufacturers' data indicate that the absolute roughness for fully extended nonmetallic flexible ducts ranges from 0.0035 to 0.015 ft. For fully extended flexible metallic ducts, absolute roughness ranges from 0.0004 to 0.007 ft. This range covers flexible duct with the supporting wire exposed to flow or covered by the material. Figure 4 provides a pressure drop correction factor for straight flexible duct when less than fully extended.

Table 1 Duct Roughness Factors

Duct Material	Roughness Category	Absolute Roughness ϵ, ft
Uncoated carbon steel, clean (Moody 1944) (0.00015 ft)	Smooth	0.0001
PVC plastic pipe (Swim 1982) (0.00003 - 0.00015 ft)		
Aluminum (Hutchinson 1953) (0.000015 - 0.0002 ft)		
Galvanized steel, longitudinal seams, 4-ft joints (Griggs *et al.* 1987) (0.00016 - 0.00032 ft)	Medium smooth	0.0003
Galvanized steel, continuously rolled, spiral seams, 10-ft joints (Jones 1979) (0.0002 - 0.0004 ft)		
Galvanized steel, spiral seam with 1, 2, and 3 ribs, 12-ft joints (Griggs *et al.* 1987) (0.00029 - 0.00038 ft)		
Galvanized steel, longitudinal seams, 2.5-ft joints (Wright 1945) (0.0005 ft)	Average	0.0005
Fibrous glass duct, rigid	Medium Rough	0.003
Fibrous glass duct liner, air side with facing material (Swim 1978) (0.005 ft)		
Fibrous glass duct liner, air side spray coated (Swim 1978) (0.015 ft)	Rough	0.01
Flexible duct, metallic (0.004 - 0.007 ft when fully extended)		
Flexible duct, all types of fabric and wire (0.0035 - 0.015 ft when fully extended)		
Concrete (Moody 1944) (0.001 - 0.01 ft)		

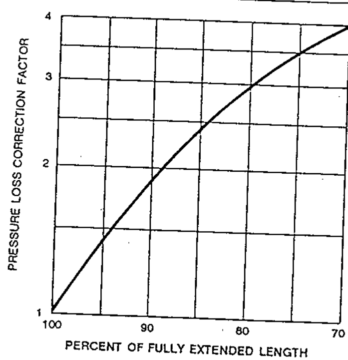

Fig. 4 Correction Factor for Unextended Flexible Duct

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Friction Chart

Fluid resistance caused by friction in round ducts can be determined by the Friction Chart (Figure 5). This chart is based on standard air flowing through round galvanized ducts with beaded slip couplings on 48-in. centers, equivalent to an absolute roughness of 0.0003 ft.

Changes in barometric pressure, temperature, and humidity affect air density, air viscosity, and Reynolds number. No corrections to the Friction Chart are needed for (1) duct materials with a medium smooth roughness factor, (2) temperature variations in the order of ±30°F from 70°F, (3) elevations to 1500 ft, and (4) duct pressures from −20 in. of water to +20 in. of water relative to the ambient pressure. These individual variations in temperature, elevation, and duct pressure result in duct losses within ±5% of the standard air friction chart.

For duct materials other than those categorized as medium smooth in Table 1, and for variations in temperature, barometric pressure (elevation), and duct pressures (outside the range listed), calculate the pressure loss in a duct due to friction by the Altshul-Tsal and Darcy equations [(21) and (19), respectively].

Noncircular Ducts

A momentum analysis can relate average wall shear stress to pressure drop per unit length for fully developed turbulent flow in a passage of arbitrary shape but of uniform longitudinal cross-sectional area. Combining the result with the definition of the Darcy friction factor leads to Equation (24), with the ratio $4A/P$ defined as hydraulic diameter:

$$D_h = 4A/P \tag{24}$$

where

D_h = hydraulic diameter, in.
A = duct area, in²
P = perimeter of cross section, in.

While the hydraulic diameter is often used to correlate noncircular data, exact solutions for laminar flow in noncircular passages show that such practice causes some inconsistencies. No exact solutions exist for turbulent flow. Tests over a limited range of turbulent flow indicated that fluid resistance is the same for equal lengths of duct for equal mean velocities of flow if the ducts have the same ratio of cross-sectional area to perimeter. From a series of experiments using round, square, and rectangular ducts having essentially the same hydraulic diameter, Huebscher (1948) found that each, for most purposes, had the same flow resistance at equal mean velocities. Tests by Griggs and Khodabakhsh-Sharifabad (1992) also indicated that experimental rectangular duct data for airflow over the range typical of HVAC systems can be correlated satisfactorily using Equation (20) together with hydraulic diameter, particularly when a realistic experimental uncertainty is accepted. These tests support using hydraulic diameter to correlate noncircular duct data.

Rectangular ducts. Huebscher developed the relationship between rectangular and round ducts that is used to determine size equivalency based on equal flow, resistance, and length. This relationship, Equation (25), is the basis for Table 2.

$$D_e = 1.30 \frac{(ab)^{0.625}}{(a+b)^{0.250}} \tag{25}$$

where

D_e = circular equivalent of rectangular duct for equal length, fluid resistance, and airflow, in.
a = length of one side of duct, in.
b = length of adjacent side of duct, in.

To size retangular ducts, determine the circular duct diameter by any design method, and use Table 2 to select the equivalent duct size as a function of aspect ratio. Equations (21) or (20) and (19) must be used to determine pressure loss.

Flat oval ducts. To convert round ducts to spiral flat oval sizes, use Table 3. Table 3 is based on Equation (26) (Heyt and Diaz 1975), the circular equivalent of a flat oval duct for equal airflow, resistance, and length. Equations (21) or (20) and (19) must be used to determine frictional pressure loss.

$$D_e = \frac{1.55\,A^{0.625}}{P^{0.250}} \tag{26}$$

where A is the cross-sectional area of flat oval duct defined as:

$$A = (\pi b^2/4) + b\,(a - b) \tag{27}$$

and the perimeter P is calculated by:

$$P = \pi b + 2(a - b) \tag{28}$$

where

P = perimeter of flat oval duct, in.
a = major dimension of flat oval duct, in.
b = minor dimension of flat oval duct, in.

DYNAMIC LOSSES

Dynamic losses result from flow disturbances caused by fittings that change the airflow path's direction and/or area. These fittings include entries, exits, transitions, and junctions. Idelchik (1986) discusses parameters affecting fluid resistance of fittings and presents loss coefficients in three forms: tables, curves, and equations.

Local Loss Coefficients

The following dimensionless coefficient is used for fluid resistance, since this coefficient has the same value in dynamically similar streams, *i.e.*, streams with geometrically similar stretches, equal values of Reynolds number, and equal values of other criteria necessary for dynamic similarity. The fluid resistance coefficient represents the ratio of total pressure loss to velocity pressure at the referenced cross section.

$$C = \frac{\Delta p_j}{\rho(V/1097)^2} = \frac{\Delta p_j}{p_v} \tag{29}$$

where

C = local loss coefficient, dimensionless
Δp_j = fitting total pressure loss, in. of water
ρ = density, lb_m/ft^3
V = velocity, fpm
p_v = velocity pressure, in. of water

Dynamic losses occur along a duct length and cannot be separated from frictional losses. For ease of calculation, dynamic losses are assumed to be concentrated at a section (local) and to exclude friction. Frictional losses must be considered only for relatively long fittings. Generally, fitting friction losses are accounted for by measuring duct lengths from the centerline of one fitting to that of the next fitting. For fittings closely coupled (less than six hydraulic diameters apart), the flow pattern entering subsequent fittings differs from the flow pattern used to determine loss coefficients. Adequate data for these situations are unavailable.

For all fittings, except junctions, calculate the total pressure loss Δp_j at a section by:

$$\Delta p_j = C_o\,p_{v,o} \tag{30}$$

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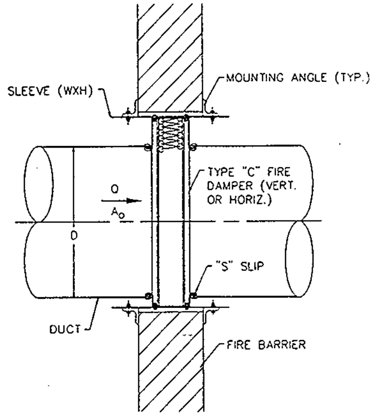
CD9-3 Fire Damper, Curtain Type, Type C

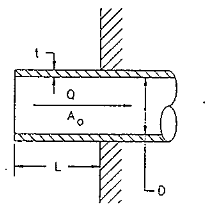
$C_o = 0.12$



ED1-1 Duct Mounted in Wall (Idelchik *et al.* 1986, Diagram 3-1)

C_o Values

	L/D								
t/D	0.000	0.002	0.010	0.050	0.100	0.200	0.300	0.500	10.000
0.00	0.50	0.57	0.68	0.80	0.86	0.92	0.97	1.00	1.00
0.02	0.50	0.51	0.52	0.55	0.60	0.66	0.69	0.72	0.72
0.05	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
10.00	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50



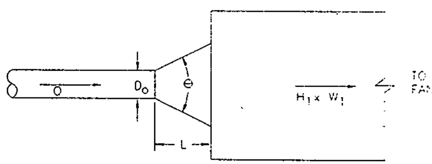
ED2-1 Conical Diffuser, Round to Plenum, Exhaust/Return Systems (Idelchik *et al.* 1986, Diagram 5-8)

C_o Values

	L/D_o										
A_1/A_o	0.5	1.0	2.0	3.0	4.0	5.0	6.0	8.0	10.0	12.0	14.0
1.5	0.03	0.02	0.03	0.03	0.04	0.05	0.06	0.08	0.10	0.11	0.13
2.0	0.08	0.06	0.04	0.04	0.04	0.05	0.05	0.06	0.08	0.09	0.10
2.5	0.13	0.09	0.06	0.06	0.06	0.06	0.06	0.06	0.07	0.08	0.09
3.0	0.17	0.12	0.09	0.07	0.07	0.06	0.06	0.07	0.07	0.08	0.08
4.0	0.23	0.17	0.12	0.10	0.09	0.08	0.08	0.08	0.08	0.08	0.08
6.0	0.30	0.22	0.16	0.13	0.12	0.10	0.10	0.09	0.09	0.09	0.08
8.0	0.34	0.26	0.18	0.15	0.13	0.12	0.11	0.10	0.09	0.09	0.09
10.0	0.36	0.28	0.20	0.16	0.14	0.13	0.12	0.11	0.10	0.09	0.09
14.0	0.39	0.30	0.22	0.18	0.16	0.14	0.13	0.12	0.10	0.10	0.10
20.0	0.41	0.32	0.24	0.20	0.17	0.15	0.14	0.12	0.11	0.11	0.10

Optimum Angle, θ

A_1/A_o	0.5	1.0	2.0	3.0	4.0	5.0	6.0	8.0	10.0	12.0	14.0
1.5	34	20	13	9	7	6	4	3	2	2	2
2.0	42	28	17	12	10	9	8	6	5	4	3
2.5	50	32	20	15	12	11	10	8	7	6	5
3.0	54	34	22	17	14	12	11	10	8	8	6
4.0	58	40	26	20	16	14	13	12	10	10	9
6.0	62	42	28	22	19	16	15	12	11	10	9
8.0	64	44	30	24	20	18	16	13	12	11	10
10.0	66	46	30	24	22	19	17	14	12	11	10
14.0	66	48	32	26	22	19	17	14	13	11	11
20.0	68	48	32	26	22	20	18	15	13	12	11



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Appendix F
Dimensions of Welded and Seamless Steel Pipe

Nominal Diameter	Schedule	Outside Diameter	Wall Thickness	Internal Diameter	Internal Area	Internal Diameter	Internal Area
Inches		Inches	Inches	Inches	Sq Inches	Feet	Sq Feet
1/8	40 (S)	0.405	0.068	0.269	0.0568	0.0224	0.00039
	80 (X)		0.095	0.215	0.0363	0.0179	0.00025
1/4	40 (S)	0.540	0.088	0.364	0.1041	0.0303	0.00072
	80 (X)		0.119	0.302	0.0716	0.0252	0.00050
3/8	40 (S)	0.675	0.091	0.493	0.1909	0.0411	0.00133
	80 (X)		0.126	0.423	0.1405	0.0353	0.00098
1/2	40 (S)	0.840	0.109	0.622	0.3039	0.0518	0.00211
	80 (X)		0.147	0.546	0.2341	0.0455	0.00163
	160		0.187	0.466	0.1706	0.0388	0.00118
	(XX)		0.294	0.252	0.499	0.0210	0.00035
3/4	40 (S)	1.050	0.113	0.824	0.5333	0.0687	0.00370
	80 (X)		0.154	0.742	0.4324	0.0618	0.00300
	160		0.219	0.612	0.2942	0.0510	0.00204
	(XX)		0.308	0.434	0.1479	0.0362	0.00103
1	40 (S)	1.315	0.133	1.049	0.8643	0.0874	0.00600
	80 (X)		0.179	0.957	0.7193	0.0798	0.00500
	160		0.250	0.815	0.5217	0.0679	0.00362
	(XX)		0.358	0.599	0.2818	0.0499	0.00196
1 1/4	40 (S)	1.660	0.140	1.380	1.496	0.1150	0.01039
	80 (X)		0.191	1.278	1.283	0.1065	0.00890
	160		0.250	1.160	1.057	0.0967	0.00734
	(XX)		0.382	0.896	0.6305	0.0747	0.00438
1 1/2	40 (S)	1.900	0.145	1.610	2.036	0.1342	0.01414
	80 (X)		0.200	1.500	1.767	0.1250	0.01227
	160		0.281	1.338	1.406	0.1115	0.00976
	(XX)		0.400	1.100	0.9503	0.0917	0.00660
2	40 (S)	2.375	0.154	2.067	3.356	0.1723	0.02330
	80 (X)		0.218	1.939	2.953	0.1616	0.02051
	160		0.344	1.687	2.235	0.1406	0.01552
	(XX)		0.436	1.503	1.774	0.1253	0.01232
2 1/2	40 (S)	2.875	0.203	2.469	4.788	0.2058	0.03325
	80 (X)		0.276	2.323	4.238	0.1936	0.02943
	160		0.375	2.125	3.547	0.1771	0.02463
	(XX)		0.552	1.771	2.464	0.1476	0.01711
3	40 (S)	3.500	0.216	3.068	7.393	0.2557	0.05134
	80 (X)		0.300	2.900	6.605	0.2417	0.04587
	160		0.438	2.624	5.408	0.2187	0.03755
	(XX)		0.600	2.300	4.155	0.1917	0.02885
3 1/2	40 (S)	4.000	0.226	3.548	9.887	0.2957	0.06866
	80 (X)		0.318	3.364	8.888	0.2803	0.06172
4	40 (S)	4.500	0.237	4.026	12.73	0.3355	0.08841
	80 (X)		0.337	3.826	11.50	0.3188	0.07984
	120		0.438	3.624	10.32	0.3020	0.07163
	160		0.531	3.438	9.283	0.2865	0.06447
	(XX)		0.674	3.152	7.803	0.2627	0.05419

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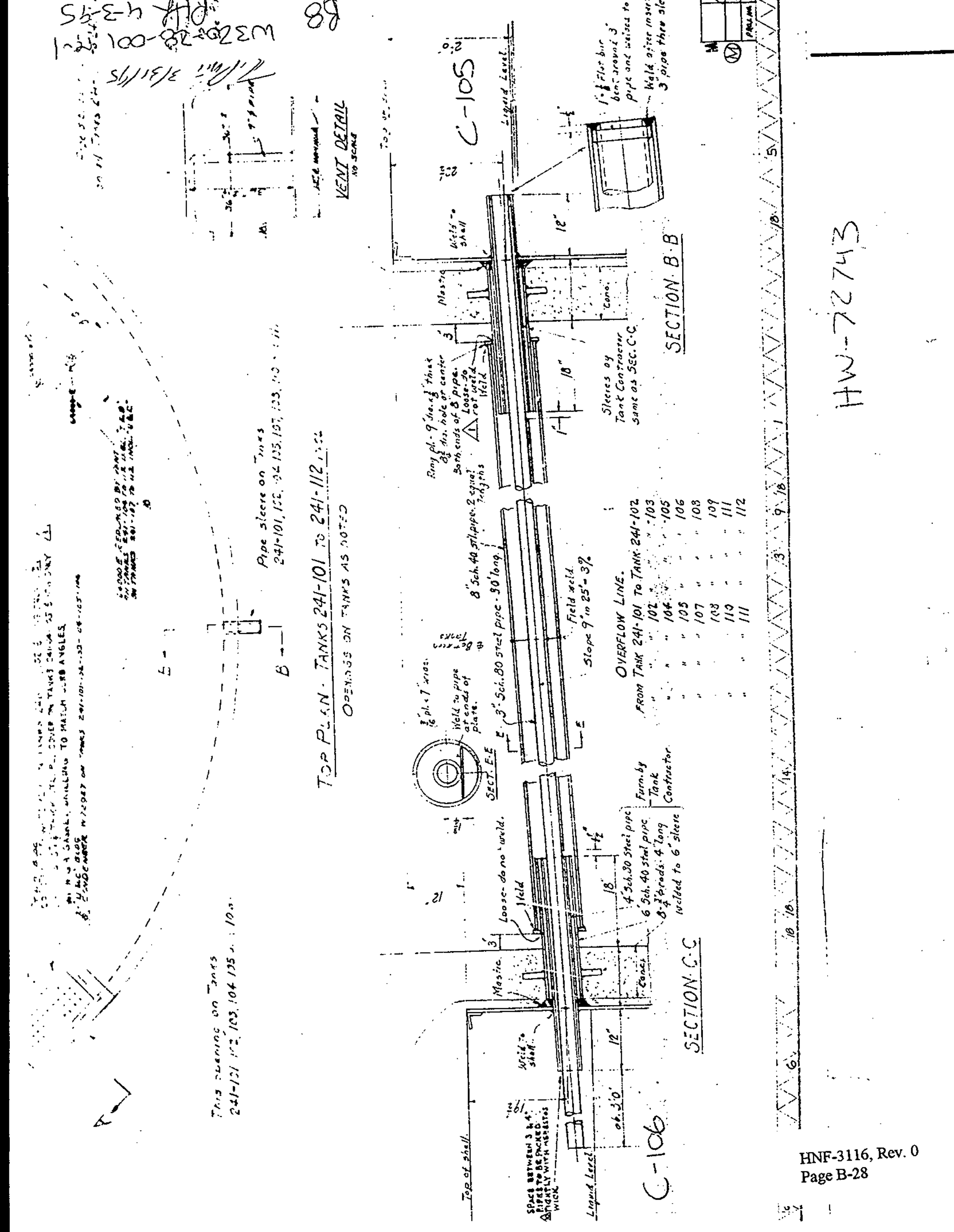

VENT DETAIL
NO SCALE
C-105
SECTION B-B
Sleeves by Tank Contractor same as SEC. C-C
TOP PLAN - TANKS 241-101 TO 241-112 INCL.
OPENINGS ON TANKS AS NOTED
Field weld
Slope 9" in 25'-3⅜
3" Sch. 80 steel pipe - 30' long
8" Sch. 40 stl pipe - 2 equal lengths
OVERFLOW LINE.
SECT. E-E
4" Sch. 80 Steel pipe
6" Sch. 40 steel pipe
Furn. by Tank Contractor
Loose - do not weld.
Weld to shell
Mastic
Conc.
SECTION C-C
Top of shell
Liquid Level
C-106
HW-72743

CALCULATION IDENTIFICATION AND INDEX

Date 3-28-95

This sheet shows the status and description of the attached Design Analysis sheets.

Discipline 28/HVAC　　WO/Job No. ER4319　　Calculation No. ~~W320-H-011~~ 28 W320-28-011

Project No. & Name W-320 Tank 241-C-106 Waste Retrieval

Calculation Item Exhaust Skid Stack Sizing and Fan Sizing

These calculations apply to:

Dwg. No. N/A　　Rev. No. N/A

Dwg. No. N/A　　Rev. No. N/A

Other (Study, CDR) Procurement Specifications:
W-320-P1 Exhaust Skid　　Rev. No. preliminary

The status of these calculations is:

[] Preliminary Calculations

[X] Final Calculations

[] Check Calculations (On Calculation Dated)

[] Void Calculation (Reason Voided)

Incorporated in Final Drawings? [] Yes [X] No

This calculation verified by independent "check" calculations? [] Yes [X] No

Original and Revised Calculation Approvals:

	Rev. 0 Signature/Date	Rev. 1 Signature/Date	Rev. 2 Signature/Date
Originator	PH Langseth 3-28-95	Danny Nguyen 2/13/96	
Checked by	[signature] 3/28/95	[signature] 2/13/96	
Approved by	PH Langseth 3-28-95	[signature] 2/13/96	
Checked Against Approved Vendor Data		Charles T. Li 4/14/98	

INDEX

Design Analysis Page No.	Description
i	Calculation Identification and Index
1	Objective, Design Inputs, Calculations
2-3	Calculations cont.
4	Findings & Conclusions
A1-A9	Appendix A: References, Psychrometric Chart, Vendor Data

KEH 0378.00 (06/92) KEF072

		Calc. No. W320-H-011
		Revision 0
DESIGN ANALYSIS		Page No. 1 of 5
Client WHC	WO/Job No. ER4319	
Subject Exhaust Skid Stack Sizing & Fan Sizing	Date 3-28-95	By PH Langowski
	Checked 3/28/95	By [signature]
Location 241-C/200 East	Revised	By

1.0 OBJECTIVE

The objective of this calculation is to determine the stack sizing required for input to the Exhaust Skid procurement specification. The calculation shall also size the pressure drop on the Exhaust Skid for fan sizing input to the Exhaust Skid procurement specification and estimate heating coil and exhaust fan power requirements.

2.0 DESIGN INPUTS

2.1 CRITERIA AND SOURCE

DOE General Order 6430.1A
Functional Design Criteria WHC-SD-W320-FDC-001, rev. 2, 1/18/94

2.2 GIVEN DATA

1. Upstream pressure drop information from W320-H-018, rev. 1

2.3 ASSUMPTIONS

no major assumptions, see text for minor assumptions.

2.4 METHODS

Hand calculations.

2.5 REFERENCES

1. W320-P1 rev. 0 (IFA draft date 3-29-95) Procurement Specification, Exhaust Skid Ventilation Air Cleanup Trains
2. W320-H-018 rev. 1 Calculation, Pressure Loss Upstream of the Exhaust Skid
3. 1993 ASHRAE Fundamentals
4. SDC 5.1 rev. 7
5. W320-P41 rev. 0 (IFA draft date March 1995) Procurement Specification, Isokinetic Air Sampler Stack Monitor
6. 1985 ASHRAE Fundamentals

3.0 CALCULATIONS

3.1 Stack Sizing

Stack sizing was originally performed by offsite author based on 4" diameter stack, modeling the Exhaust Skid as a 9' tall building. The stack size was changed to a 6" diameter stack to facilitate support of the relocated stack monitor instruments directly on the stack (see ref. 5, App. A). The 6" stack size will be examined with the same logic per ASHRAE Fundamentals (ref. 3) Chapter 14 information except a 6' tall building air intake assumption shall be used instead of 9' tall. The nearest building air intake is not close enough to warrant attention. The 6" stack has a 7" diameter stack head (ref. 5).

The larger diameter stack size drops us below the recommended ASHRAE limit of 2000 fpm since 180 cfm/$[(pi)(7/12)^2/4]$=674 fpm, and at 360 cfm yields 1347 fpm. With a

7 mph wind speed (ref. 4) which equals (7)(5280)/60=616 fpm, we find that V_e is not 1.5 times as high as the wind speed U_H. Using equation 24, it is seen that the additional downwash height h_d, is equal to (2.0)(7/12)(1.5)(1)674/616=1.91 ft.

Using Equation 25, the plume rise, h_r, is calculated as (3.0)(674/616)(7/12)=1.91 ft. Equation 26 shows that h_r and h_d cancel each other out. The capped height of the stack above the fictional Exhaust Skid building, h_{sc}, is therefore determined using Equations 1 and 5 with the 1:5 slope. From Equation 1, $R=6.5^{0.67}26^{0.33}$ = 10.3 ft. From Equation 5, L_r=(1)(10.3) = 10.3 ft. For the 1:5 sloping plume to not enter the recirculation region of Figure 3, h_{sc} must be greater than (26.5+10.3)/5 = 7.4 ft. The total stack height must therefore be greater than the sum of the height of the building (6 ft.) and h_{sc}. Therefore, the total stack height must be greater than 6+7.4 = 13.4 ft. This minimum stack height will yield a suitable design. Ref. 5 shows a total stack and head height of 20'.

3.2 Exhaust fan sizing

From ref 2 calculation, the upstream pressure drops are as follows:

condition	minimum exhaust 180 scfm	maximum exhaust 360 scfm
clean & dry components	18.6" w.g.	24.4" w.g.
dirty & wet components	33.9" w.g.	34.5" w.g.

The pressure losses on the Exhaust Skid are estimated at 180 scfm as follows:

component	reference	loss in. w.g.
shutoff valve, 6"	ref. 6, 7-5, C_o=0.50 (180)/[(pi)(6/12)^2/4]=917 fpm, V_p=0.052	(0.50)(0.052) =0.026
electric heating coil	ref. 2, similar to recirculation heating coil	0.060
transition to square	use C_o=0.50	(0.50)(0.052) =0.026
inlet test section, 24"x24"	assumed negligible	0.000
HEPA filter, 24"x24"	(180/1000)(1)=0.18, assumes 1000 cfm size filter	0.18
combination test section, 24"x24"	assumed negligible	0.000

DESIGN ANALYSIS

Client WHC
Subject Exhaust Skid Stack Sizing & Fan Sizing
Location 241-C/200 East
WO/Job No. ER4319
Date 3-28-95 By PH Langowski
Checked 5/28/95 By [signature]
Revised By

HEPA filter, 24"x24"	(180/1000)(1)=0.18, assumes 1000 cfm size filter	0.18
outlet test section, 24"x24"	assumed negligible	0.000
transition to round	assumed negligible	0.000
shutoff valve, 6"	ref. 6, 7-5, C_o=0.50 (180)/[(pi)(6/12)^2/4]=917 fpm, V_p=0.052	(0.50)(0.052) =0.026
stack & duct misc., 6"	20'(0.3" w.g./100')	0.060
stack head, 7"	ref. 3, SD2-6, C_o=1.00	0.052
		total 0.610

18.6 + 0.6 = 19.2" w.g. at 180 scfm (clean & dry). Round down to 19" for use in ref. 1.

The pressure losses on the Exhaust Skid are estimated at 360 scfm as follows:

component	reference	loss in. w.g.
shutoff valve, 6"	ref. 6, 7-5, C_o=0.50 (360)/[(pi)(6/12)^2/4]=1833 fpm, V_p=0.210	(0.50)(0.210) =0.105
electric heating coil	ref. 2, similar to recirculation heating coil, use 0.100 as heating coil sized for variable flow will probably have a higher pressure drop than normal at the high end.	0.100
transition to square	use C_o=0.50	(0.50)(0.210) =0.105
inlet test section, 24"x24"	assumed negligible	0.050
HEPA filter, 24"x24"	filter loaded to 4" w.g.	4.000
combination test section, 24"x24"	assumed negligible	0.050
HEPA filter, 24"x24"	filter loaded to 2" w.g. (note that the project documentation shows that the maximum allowable across both filters is 5.9" w.g.)	2.000
outlet test section, 24"x24"	assumed negligible	0.050

DESIGN ANALYSIS

Client WHC
Subject Exhaust Skid Stack Sizing & Fan Sizing
Location 241-C/200 East

WO/Job No. ER4319
Date 3-28-95 By PH Langowski
Checked 3/28/95 By [signature]
Revised 2/13/96 By [signature] 2/13/96

transition to round	assumed negligible	0.000
shutoff valve, 6"	ref. 6, 7-5, C_o=0.50 (360)/[(pi)(6/12)^2/4]=1833 fpm, V_p=0.210	(0.50)(0.210) =0.105
stack & duct misc., 6"	20'(1.0" w.g./100')	0.200
stack head, 7"	ref. 3, SD2-6, C_o=1.00	0.210
		total 6.975

34.5 + 7.0 = 41.5" w.g. at 360 scfm (dirty, wet). Round up to 42" for use in ref. 1.

The brakehorspower required is estimated based on vendor data (App. A) of fan operating at 360 acfm at 40.8" w.g. at 140F & density=0.0644 (309 scfm at density=0.075). The 5.95 bhp with a 90% efficiency motor is equivalent to a 6.61 hp motor requirement. A 7.5 hp nameplate motor should be sufficient.

3.3 Exhaust heating coil sizing, 60% relative humidity

The normal maximum heating coil size would be required for the case of 360 scfm entering air at 40F saturated and the design exiting condition of 60% relative humidity at 53F (see psychrometric chart, App. A). The enthalpy change between these two states is 18.3 - 15.3 Btu/lb_{da} = 3.0 Btu/lb_{da}. At the entering density of 12.696 ft^3/lb_{da}, this yields (360 scfm)(3.0 Btu/lb_{da})/(12.696 ft^3/lb_{da}) = 85.07 Btu/min (5104 Btu/h, or 1.5 KW).

⚠1 The maximum upset heating coil size would be required for the case of 360 scfm entering air at 120F saturated and the design exiting condition of 60% relative humidity at 139F (see psychrometric chart, App. A). The enthalpy change between these two states is ~~131~~ 125 - 119.5 Btu/lb_{da} = ~~11.5~~ 5.5 Btu/lb_{da}. At the entering density of 16.519 ft^3/lb_{da}, this yields (360 scfm)(~~11.5~~ 5.5 Btu/lb_{da})/(16.519 ft^3/lb_{da}) = ~~250.06~~ 119.86 Btu/min (~~15,037~~ 7,192 Btu/h, or ~~4.4~~ 2.1 KW).

KEH 0037.00 (06/92) KEF055

DESIGN ANALYSIS

Client WHC
Subject Exhaust Skid Stack Sizing & Fan Sizing
Location 241-C/200 East

WO/Job No. ER4319
Date 3-28-95 By PH Langowski
Checked 3/28/95 By R. Pino
Revised 2/13/96 By Danny Nguyen

4.0 FINDINGS & CONCLUSIONS

The Exhaust Skid stack sizing of 20' total (including stack head) will be adequate.

The Exhaust Skid fan will be required to be selected for the following pressure loss conditions. The fan motor will be required to be approximately 7.5 hp.

	minimum exhaust 180 scfm	maximum exhaust 360 scfm
design condition	19" w.g.	42" w.g.

The Exhaust Skid heating coil will be approximately 1.5 KW under normal operating conditions. In the upset condition, ~~24.4~~ 2 KW will be required. The heating coil with SCR control shall be capable of operating across a power range up to ~~4.4~~ 2 KW.

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APPENDIX A

PHL 3-28-95
RP 3/28/95

CHAPTER 14

AIRFLOW AROUND BUILDINGS

AIRFLOW around buildings affects worker safety, process and building equipment operation, weather and pollution protection at inlets, and the ability to control environmental factors of temperature, humidity, air motion, and contaminants. Wind causes surface pressures that vary around buildings, changing intake and exhaust system flow rates, natural ventilation, infiltration and exfiltration, and interior pressure. The mean flow patterns and turbulence of wind passing over a building can cause a recirculation of exhaust gases to air intakes. This chapter contains information for evaluating flow patterns, estimating wind pressures and air intake contamination, and solving problems caused by the effects of wind on intakes, exhausts, and equipment. Related information can be found in Chapters 11, 13, 23, and 24 of this volume; in Chapters 25, 27, and 47 of the 1991 Applications volume; and in Chapters 26, 31, 36, and 37 of the 1992 Systems and Equipment volume.

FLOW PATTERNS

Buildings of an even moderately complex shape, such as L- or U-shaped structures formed by two or three rectangular blocks, can generate flow patterns too complex to generalize for design. To determine flow conditions influenced by surrounding buildings or topography, a wind tunnel or water channel test of scale models or tests of existing buildings are required. However, if a building is oriented perpendicular to the wind, it can be considered as consisting of several independent rectangular blocks. Only isolated rectangular block buildings will be discussed here. Hosker (1984, 1985) reviews the effects of nearby buildings.

The mean speed of wind approaching a building increases with height above the ground (Figure 1). Both the upwind velocity profile shape and its turbulence level strongly influence flow patterns and surface pressures. A stagnation zone exists on the upwind wall. The flow separates at the sharp edges to generate recirculating flow zones that cover the downwind surfaces of the building (roof, sides, and leeward walls) and extend for some distance into the wake. If the building has sufficient length L in the windward direction, the flow will reattach to the building (Figure 2) and may generate two distinct regions of separated recirculating flow—on the building and in its wake.

Surface flow patterns on the upwind wall are largely influenced by approach wind characteristics. Higher wind speed at roof level causes a larger stagnation pressure on the upper part of the wall than near the ground, which leads to downwash on the lower one-half to two-thirds of the building (Figure 1). On the upper one-quarter to one-third of the building, the surface flow is directed upward over the roof. For a building whose height H is three or ·times the width W of the upwind face, an intermediate zone exist between the upwash and downwash regions, where the surface streamlines pass horizontally around the building. The downwash on the lower surface of the upwind face separates from the building before it reaches ground level and moves upwind to form a vortex that can generate high velocities close to the ground. This ground level upwind vortex is carried around the sides of the building in a U shape (Figure 1b) and is responsible for the suspension of dust and debris that can contaminate air intakes close to ground level.

Recirculation and High Turbulence Regions

For wind perpendicular to a building wall, the height H and width W of the upwind building face determine the flow patterns shown in Figure 3. According to Wilson (1979), the scaling length R which combines these dimensions is:

$$R = B_s^{0.67} B_L^{0.33} \tag{1}$$

where B_s is the smaller and B_L the larger of the dimensions H and W. When B_L is larger than $8B_s$, use $B_L = 8B_s$ in Equation (1). For buildings with varying roof levels or with wings separated by at least a distance B_s, only the height and width of the building face below the portion of the roof in question should be used to calculate R. Wilson (1976) indicates that for a flat-roofed building, the recirculation region maximum height H_c, at location X_c, and reattachment lengths L_c and L_r shown in Figures 3 and 17 are:

$$H_c = 0.22R \tag{2}$$

$$X_c = 0.5R \tag{3}$$

$$L_c = 0.9R \tag{4}$$

$$L_r = 1.0R \tag{5}$$

The downwind boundary of the rooftop recirculation region may be approximated by a straight line sloping downward from H_c to the roof at L_c. The dimensions of the recirculation zones are somewhat sensitive to the intensity and scale of turbulence in the approaching wind. High levels of turbulence from upwind obstacles may decrease the coefficients in Equations (2) through (5) by up to a factor of 2. Turbulence in the recirculation region and in the approaching wind also causes the reattachment locations on Figure 2 to fluctuate.

To account for changes in roof level, penthouses, and equipment housings and enclosures, the scaling length R of each of these obstacles should be calculated from Equation (1) using the dimensions of the upwind face of the obstacle. The recirculation region for each obstacle may be calculated from Equations (2), (3), and (4). The length L_r of the recirculation region downwind from the obstacle, or from the entire building, is given by Equation (5), with R based on the dimensions of the downwind face of the obstacle. The high turbulence region boundary Z_2 in Figure 17 follows a 1:10 (5.7°) downward slope from the top of the recirculation regions at X_c or L_r. When an obstacle is close to the

The preparation of this chapter is assigned to TC 2.5, Air Flow Around Buildings

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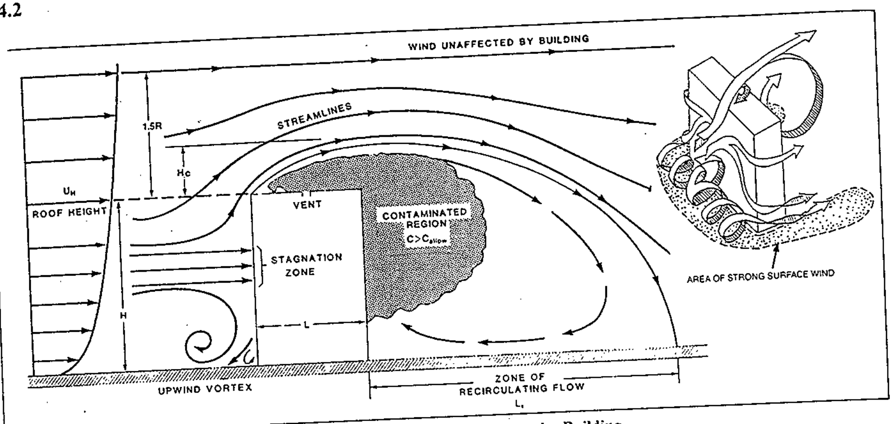

Fig. 1 Flow Patterns around Rectangular Building

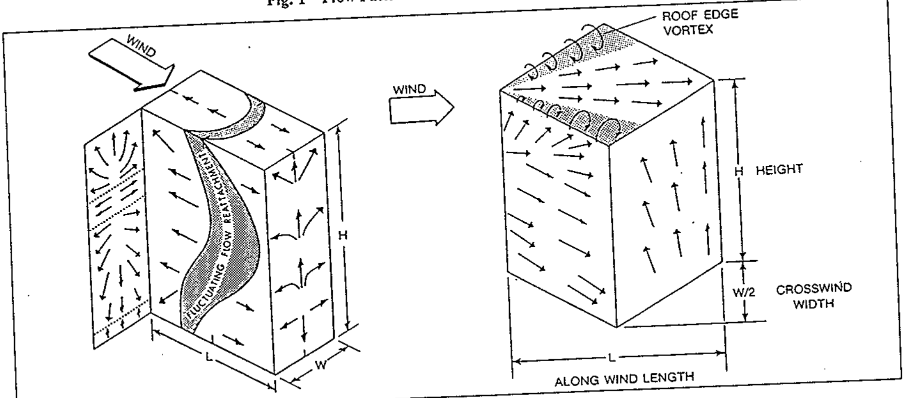

Fig. 2 Surface Flow Patterns and Building Dimensions

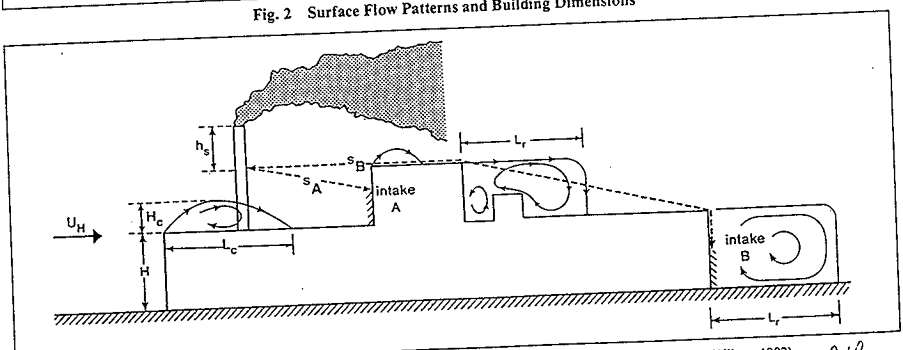

Fig. 3 Flow Recirculation Regions and Exhaust to Intake Stretched String Distances (Wilson 1982)

wind directions, when the exhaust is uncapped ($\beta = 1$) and $/U_H > 0.5$. A value of $B_1 = 0.0204$ should be used if V_e/U_H 5 or the stack is capped ($\beta = 1$) and the wind is at 45° to the upwind wall, or if there is no significant atmospheric turbulence, for example, at roof level of high-rise buildings, or in flat rural surroundings [Wilson and Chui (1987), Chui and Wilson (1988)].

Equations (19), (20), and (21) imply that minimum dilution does not depend on the location of either the exhaust or intake, only on the distance S between them. This is true when exhaust and intake locations are on the same building wall or on the roof. The dilution may increase if the intake and exhaust are located on different faces, as indicated by the M factor in Equation (18). For roof exhausts with wall intakes, the results of Li and Meroney (1983) suggest that $B_1 \cong 0.20$ in Equation (21).

For buildings less than about 330 ft high and also less than twice as high as the surrounding buildings, atmospheric turbulence makes a significant contribution to exhaust gas dilution. Wilson (1976, 1977) gives surface concentration contours for flat-roofed buildings in a simulated approach wind typical of an urban area. Flush vents with small exhaust velocity make these results suitable for estimates for capped exhaust stacks or louvered exhaust vents.

The effect of atmospheric turbulence is relatively insignificant for high-rise buildings taller than 330 ft and also twice the average building height for 3000 ft upwind. On these high-rise buildings, where the effects of atmospheric turbulence are small, Wilson and Chui (1987) found that maximum surface concentrations for 10-min exposures were two to ten times higher than on an equivalent low-rise building. A dilution coefficient of $B_1 = 0.02$ should be used for high-rise buildings.

When exhaust from several collecting stations is combined in a single vent or in a tight cluster of stacks, the effective exhaust area A_e will increase, causing the minimum dilution in ation (19) to decrease. To qualify as a cluster, the stacks must all lie within a two-stack diameter radius of the middle of the group. Stacks lined up in a row do not act as a single stack, as shown by Gregoric *et al.* (1982). However, the exhaust concentration C_e of each contaminant will decrease by mixing with other exhaust streams, and the plume rise will increase due to the higher momentum in the combined jets. For combined vertical exhaust jets, the roof level intake concentration C in Equation (12) will almost always be lower than the intake concentration caused by separate exhausts. Where possible, exhausts should be combined before release to take advantage of this increase in overall dilution.

Critical Wind Speed and Dilution

At very low wind speed, the exhaust jet from an uncapped stack will rise high above roof level, producing a large exhaust dilution D_{min} at a given intake location. Likewise, at high wind speed, the dilution will also be large because of the longitudinal stretching of the plume by the wind. Between these extremes, a critical wind speed exists at which the least dilution will occur for a given exhaust and intake location. This critical, absolute minimum dilution D_{crit} may be used to determine if an exhaust vent will be safe under all wind conditions. The critical wind speed for an uncapped vertical exhaust ($\beta = 1.0$) can be evaluated by finding the absolute minimum in Equations (19), (20), and (21). It is closely approximated by

$$U_{crit,o}/V_e = 2.9B_1^{-0.33}(S/A_e^{0.5})^{-0.67} \quad (22)$$

re $U_{crit,o}$ is the critical wind speed producing the smallest num dilution for an uncapped vertical exhaust with negligible stack height. This critical dilution $D_{crit,o}$ may be found by using Equation (22) in Equation (19). For $S/A_e^{0.5} > 5$, this minimum is closely approximated by

$$D_{crit,o} = 1 + 7.0B_1^{0.67}(S/A_e^{0.5})^{1.33} \quad (23)$$

The critical dilution in Equation (23) depends only on distance from the exhaust and not on the exhaust velocity V_e. However, increasing the exhaust velocity increases the critical wind speed in Equation (22), usually causing this worst-case critical dilution to occur less frequently.

To assess the severity of the hazard caused by intake contamination, it is useful to know how often the worst case D_{crit} is likely to occur. The number of hours per year during which the dilution is no more than a factor of 2 higher than the critical minimum value may be estimated from weather records by finding the fraction of time that the wind speed lies in the range from 0.5 $U_{crit,o}$ to 3.0 $U_{crit,o}$ (Wilson 1982, 1983). This fraction is then multiplied by the fraction of time the local wind direction lies in a sector ± 22.5° on each side of the line joining the exhaust and intake location.

EXHAUST STACK DESIGN

Before discharge, exhaust contamination should be reduced by filters, collectors, and scrubbers. Central exhaust systems that combine flows from many collecting stations should always be used where safe and practical. By combining several exhaust streams, central systems dilute intermittent bursts of contamination from a single station. However, in some cases, separate exhaust systems are mandatory. The nature of the contaminants to be combined, the recommended industrial hygiene practice, and the applicable safety codes need to be considered. Halitsky (1966) and Briggs (1984) present methods for estimating the trajectory of jets and the subsequent dispersion of jet plumes.

Separate exhaust stacks should be grouped in a tight cluster to take advantage of the larger plume rise of the resulting combined jet. In addition, a single stack from a central exhaust system or a tight cluster of stacks allows building air intakes to be placed as far as possible from the exhaust location. As shown in Figure 3, the effective stack height h_s is the portion of the exhaust stack that extends above local recirculation zones and upwind and downwind obstacles. Wilson and Winkel (1982) demonstrated that stacks terminating below the level of adjacent walls and architectural enclosures do not effectively reduce roof-level exhaust contamination. To take full advantage of their height, stacks should be located on the highest roof of a building. Where architectural enclosures are used to mask rooftop equipment, stacks must extend above the height H_c of the flow recirculation zone over the enclosure to prevent exhaust contamination of equipment within the enclosure.

Required Stack Exhaust Velocity

High stack discharge velocity and temperature increase plume rise and reduce intake contamination by increased jet dilution and by the elevated plume trajectory. However, high discharge velocity is a poor substitute for increased stack height.

As shown in Figure 15, stacks should have vertically directed uncapped exhaust jets. Stack caps which deflect the exhaust jet have a detrimental effect on both minimum dilution and critical wind speed. In any case, conical stack caps often do not eliminate rain, because rain does not usually fall straight down. Changnon (1966) shows that periods of heavy rainfall are often accompanied by high winds that deflect the raindrops under the cap and into the stack. A stack velocity of about 2500 fpm prevents condensed moisture from draining down the stack and keeps rain from entering the stack. Even when there are drains in the stack, the exhaust velocity should be maintained above 2000 fpm to provide adequate plume rise and jet dilution. Where stack condensate is corrosive, the body of the stack should be sized for a velocity of 1000 fpm

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or less, and a drain provided for the condensate (Anonymous 1964). The stack tip should have a converging cone (Figure 15B) to provide the required high-velocity discharge of 2000 to 3000 fpm. For intermittently operated systems, protection from rain and snow should be provided by stack drains as shown in Figures 15F through 15J.

Stack Height to Avoid Exhaust Entrainment

To avoid entrainment of exhaust gases into the wake, stacks must terminate above the flow recirculation height H_c. Where stacks or exhaust vents discharge within this recirculation region, gases rapidly diffuse to the roof and may enter ventilation intakes or other openings. Figure 1 shows that this effluent will flow into the zone of recirculating flow behind the downwind face and will, in some cases, be brought back up onto the roof.

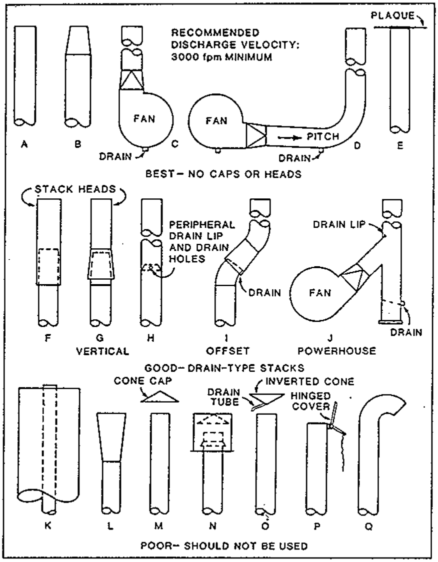

Fig. 15 Stack Designs Providing Vertical Discharge and Rain Protection

A high velocity exhaust with V_e at least 1.5 times as large as the wind speed U_H at roof height is essential not only to provide good initial dilution near the stack, but also to avoid stack wake downwash, which can reduce or eliminate plume rise. Downwash of the exhaust into the stack wake, shown in Figure 16, is caused by the low-pressure region which develops in the wake on the lee side of the stack. In situations where exhaust velocity cannot be maintained at a value larger than 1.5 times the wind speed, an additional downwash height h_d (see Figure 16) should be added to the stack height h_s. For a vertically directed jet from an uncapped stack ($\beta = 1.0$), Briggs (1973) recommends

$$h_d = 2.0d(1.5\beta V_e / U_H) \qquad (24)$$

for $V_e/U < 1.5$, where $d = (4A_e/\pi)^{0.5}$ is the effective stack diameter. Rain caps are frequently used on stacks of gas-and oil-fired furnaces and package ventilation units. These units will have $\beta = 0$, so $h_d = 3.0d$, and this should be added to the nominal height h_s to avoid flue gas contamination of roof-mounted equipment and air intakes.

The design procedure for selecting an appropriate stack height starts by calculating the height h_{sc} of a stack with a rain cap and, therefore, no plume rise. For an uncapped vertical exhaust, the minimum rise h_r of the bent-over exhaust jet is estimated, and the

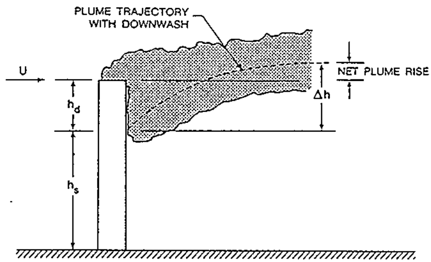

Fig. 16 Reduction of Effective Stack Height by Stack Wake Downwash

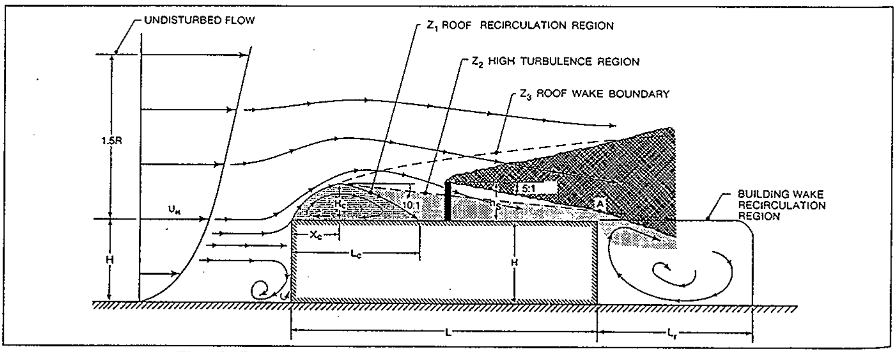

Fig. 17 Design Procedure for Required Stack Height to Avoid Contamination
(Wilson 1979)

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capped height h_{sc} is lowered by an amount h_r to give credit for plume rise (see Figure 16).

The capped stack height h_{sc} required to avoid excessive exhaust gas reentry is estimated by assuming that the plume spreads upward and downward from h_{sc} with a 1:5 slope (11.3°), as shown in Figure 17. The first step is to raise the capped height h_{sc} until the lower edge of the 1:5 sloping plume avoids contact with all recirculation (zone 1) boundaries on rooftop obstacles such as air intake housings, architectural screens, or penthouses. The size of these recirculation zones, shown in Figures 3 and 17, are calculated using Equations (2), (3), and (4).

If air intakes are located on the downwind wall, the lower edge of the plume, sloping down at 1:5, must lie above the downwind edge of the roof when a nontoxic exhaust contaminant, such as an odor or water vapor, is being dealt with. For a toxic contaminant that requires a large dilution factor at the wall intake, the lower edge of the plume should lie above the flow recirculation zone in the wake downwind of the building. The boundary of the building wake recirculation, shown in Figures 1, 3, and 17, is defined by a horizontal line extending a distance L_r from the downwind edge of the roof. The recirculation length L_r is calculated from Equation (5).

For an uncapped stack, the plume rise h_r due to the vertical momentum of the exhaust is estimated from Briggs (1984) as

$$h_r = 3.0(V_e/U_H)d \tag{25}$$

where the wind speed U_H is the maximum design wind speed for which air intake contamination must be avoided. The required height h_s of the uncapped stack extending above local recirculation zones and obstacles is

$$H_S = h_{SC} - h_r + h_d \tag{26}$$

If the minimum recommended exhaust velocity of $V_e = 1.5\ U_H$ is maintained, plume downwash $h_d = 0$, and $h_r = 4.5d$; thus, an uncapped stack can be made 4.5d shorter than a capped one.

The largest flow recirculation, high turbulence, and wake regions occur when wind is normal to the upwind wall of the building. Required stack heights should be the largest of the heights determined for all four directions for which the wind is normal to a building wall.

Estimating Critical Dilution for Exhaust Stacks

The geometric design for avoiding excessive contamination does not give any estimate of the worst case critical dilution factor D_{crit} between the stack and an air intake. In this section, D_{crit} will be estimated for a predetermined stack height.

An increase in stack height or in exhaust velocity ratio V_e/U_H reduces roof-level contamination by keeping the high concentrations on the plume centerline far enough above the roof so that the intakes see only intermittent concentrations in the fringes of the plume. In addition, stack height or high exhaust velocity increases the critical wind speed at which the absolute minimum dilution occurs. This higher critical wind speed often reduces significantly the number of hours per year that high intake contamination (*i.e.*, low dilution) will be observed.

Using a Gaussian plume dispersion equation, with a plume spread standard deviation of 0.14S, and an uncapped vertical exhaust jet with no buoyancy and with plume rise inversely proportional to wind speed, the critical wind speed U_{crit} at which the smallest minimum dilution D_{crit} observed is

$$\frac{U_{crit,o}}{U_{crit}} = (Y + 1)^{0.5} - Y^{0.5} \tag{27}$$

where $U_{crit,o}$ is the critical wind speed for a flush (zero stack height) vertical exhaust, computed from Equation (22). The influence of stack height on the worst case critical dilution for the standard 10-min exposure time may be calculated from

$$\frac{D_{crit}}{D_{crit,o}} = \frac{U_{crit}}{U_{crit,o}} \exp[Y + Y^{0.5}(Y + 1)^{0.5}] \tag{28}$$

where $Y = 12.6(h_s/S)^2$, and $D_{crit,o}$ is the dilution at critical wind speed for a flush vertical roof exhaust with no stack height, from Equation (23). Equations (27) and (28) are reliable only for $Y < 2.0$. Close to the stack, where $Y > 2.0$, use $Y = 2.0$ in Equations (27) and (28). Because both wind speed and turbulence intensity vary strongly with height above the building roof, the plume rise of the exhaust jet may not be inversely proportional to wind speed; normally its behavior is between $\Delta h \propto U^{-0.4}$ and $U^{-1.0}$. Thus, Equations (27) and (28) are only approximations. Because buoyancy is not included, the added rise due to buoyancy provides a factor of safety, particularly at low wind speed.

Because Equations (27) and (28) give the effect of a stack relative to a flush exhaust with $h_s = 0$, they are useful for assessing the advantages of increasing stack height as a remedial measure. By comparing two different heights, this calculation allows the relative benefits of a stack to be estimated without knowing any details of the contaminant concentrations or exhaust velocity in the existing stack. For example, the stack height required using the simple geometrical design procedure in the following section will have h_s/S of at least 0.2. Equations (27) and (28) show that the critical wind speed U_{crit} for this stack height will be about a factor of 2 larger, and the critical dilution D_{crit}, about eight times more than for the vertical jet from an uncapped exhaust with zero effective stack height.

Example 1. The stack height h_s of the uncapped vertical exhaust on the building shown in Figure 3 must be specified to avoid excessive contamination of air intakes A and B by stack gases. The stack has a diameter d of 1.64 ft and an exhaust velocity V_e of 1770 fpm. It is located 52.5 ft from the upwind edge of the roof. The penthouse has its upwind wall (with intake A) located 98.4 ft from the upwind edge of the roof, a height of 13.1 ft, and a length of 23.0 ft in the wind direction. The top of intake A is 6.56 ft below the penthouse roof. The building has a height H of 49.2 ft and a length of 203 ft. The top of intake B is 19.7 ft below roof level. The width (measured into the page) of the building is 164 ft, and the penthouse is 29.5 ft wide. What are the required stack heights h_s for both nontoxic and highly toxic exhaust contaminants for a design wind speed specified at a factor of 2 higher than the annual average hourly wind speed of 9.32 mph at a nearby airport with anemometer height H_{ref} of 32.8 ft? The building is located in unshielded suburban terrain.

Solution: The first step is to set the height h_{sc} of a capped stack by projecting lines with 5:1 slopes upwind from points of potential plume impact. For intake A, the highest point of impact is the top of the recirculation zone on the roof of the penthouse. To find the height of this recirculation zone, start with Equation (1).

$$R = (13.1)^{0.67}(29.5)^{0.33} = 17.2 \text{ ft}$$

Then use Equations (2) and (3):

$$H_c = 0.22(17.2) = 3.77 \text{ ft}$$
$$X_c = 0.5(17.2) = 8.60 \text{ ft}$$

With the 5:1 slope of the lower plume boundary shown in Figure 17, the capped stack in Figure 3 must be

$$h_{sc} = 0.2(98.4 - 52.5 + 8.60) + 3.77 = 14.7 \text{ ft}$$

above the penthouse roof to avoid intake A. For intake B on the downwind wall, the plume boundary from the stack in Figure 3 must lie above the end of the roof for nontoxic exhaust gas or the end of the building flow recirculation zone for highly toxic exhaust gas. For this recirculation zone, from Equation (1):

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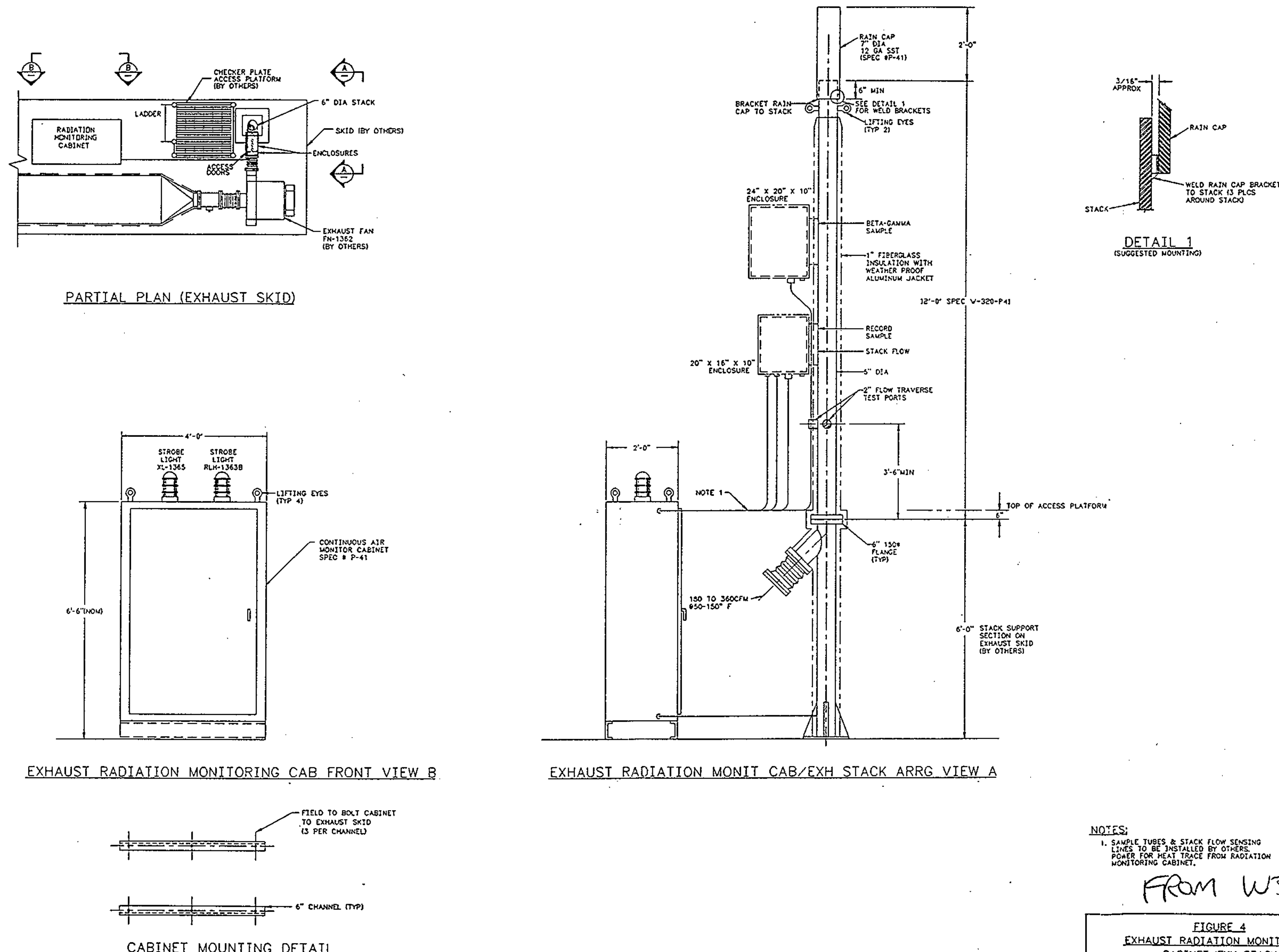

NOTES:

1. SAMPLE TUBES & STACK FLOW SENSING LINES TO BE INSTALLED BY OTHERS. POWER FOR HEAT TRACE FROM RADIATION MONITORING CABINET.

FROM W320-P41 rev 0 IFA March 9

FIGURE 4
EXHAUST RADIATION MONITORING CABINET/EXH STACK

PAGE 22

THE NEW YORK BLOWER COMPANY

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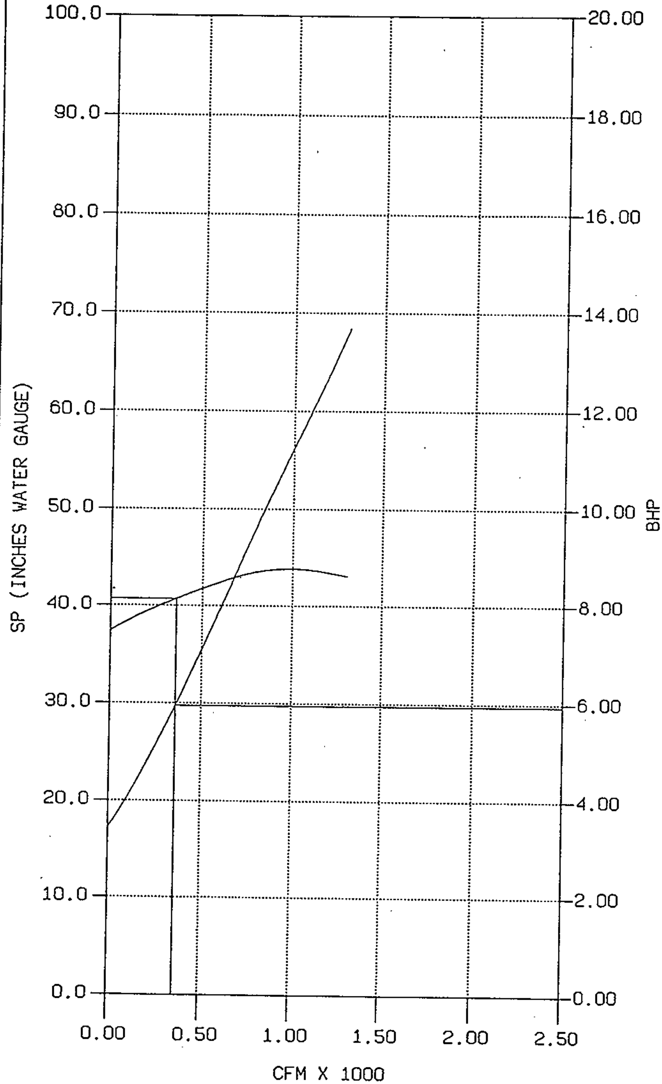

FAN INFORMATION

Pressure Blower - AL
Belt Drive MATL: Alumin
Size: 2606
Tag : 2DT
Date: 3/1/1994
CFM : 360 SP : 40.80
OV : 1800 why not 40
RPM : 3406 BHP: 5.95
DEN : 0.0644
TEMP: 140 DEG F
SE : 38.6% ME : 38.8%
** LEFT-OF-PEAK **

CUSTOMER

EXHAUST SKID
3/4/94 JThomas
91044-013
PAGE 13 OF 13

W320-H-011

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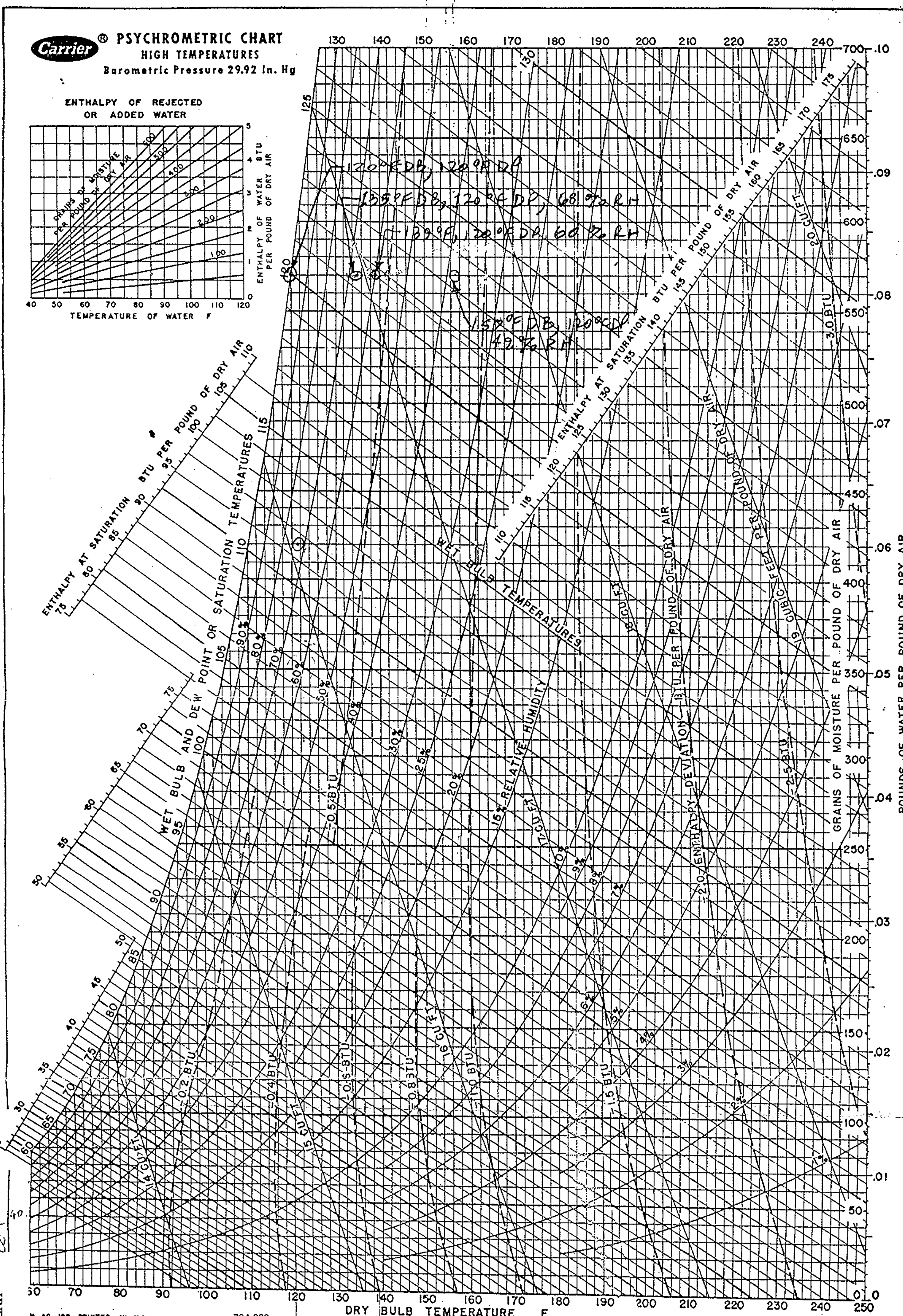

Carrier ® PSYCHROMETRIC CHART
HIGH TEMPERATURES
Barometric Pressure 29.92 In. Hg
ENTHALPY OF REJECTED OR ADDED WATER
GRAINS OF MOISTURE PER POUND OF DRY AIR
ENTHALPY OF WATER BTU PER POUND OF DRY AIR
TEMPERATURE OF WATER F
ENTHALPY AT SATURATION BTU PER POUND OF DRY AIR
WET BULB AND DEW POINT OR SATURATION TEMPERATURES
WET BULB TEMPERATURES
RELATIVE HUMIDITY
ENTHALPY DEVIATION BTU PER POUND OF DRY AIR
CUBIC FEET PER POUND OF DRY AIR
GRAINS OF MOISTURE PER POUND OF DRY AIR
POUNDS OF WATER PER POUND OF DRY AIR
DRY BULB TEMPERATURE F
120°F DB, 120°F DP
135°F DB, 120°F DP, 68% RH
139°F, 120°F DP, 60% RH
155°F DB, 120°F DP
49% RH
M AC-199 PRINTED IN USA
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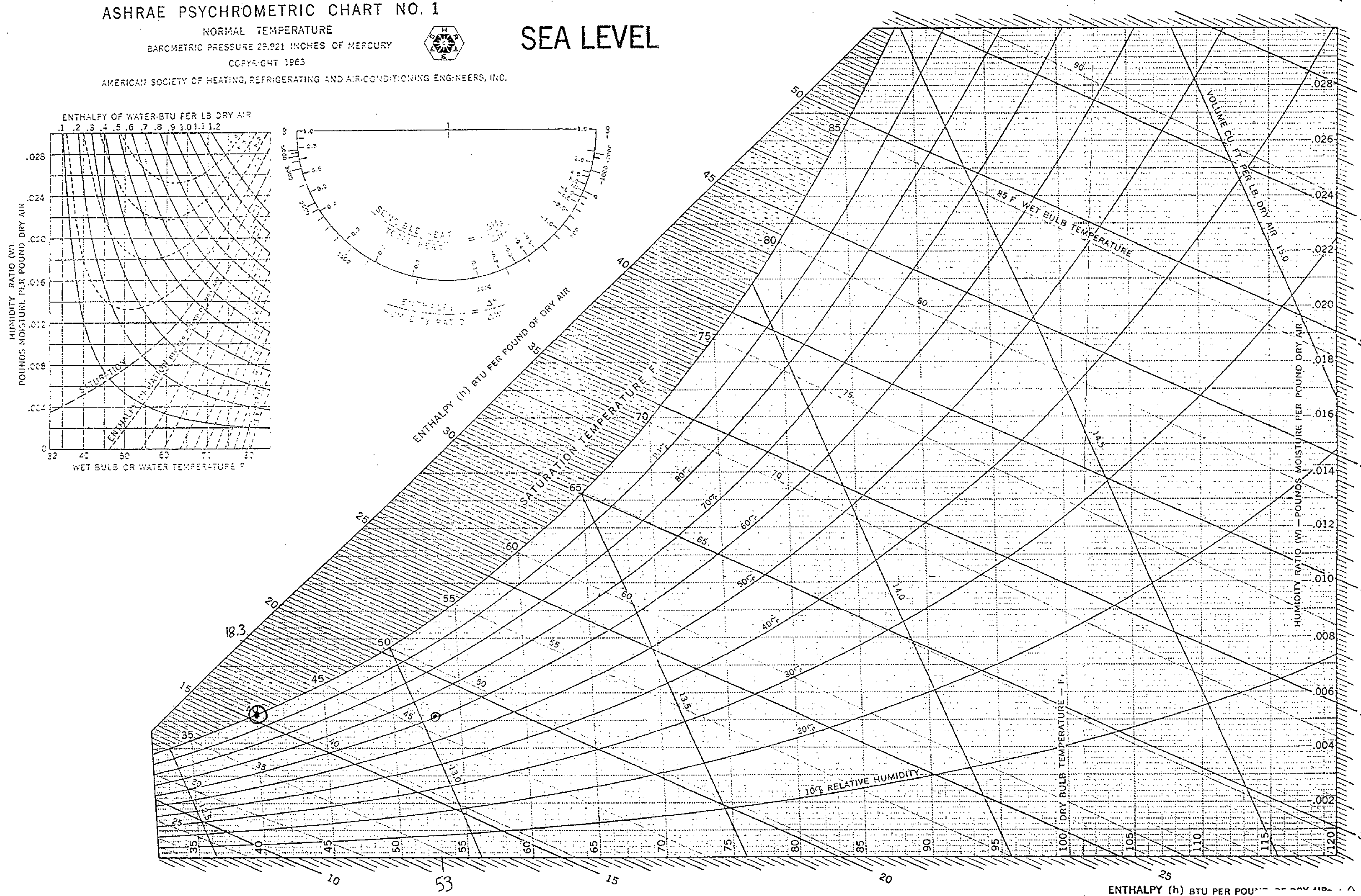
W320-H-011

ASHRAE PSYCHROMETRIC CHART NO. 1

NORMAL TEMPERATURE

BAROMETRIC PRESSURE 29.921 INCHES OF MERCURY

SEA LEVEL



CALCULATION IDENTIFICATION AND INDEX

Date 6-17-94

This sheet shows the status and description of the attached Design Analysis sheets.

Discipline 28/HVAC WO/Job No. ER4319 Calculation No. ~~W320-H-018~~ W320-28-018

Project No. & Name W-320 Tank 241-C-106 Waste Retrieval

Calculation Item Pressure loss upstream of the Exhaust Skid

These calculations apply to:

Dwg. No. N/A Rev. No. N/A

Dwg. No. N/A Rev. No. N/A

Other (Study, CDR) Procurement Specifications:
W-320-P1 Exhaust Skid Rev. No. ~~preliminary~~ 0
W-320-P6 Recirculation fan Rev. No. ~~preliminary~~ 0
W-320-P8 Moisture Separator Rev 0

The status of these calculations is:

- ~~[X]~~ Preliminary Calculations
- [X] Final Calculations
- [ ] Check Calculations (On Calculation Dated)
- [ ] Void Calculation (Reason Voided)

Incorporated in Final Drawings? [ ] Yes [X] No

This calculation verified by independent "check" calculations? [ ] Yes [X] No

Original and Revised Calculation Approvals:

	Rev. 0 Signature/Date	Rev. 1 Signature/Date	Rev. 2 Signature/Date
Originator	PH Laughn 6-17-94	PH Laughn 2-3-95	
Checked by	Paul Rice 6/23/94	[signature] 2/27/95	
Approved by	PH Laughn 6-24-94	PH Laughn 2-28-95	
Checked Against Approved Vendor Data		Charles T. Li 4/15/98	

INDEX

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1	Objective, Design Inputs
2	Calculations & Findings & Conclusions
A1-~~A5~~ A10	Appendix A: Maximum flow & Pressure Drop
B1-~~B10~~ B14	Appendix B: Supporting Information
C1-~~C8~~ C9	Appendix C: Other Flow Conditions

KEH 0378.00 (06/92) KEF072

Calc. No. W320-~~H~~ 28-018
Revision ~~0~~ 1 PHL
Page No. 1 of 2

DESIGN ANALYSIS

Client WHC
Subject Pressure Drop Upstream of the Exhaust Skid
Location 241-C/200 East

WO/Job No. ER4319
Date 6-17-94 By PH Langowski
Checked 6/23/94 By Paul Rice
Revised 2/22/95 By PR

1.0 OBJECTIVE

The objective of this calculation is to determine the pressure drop upstream of the Exhaust Skid for input to the offsite engineer author of the Exhaust Skid procurement specification. Portions of the pressure loss calculation will also be used to size the recirculation fan.

2.0 DESIGN INPUTS

2.1 CRITERIA AND SOURCE

DOE General Order 6430.1A
Functional Design Criteria WHC-SD-W320-FDC-001, rev. 2, 1/18/94

2.2 GIVEN DATA

1. Component pressure drop data from procurement specifications W-320-P3, P4, ~~and~~ P5, and P8.
2. See H-2-818480 and H-2-818~~468~~ 486 for the piping layout.

2.3 ASSUMPTIONS

1. Tank pressure at -1.5" w.g.
2. ~~Mist eliminator pressure drop at 0.75" w.g. (see vendor quote App B).~~
3. Condenser pressure drop at 10" w.g. maximum (see W-320-P4)
4. HEME pressure drop (dirty & wet) at 10" w.g. maximum (see W-320-P5).
5. HEMF pressure drop (dirty and/or wet) at 10" w.g. maximum (see W-320-P3).
6. HEMF clean and dry pressure drops: 2.2" to 4.5" w.g. (180 to 360 scfm, see W320-~~H~~ 28-008).
7. HEME clean and dry pressure drops: ~~3.6"~~ 2.5" to ~~6.6"~~ 5.0" w.g. (180 to 360 scfm, see W-320-P5 and PNL-7188).
8. Moisture separator pressure drops: 5.5" maximum (see W-320-P8)
9. Heating coil pressure drop = 0.06" maximum (see App B)

2.4 METHODS

Hand calculations and Excel spreadsheet.

2.5 REFERENCES

W-320-P3	Procurement Specification, High Efficiency Metal Filter
W-320-P4	Procurement Specification, Heat Exchanger
W-320-P5	Procurement Specification, High Efficiency Mist Eliminator
W-320-P6	Procurement Specification, Recirculation Fan
W320-~~H~~ 28-003	Calculation, Recirculation Fan Sizing
W320-~~H~~ 28-008	Calculation, High Efficiency Metal Filter
W320-~~H~~ 28-011	Calculation, Exhaust Skid
1993 ASHRAE	Fundamentals
1985 ASHRAE	Fundamentals
1991 ASHRAE	Applications
PNL-7188	Performance Evaluation of the Pilot-Scale, Double-Shell Tank Ventilation System Using Simulated Aerosol Streams
W-320-P8	Procurement Specification, Moisture Separator

DESIGN ANALYSIS

Client WHC
WO/Job No. ER4319
Subject Pressure Drop Upstream of the Exhaust Skid
Date 6-17-94 By PH Langowski
Checked 6/23/94 By Paul Rice
Location 241-C/200 East
Revised 2/27/95 By PHL

3.0 CALCULATIONS

See Excel spreadsheet (App A) for detailed pressure drop record by fitting and component for the maximum airflow and pressure drop condition (dirty and wet). See App C for other flows and conditions to size the range of exhaust fan control required.

Equations used for the spreadsheet are:

- pressure loss per 1993 Fundamentals p. 32.4, Darcy Equation (19)
- hydraulic diameter per 1993 Fundamentals p. 32.6 Equation (24)
- Reynold's number per 1993 Fundamentals p. 32.5, Equation (22)

4.0 FINDINGS & CONCLUSIONS

The Exhaust Skid fan will be required to be selected for the following upstream pressure loss conditions along with the pressure loss on the Exhaust Skid itself in calculation W-320-28-011. Calculation W-320-28-011 was completed earlier with pressure losses ~~slightly greater than~~ comparable to those calculated here.

condition	minimum exhaust 230 ~~180~~ scfm	maximum exhaust 360 scfm
clean & dry components	18.6" ~~18.98"~~ w.g.	24.4" ~~25.23"~~ w.g.
dirty & wet components	33.9" ~~33.18"~~ w.g.	34.5" ~~34.13"~~ w.g. 34.87

The Recirculation fan sizing will use the information ~~up to the flow split in calculation W320-H-003. The pressure loss up to the flow split at maximum flowrate to be used in sizing the recirculation fan is 11.67" w.g.~~ at 860 scfm and 18.9" w.g. static pressure.

KEH 0037.00 (06/92) KEF055

APPENDIX A

HIGH FLOW, UK1Y/WEI

Ckd Paul Rue 4/27/94

KAISER ENGINEERS HANFORD CO.
DUCT PRESSURE LOSS
CALCULATION SHEET

JOB NO./ W.O. NO. : W-320/ER4319
BLDG NO./ AREA : 241-C-106/200E
DUCT SYSTEM : Exhaust system up to the exhaust skid

PREPARED BY: Peter H. Langowski
DATE: 6/17/94
CHECKED BY:

NOTES: Calculation W320-~~H~~28-018.
Pressure loss per 1993 Fundamentals p.32.4 Darcy Equation (19).
Hydraulic diameter per 1993 Fundamentals p.32.6 Equation (24).
Reynold's Number per 1993 Fundamentals p.32.5 Equation (22).
Alphanumeric ASHRAE fitting numbers from 1993 Fundamentals. Numeric fitting numbers from 1985 Fundamentals. Pipe sizes for schedule 10S.

Long Radius (LR) elbows: r/D = 1.5, fitting loss = 0.15; Short Radius (SR) elbows: r/D = 1.0, fitting loss = 0.22, losses per 1991 Applications, p. 27.9, Table 4.

NOTE: COLUMNS UNDER SHADED AREAS REQUIRE USER INPUT

#	TYPE OF FITTING (ASHRAE #)	AIR FLOW	TEMP	AIR FLOW	AIR FLOW TAKEOFF	DUCTSIZE either round or rectangular WIDTH	HEIGHT	DIA.	PRESS. LOSS	FITTING LOSS COEFF.	EQUIV DUCT LENGTH	DUCT AREA	PERI METER	HYDRAL DIA	REY	FPRIME	F	VEL.	VEL. PRESS. Vp
		SCFM	DEG F	ACFM	SCFM	IN.	IN.	IN.	IN. WG	Co	FT.	SQ. IN.	IN.	IN.				FPM	IN. WG
		Initial only								fittings only	duct only								
1	tank pressure	1220	95	1278	0				1.500			0.00	0.00	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
2	inlet to hatchway (ED1-1)	1220	95	1278	0			24.375	0.005	0.50		466.64	76.58	24.38	91,415	0.018	0.018	394	0.010
3	hatchway elbow (CD3-12)	1220	95	1278	0			24.375	0.004	0.42		466.64	76.58	24.38	91,415	0.018	0.018	394	0.010
4	hatchway pipe	1220	95	1278	0			24.375	0.001		6	466.64	76.58	24.38	91,415	0.018	0.018	394	0.010
5A	hatchway exit (SD4-1)	1220	95	1278	0	69	39		0.007	25.00		2691.00	216.00	49.83	32,409	0.024	0.024	68	0.000
5B	hatchway loss	1220	95	1278	0	69	39		0.000		10	2691.00	216.00	49.83	32,409	0.024	0.024	68	0.000
6	inlet to mist eliminator (ED1-1)	1220	95	1278	0			16.876	0.021	0.50		223.68	53.02	16.88	132,037	0.017	0.017	822	0.042
7	mist eliminator	1220	95	1278	0			16.876	0.750			223.68	53.02	16.88	132,037	0.017	0.017	822	0.042
8	transition to 12" (ED4-1)	1220	95	1278	0			12.390	0.029	0.20		120.57	38.92	12.39	179,843	0.016	0.017	1,526	0.145
9	pipe section	1220	95	1278	0			12.390	0.007		3	120.57	38.92	12.39	179,843	0.016	0.017	1,526	0.145
10	transition to 10" (ED4-1)	1220	95	1278	0			10.420	0.058	0.20		85.28	32.74	10.42	213,844	0.016	0.016	2,157	0.290
11	deleted	1220	95	1278	0			10.420	0.000	0.00		85.28	32.74	10.42	213,844	0.016	0.016	2,157	0.290
12	elbow, 45 (LR)	1220	95	1278	0			10.420	0.026	0.09		85.28	32.74	10.42	213,844	0.016	0.016	2,157	0.290
13	pipe section	1220	95	1278	0			10.420	0.046		8	85.28	32.74	10.42	213,844	0.016	0.016	2,157	0.290
14	elbow, 45 (LR)	1220	95	1278	0			10.420	0.026	0.09		85.28	32.74	10.42	213,844	0.016	0.016	2,157	0.290
15	pipe section	1220	95	1278	0			10.420	0.029		5	85.28	32.74	10.42	213,844	0.016	0.016	2,157	0.290
16	elbow, 90 (SR), in Process Bldg	1220	95	1278	0			10.420	0.064	0.22		85.28	32.74	10.42	213,844	0.016	0.016	2,157	0.290
17A	elbow, 90 (SR)	1220	95	1278	0			10.420	0.064	0.22		85.28	32.74	10.42	213,844	0.016	0.016	2,157	0.290
17B	shutoff valve (7-5)	1220	95	1278	0			10.420	0.145	0.50		85.28	32.74	10.42	213,844	0.016	0.016	2,157	0.290
18	heat exchanger	1220	95	1278	0			10.420	10.000			85.28	32.74	10.42	213,844	0.016	0.016	2,157	0.290
19A	shutoff valve	1220	40	1151	0			10.420	0.118	0.50		85.28	32.74	10.42	192,652	0.016	0.017	1,944	0.235
19B	elbow, 90 (SR)	1220	40	1151	0			10.420	0.052	0.22		85.28	32.74	10.42	192,652	0.016	0.017	1,944	0.235
20	elbow, 90 (SR)	1220	40	1151	0			10.420	0.052	0.22		85.28	32.74	10.42	192,652	0.016	0.017	1,944	0.235
21	tee, portable takeoff (6-3)	1220	40	1151	0			10.420	0.000	0.00		85.28	32.74	10.42	192,652	0.016	0.017	1,944	0.235
22	elbow, 90 (SR)	1220	40	1151	0			10.420	0.052	0.22		85.28	32.74	10.42	192,652	0.016	0.017	1,944	0.235
23	tee, transition (SD5-2)	1220	40	1151	0			10.420	0.115	0.49		85.28	32.74	10.42	192,652	0.016	0.017	1,944	0.235
24A	tee (6-3)	360	40	340	860			6.357	0.000	0.00		31.74	19.97	6.36	93,182	0.019	0.019	1,541	0.148
24B	bypass valve (7-5)	360	40	340	0			6.357	0.074	0.50		31.74	19.97	6.36	93,182	0.019	0.019	1,541	0.148
24C	pipe section	360	40	340	0			6.357	0.034		6	31.74	19.97	6.36	93,182	0.019	0.019	1,541	0.148
25	elbow, 90 (SR)	360	40	340	0			6.357	0.033	0.22		31.74	19.97	6.36	93,182	0.019	0.019	1,541	0.148
26	pipe section	360	40	340	0			6.357	0.011		2	31.74	19.97	6.36	93,182	0.019	0.019	1,541	0.148
27	elbow, 90 (SR)	360	40	340	0			6.357	0.033	0.22		31.74	19.97	6.36	93,182	0.019	0.019	1,541	0.148
28	pipe section	360	40	340	0			6.357	0.011		2	31.74	19.97	6.36	93,182	0.019	0.019	1,541	0.148
29	elbow, 45 (SR)	360	40	340	0			6.357	0.019	0.13		31.74	19.97	6.36	93,182	0.019	0.019	1,541	0.148
30	HEME	360	40	340	0			6.357	10.000			31.74	19.97	6.36	93,182	0.019	0.019	1,541	0.148
31	elbow, 45 (SR)	360	40	340	0			6.357	0.019	0.13		31.74	19.97	6.36	93,182	0.019	0.019	1,541	0.148
32	pipe section	360	40	340	0			6.357	0.022		4	31.74	19.97	6.36	93,182	0.019	0.019	1,541	0.148
33	elbow, 90 (SR)	360	40	340	0			6.357	0.033	0.22		31.74	19.97	6.36	93,182	0.019	0.019	1,541	0.148
34	elbow, 90 (SR)	360	40	340	0			6.357	0.033	0.22		31.74	19.97	6.36	93,182	0.019	0.019	1,541	0.148
35	pipe section	360	40	340	0			6.357	0.022		4	31.74	19.97	6.36	93,182	0.019	0.019	1,541	0.148
36	bypass valve (7-5)	360	40	340	0			6.357	0.074	0.50		31.74	19.97	6.36	93,182	0.019	0.019	1,541	0.148
37	elbow, 90 (SR)	360	40	340	0			6.357	0.033	0.22		31.74	19.97	6.36	93,182	0.019	0.019	1,541	0.148
38	tee (6-3)	360	40	340	0			6.357	0.000	0.00		31.74	19.97	6.36	93,182	0.019	0.019	1,541	0.148
39	bypass valve (7-5)	360	40	340	0			6.357	0.074	0.50		31.74	19.97	6.36	93,182	0.019	0.019	1,541	0.148
40	elbow, 90 (SR)	360	40	340	0			6.357	0.033	0.22		31.74	19.97	6.36	93,182	0.019	0.019	1,541	0.148
41	HEMF	360	40	340	0			6.357	10.000			31.74	19.97	6.36	93,182	0.019	0.019	1,541	0.148
42	bypass valve (7-5)	360	40	340	0			6.357	0.074	0.50		31.74	19.97	6.36	93,182	0.019	0.019	1,541	0.148

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Chs Paul Rice 6/23/99

KAISER ENGINEERS HANFORD CO.
DUCT PRESSURE LOSS
CALCULATION SHEET

JOB NO./ W.O. NO. : W-320/ER4319
BLDG NO./AREA : 241-C-106/200E
DUCT SYSTEM : Exhaust system up to the exhaust skid

PREPARED BY: Peter H. Langowski
DATE: 6/17/94
CHECKED BY:

NOTES: Calculation W320-28-018.
Pressure loss per 1993 Fundamentals p.32.4 Darcy Equation (19).
Hydraulic diameter per 1993 Fundamentals p.32.6 Equation (24).
Reynold's Number per 1993 Fundamentals p.32.5 Equation (22).
Alphanumeric ASHRAE fitting numbers from 1993 Fundamentals. Numeric fitting numbers from 1985 Fundamentals. Pipe sizes for schedule 10S.

Long Radius (LR) elbows: r/D=1.5, fitting loss=0.15; Short Radius (SR) elbows: r/D=1.0, fitting loss=0.22, losses per 1991 Applications, p. 27.9, Table 4.

NOTE: COLUMNS UNDER SHADED AREAS REQUIRE USER INPUT

#	TYPE OF FITTING (ASHRAE #)	AIR FLOW SCFM	TEMP DEG F	AIR FLOW ACFM	AIR FLOW TAKEOFF SCFM	DUCTSIZE either round or rectangular WIDTH IN.	HEIGHT IN.	DIA. IN.	PRESS. LOSS IN. WG	FITTING LOSS COEFF. Co	EQUIV DUCT LENGTH FT.	DUCT AREA SQ. IN.	PERI METER IN.	HYDRAL DIA IN.	REY	FPRIME	F	VEL. FPM	VEL. PRESS. Vp IN. WG
		Initial only								fittings only	duct only								
43	elbow, 90 (SR)	360	40	340	0			6.357	0.033	0.22		31.74	19.97	6.36	93,182	0.019	0.019	1,541	0.148
44	pipe section	360	40	340	0			6.357	0.022		4	31.74	19.97	6.36	93,182	0.019	0.019	1,541	0.148
45	elbow, 90 (SR)	360	40	340	0			6.357	0.033	0.22		31.74	19.97	6.36	93,182	0.019	0.019	1,541	0.148
46	pipe section	360	40	340	0			6.357	0.022		4	31.74	19.97	6.36	93,182	0.019	0.019	1,541	0.148
47	elbow, 90	360	40	340	0			6.357	0.022	0.15		31.74	19.97	6.36	93,182	0.019	0.019	1,541	0.148
48	tee (6-3)	360	40	340	0			6.357	0.000	0.00		31.74	19.97	6.36	93,182	0.019	0.019	1,541	0.148
49	pipe section/flange process bldg	360	40	340	0			6.357	0.045		8	31.74	19.97	6.36	93,182	0.019	0.019	1,541	0.148
50	elbow, 45 (LR)	360	40	340	0			6.357	0.013	0.09		31.74	19.97	6.36	93,182	0.019	0.019	1,541	0.148
51	pipe section	360	40	340	0			6.357	0.028		5	31.74	19.97	6.36	93,182	0.019	0.019	1,541	0.148
52	elbow, 45 (LR)	360	40	340	0			6.357	0.013	0.09		31.74	19.97	6.36	93,182	0.019	0.019	1,541	0.148
53	pipe section	360	40	340	0			6.357	0.056		10	31.74	19.97	6.36	93,182	0.019	0.019	1,541	0.148
54	elbow, 90 (LR)	360	40	340	0			6.357	0.022	0.15		31.74	19.97	6.36	93,182	0.019	0.019	1,541	0.148
55	pipe section/flange exhaust skid	360	40	340	0			6.357	0.017		3	31.74	19.97	6.36	93,182	0.019	0.019	1,541	0.148
								total	34.13										

DATA USED ABOVE
roughness = 0.0001
density = 0.079 lbm/ft3 40F saturated air 12.696 ft3/lbm
kinematic viscosity = 0.000146 ft2/s

friction factors		
galvanized	0.0003	medium smooth
carbon steel	0.0001	smooth

The pressure loss up to the flow split for use in sizing the recirculation fan is 11.67 inches w.g.

kinematic viscosity	temp(F)	ft2/s
Mechanical Engineering Reference Manual Eighth Edition, p.3-36.	0.00	1.26E-04
	20.00	1.36E-04
	40.00	1.46E-04
	60.00	1.58E-04
	68.00	1.60E-04
	80.00	1.69E-04
	100.00	1.80E-04
	120.00	1.89E-04
	250.00	2.73E-04

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HIGH [illegible]

KAISER ENGINEERS HANFORD CO.
DUCT PRESSURE LOSS
CALCULATION SHEET

JOB NO./ W.O. NO. : W-320/ER4319
BLDG NO./ AREA : 241-C-106/200E
DUCT SYSTEM :

PREPARED BY: Peter H. Langowski
DATE: 2/8/95
CHECKED BY:

NOTES: Calculation W320-H-0~~18~~28 rev 1.
Pressure loss per 1993 Fundamentals p.32.4 Darcy Equation (19).
Hydraulic diameter per 1993 Fundamentals p.32.6 Equation (24).
Reynold's Number per 1993 Fundamentals p.32.5 Equation (22).
Alphanumeric ASHRAE fitting numbers from 1993 Fundamentals. Numeric fitting numbers from 1985 Fundamentals. Pipe sizes for schedule 40S.

Long Radius (LR) elbows: r/D = 1.5, fitting loss = 0.15; Short Radius (SR) elbows: r/D = 1.0, fitting loss = 0.22, losses per 1991 Applications, p. 27.9, Table 4. Combined elbow factor of 1.25 per p. B-14.

NOTE: COLUMNS UNDER SHADED AREAS REQUIRE USER INPUT

#	TYPE OF FITTING (ASHRAE #)	AIR FLOW	TEMP	AIR FLOW	AIR FLOW TAKEOFF	DUCTSIZE either round or rectangular WIDTH	HEIGHT	DIA.	PRESS. LOSS	FITTING LOSS COEFF.	EQUIV DUCT LENGTH	DUCT AREA	PERI METER	HYDRAL DIA	REY	FPRIME	F	VEL.	VEL. PRESS. Vp
		SCFM	DEG F	ACFM	SCFM	IN.	IN.	IN.	IN. WG	Co	FT.	SQ. IN.	IN.	IN.				FPM	IN. WG
		initial only								fittings onl	duct only								
1	tank pressure	1220	95	1278	0				1.500			0.00	0.00	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
2	inlet to hatchway (ED1-1)	1220	95	1278	0			24.375	0.005	0.50		466.64	76.58	24.38	91,415	0.018	0.018	394	0.010
3	hatchway elbow (CD3-12)	1220	95	1278	0			24.375	0.004	0.42		466.64	76.58	24.38	91,415	0.018	0.018	394	0.010
4	hatchway pipe	1220	95	1278	0			24.375	0.001		6	466.64	76.58	24.38	91,415	0.018	0.018	394	0.010
5	hatchway exit (SD4-1)	1220	95	1278	0	69	39		0.007	25.00		2691.00	216.00	49.83	32,409	0.024	0.024	68	0.000
6	hatchway loss	1220	95	1278	0	69	39		0.000		10	2691.00	216.00	49.83	32,409	0.024	0.024	68	0.000
10	inlet to piping (ED1-1)	1220	95	1278	0			10.020	0.170	0.50		78.85	31.48	10.02	222,380	0.016	0.016	2,333	0.339
11	piping	1220	95	1278	0			10.020	0.029		4	78.85	31.48	10.02	222,380	0.016	0.016	2,333	0.339
12	elbow, 90 (LR)	1220	95	1278	0			10.020	0.051	0.15		78.85	31.48	10.02	222,380	0.016	0.016	2,333	0.339
13	pipe section	1220	95	1278	0			10.020	0.036		5	78.85	31.48	10.02	222,380	0.016	0.016	2,333	0.339
14	elbow, 90 (LR)	1220	95	1278	0			10.020	0.051	0.15		78.85	31.48	10.02	222,380	0.016	0.016	2,333	0.339
15	pipe section	1220	95	1278	0			10.020	0.036		5	78.85	31.48	10.02	222,380	0.016	0.016	2,333	0.339
16	elbow, 90 (LR), in Process Bldg	1220	95	1278	0			10.020	0.051	0.15		78.85	31.48	10.02	222,380	0.016	0.016	2,333	0.339
20	pipe section	1220	95	1278	0			10.020	0.007		1	78.85	31.48	10.02	222,380	0.016	0.016	2,333	0.339
21	elbow, 90 (SR)	1220	95	1278	0			10.020	0.075	0.22		78.85	31.48	10.02	222,380	0.016	0.016	2,333	0.339
22	shutoff valve (7-5) HV-136142	1220	95	1278	0			10.020	0.170	0.50		78.85	31.48	10.02	222,380	0.016	0.016	2,333	0.339
23	heat exchanger HX-1361	1220	95	1278	0			10.020	11.000			78.85	31.48	10.02	222,380	0.016	0.016	2,333	0.339
24	shutoff valve (7-5) HV-13639	1220	40	1151	0			10.020	0.138	0.50		78.85	31.48	10.02	200,343	0.016	0.016	2,102	0.275
25	elbow, 90 (SR)	1220	40	1151	0			10.020	0.061	0.22		78.85	31.48	10.02	200,343	0.016	0.016	2,102	0.275
26A	tee, flow split, branch (6-3)	1220	40	1151	0			10.020	0.168	0.61		78.85	31.48	10.02	200,343	0.016	0.016	2,102	0.275
30	elbow, 45 (LR)	360	40	340	860			6.065	0.016	0.09		28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
31	pipe section	360	40	340	0			6.065	0.022		3	28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
32	elbow, 90 (LR)	360	40	340	0			6.065	0.027	0.15		28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
33	pipe section	360	40	340	0			6.065	0.026		4	28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
34	tee (6-3)	360	40	340	0			6.065	0.000	0.00		28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
35	bypass valve (7-5) HV-13649	360	40	340	0			6.065	0.089	0.50		28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
36	elbow, 90 (LR)	360	40	340	0			6.065	0.034	0.19		28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
37	elbow, 90 (LR)	360	40	340	0			6.065	0.034	0.19		28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
38	elbow, 45 (LR)	360	40	340	0			6.065	0.020	0.11		28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
39	pipe section	360	40	340	0			6.065	0.015		2	28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
40	elbow, 45 (LR)	360	40	340	0			6.065	0.016	0.09		28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
41	HEME HME-1361	360	40	340	0			6.065	10.000			28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
42	elbow, 45 (LR)	360	40	340	0			6.065	0.016	0.09		28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
43	pipe section	360	40	340	0			6.065	0.015		2	28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
44	elbow, 90 (LR)	360	40	340	0			6.065	0.027	0.15		28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
45	pipe section	360	40	340	0			6.065	0.015		2	28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
46	elbow, 90 (LR)	360	40	340	0			6.065	0.027	0.15		28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
47	pipe section	360	40	340	0			6.065	0.015		2	28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
48	bypass valve (7-5) HV-13646	360	40	340	0			6.065	0.089	0.50		28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
49	tee (6-3)	360	40	340	0			6.065	0.000	0.00		28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
50	elbow, 90 (SR)	360	40	340	0			6.065	0.048	0.27		28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
50A	elbow, 90 (LR)	360	40	340	0			6.065	0.034	0.19		28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
51	pipe section	360	40	340	0			6.065	0.015		2	28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
52	elbow, 90 (SR)	360	40	340	0			6.065	0.039	0.22		28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
53	bypass valve (7-5) HV-13648	360	40	340	0			6.065	0.089	0.50		28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
54	HEMF HMF-1361	360	40	340	0			6.065	10.000			28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
55	bypass valve (7-5) HV-13648	360	40	340	0			6.065	0.089	0.50		28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179

A1 Rev 1 PHL 2-14-95
[illegible]

KAISER ENGINEERS HANFORD CO.
DUCT PRESSURE LOSS
CALCULATION SHEET

JOB NO./ W.O. NO. : W-320/ER4319
BLDG NO./ AREA : 241-C-106/200E
DUCT SYSTEM :

PREPARED BY: Peter H. Langowski
DATE: 2/8/95
CHECKED BY:

NOTES: Calculation W320-H-018 rev 1.
Pressure loss per 1993 Fundamentals p.32.4 Darcy Equation (19).
Hydraulic diameter per 1993 Fundamentals p.32.6 Equation (24).
Reynold's Number per 1993 Fundamentals p.32.5 Equation (22).
Alphanumeric ASHRAE fitting numbers from 1993 Fundamentals. Numeric fitting numbers from 1985 Fundamentals. Pipe sizes for schedule 40S.

Long Radius (LR) elbows: r/D = 1.5, fitting loss = 0.15; Short Radius (SR) elbows: r/D = 1.0, fitting loss = 0.22, losses per 1991 Applications, p. 27.9, Table 4.
Combined elbow factor of 1.25 per p. B-14.

NOTE: COLUMNS UNDER SHADED AREAS REQUIRE USER INPUT

#	TYPE OF FITTING (ASHRAE #)	AIR FLOW SCFM	TEMP DEG F	AIR FLOW ACFM	AIR FLOW TAKEOFF SCFM	DUCTSIZE either round or rectangular WIDTH IN.	HEIGHT IN.	DIA. IN.	PRESS. LOSS IN. WG	FITTING LOSS COEFF. Co	EQUIV DUCT LENGTH FT.	DUCT AREA SQ. IN.	PERI METER IN.	HYDRAL DIA IN.	REY	FPRIME	F	VEL. FPM	VEL. PRESS. Vp IN. WG
		initial only								fittings onl	duct only								
56	elbow, 90 (LR)	360	40	340	0			6.065	0.027	0.15		28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
57	pipe section	360	40	340	0			6.065	0.029		4	28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
58	elbow, 90 (LR)	360	40	340	0			6.065	0.027	0.15		28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
59	tee (6-3)	360	40	340	0			6.065	0.000	0.00		28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
60	tee (6-3)	360	40	340	0			6.065	0.197	1.10		28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
70	pipe section/flange process bldg	360	40	340	0			6.065	0.026		4	28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
71	elbow, 90 (LR)	360	40	340	0			6.065	0.027	0.15		28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
72	pipe section	360	40	340	0			6.065	0.124		17	28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
73	elbow, 90 (LR)	360	40	340	0			6.065	0.027	0.15		28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
74	pipe section/flange exhaust skid	360	40	340	0			6.065	0.015		2	28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
								total to exhaust skid	34.87										
26B 28A	tee, flow split, main (6-3)	860	40	811	0			10.020	0.052	0.38		78.85	31.48	10.02	141,225	0.017	0.017	1,482	0.137
80	reducer, contraction (5-1)	860	40	811	0			6.065	0.071	0.07		28.89	19.05	6.07	233,318	0.016	0.017	4,044	1.020
81	elbow, 90 (LR)	860	40	811	0			6.065	0.153	0.15		28.89	19.05	6.07	233,318	0.016	0.017	4,044	1.020
82	moisture separator MS-1361	860	40	811	0			6.065	5.500			28.89	19.05	6.07	233,318	0.016	0.017	4,044	1.020
83	reducer, expansion (4-1)	860	40	811	0			7.981	0.231	0.68		50.03	25.07	7.98	177,306	0.017	0.017	2,335	0.340
84	tee (6-3)	860	40	811	0			7.981	0.000	0.00		50.03	25.07	7.98	177,306	0.017	0.017	2,335	0.340
85	elbow, 90 (LR)	860	40	811	0			7.981	0.051	0.15		50.03	25.07	7.98	177,306	0.017	0.017	2,335	0.340
86	transition (4-3)	860	40	811	0			7.981	0.238	0.70		50.03	25.07	7.98	177,306	0.017	0.017	2,335	0.340
87	electric heating coil HC-1361	860	77	871	0			7.981	0.060	0.15		50.03	25.07	7.98	190,426	0.017	0.017	2,508	0.392
88	transition (5-1)	860	77	871	0			7.981	0.027	0.07		50.03	25.07	7.98	190,426	0.017	0.017	2,508	0.392
89	elbow, 90 (LR)	860	77	871	0			7.981	0.059	0.15		50.03	25.07	7.98	190,426	0.017	0.017	2,508	0.392
90	pipe section	860	77	871	0			7.981	0.043		4	50.03	25.07	7.98	190,426	0.017	0.017	2,508	0.392
91	recirculation fan FN-1361	860	77	871	0			7.981	0.000	0.00		50.03	25.07	7.98	190,426	0.017	0.017	2,508	0.392
92	pipe section	860	77	871	0			7.981	0.043		4	50.03	25.07	7.98	190,426	0.017	0.017	2,508	0.392
93	elbow, 45 (LR)	860	77	871	0			7.981	0.035	0.09		50.03	25.07	7.98	190,426	0.017	0.017	2,508	0.392
94	pipe section	860	77	871	0			7.981	0.032		3	50.03	25.07	7.98	190,426	0.017	0.017	2,508	0.392
95	elbow, 45 (LR)	860	77	871	0			7.981	0.035	0.09		50.03	25.07	7.98	190,426	0.017	0.017	2,508	0.392
96	bypass valve (7-5) HV-13648	860	77	871	0			7.981	0.196	0.50		50.03	25.07	7.98	190,426	0.017	0.017	2,508	0.392
97	pipe section	860	77	871	0			7.981	0.141		13	50.03	25.07	7.98	190,426	0.017	0.017	2,508	0.392
98	elbow, 90 (LR)	860	77	871	0			7.981	0.059	0.15		50.03	25.07	7.98	190,426	0.017	0.017	2,508	0.392
99	converging wye (6-2)	860	77	871	0			7.981	-0.059	-0.15		50.03	25.07	7.98	190,426	0.017	0.017	2,508	0.392
100	pipe section riser R-2	860	77	871	0			11.938	0.021		14	111.93	37.50	11.94	127,307	0.017	0.018	1,121	0.078
								up to flow split	11.89										
								split back to tank	6.99										
								total for recirc fan	18.88										

DATA USED ABOVE

roughness = 0.0001
density = 0.082 lbm/ft3 40F saturated air 12.239 ft3/lbm 0.964 altitude correction
kinematic viscosity = 0.000146 ft2/s

Rev 1 PHL 2-14-95
GBC 2/27/95

KAISER ENGINEERS HANFORD CO.
DUCT PRESSURE LOSS
CALCULATION SHEET

JOB NO./ W.O. NO. : W-320/ER4319
BLDG NO./ AREA : 241-C-106/200E
DUCT SYSTEM :

PREPARED BY: Peter H. Langowski
DATE: 2/8/95
CHECKED BY:

NOTES:
Calculation W320-~~H~~28-018 rev 1.
Pressure loss per 1993 Fundamentals p.32.4 Darcy Equation (19).
Hydraulic diameter per 1993 Fundamentals p.32.6 Equation (24).
Reynold's Number per 1993 Fundamentals p.32.5 Equation (22).
Alphanumeric ASHRAE fitting numbers from 1993 Fundamentals. Numeric fitting numbers from 1985 Fundamentals. Pipe sizes for schedule 40S.

Long Radius (LR) elbows: r/D = 1.5, fitting loss = 0.15; Short Radius (SR) elbows: r/D = 1.0, fitting loss = 0.22, losses per 1991 Applications, p. 27.9, Table 4.
Combined elbow factor of 1.25 per p. B-14.

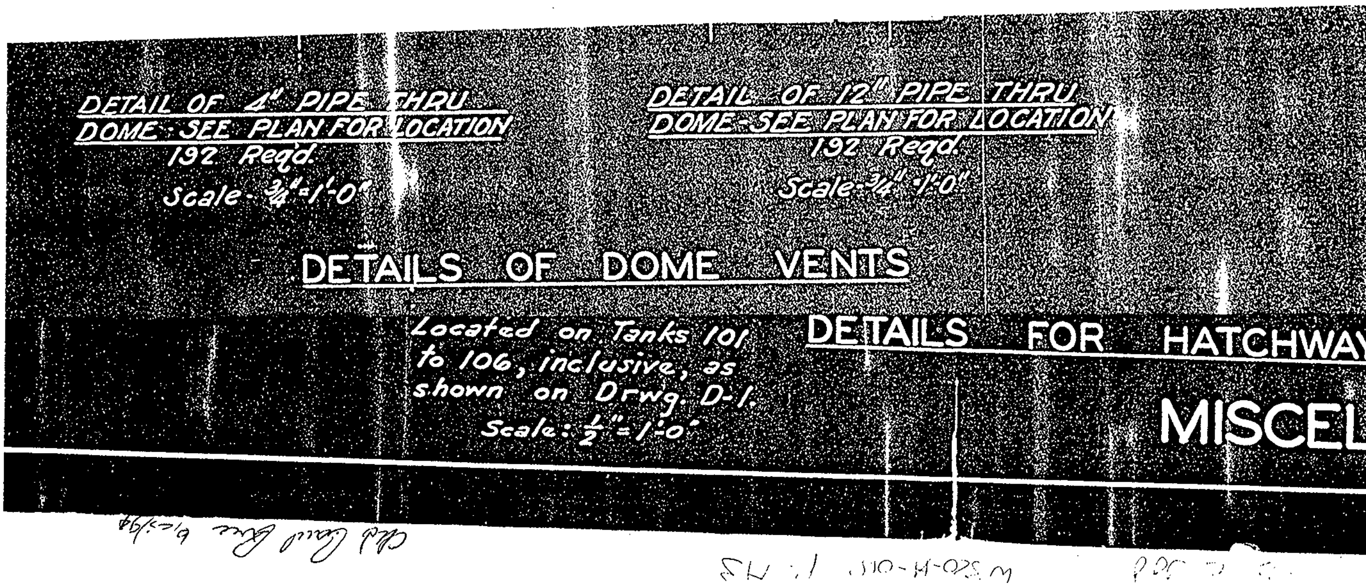
NOTE: COLUMNS UNDER SHADED AREAS REQUIRE USER INPUT

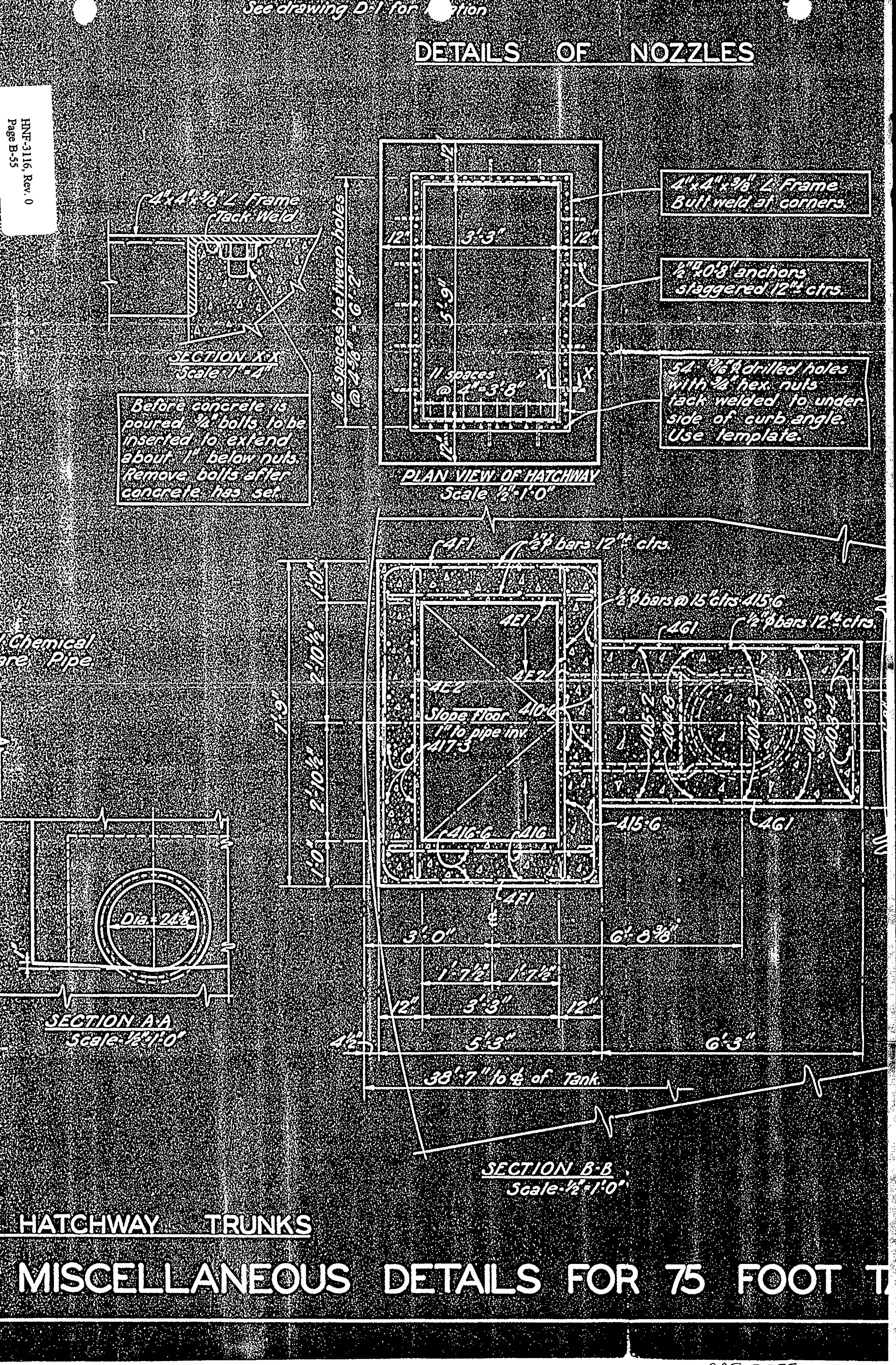
#	TYPE OF FITTING (ASHRAE #)	AIR FLOW	TEMP	AIR FLOW	AIR FLOW TAKEOFF	DUCTSIZE either round or rectangular			PRESS. LOSS	FITTING LOSS COEFF.	EQUIV DUCT LENGTH	DUCT AREA	PERI METER	HYDRAL DIA	REY	FPRIME	F	VEL.	VEL. PRESS. Vp
						WIDTH	HEIGHT	DIA.											
		SCFM	DEG F	ACFM	SCFM	IN.	IN.	IN.	IN. WG	Co	FT.	SQ. IN.	IN.	IN.				FPM	IN. WG
		initial only								fittings onl	duct only								

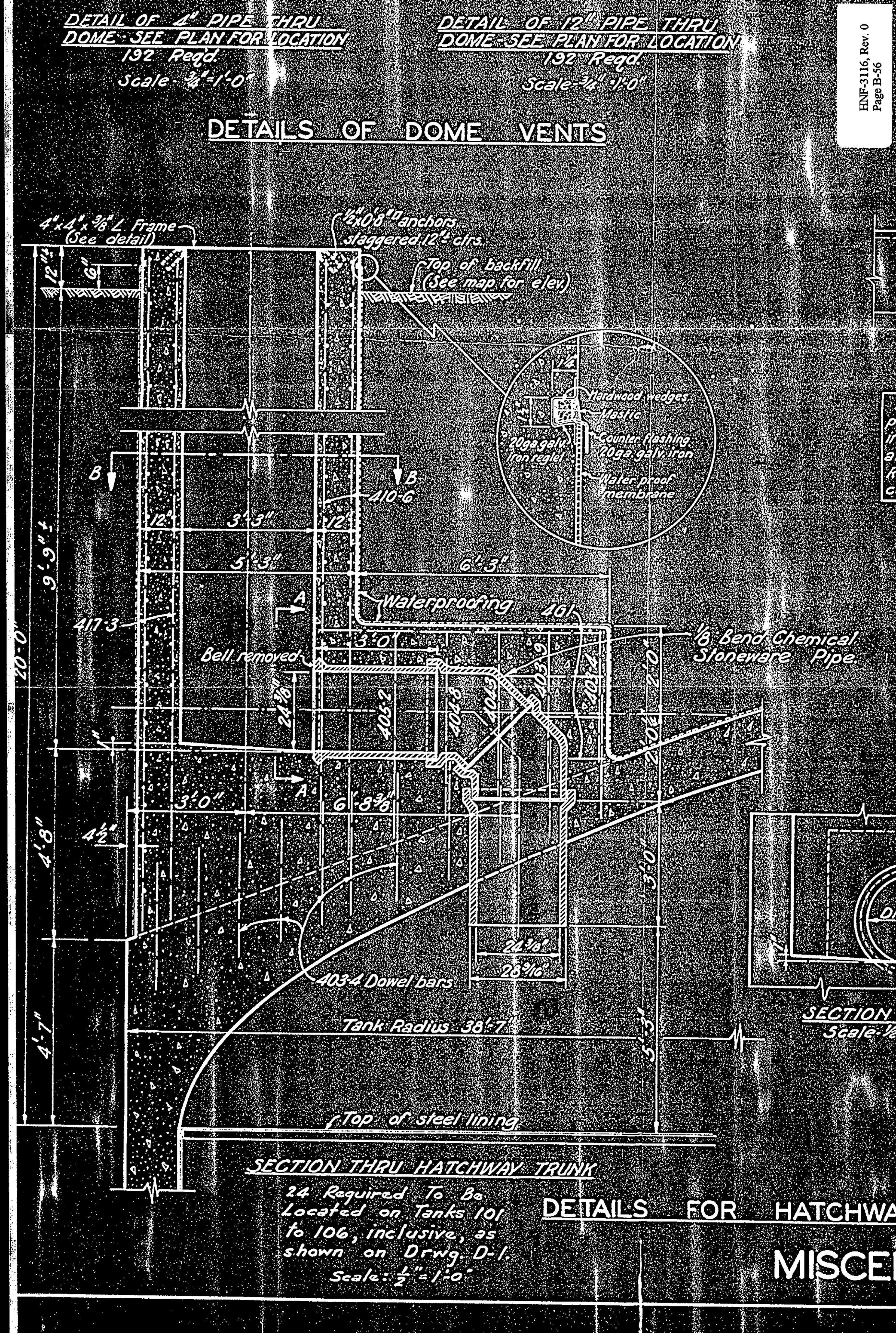
friction factors			
	galvanized	0.0003	medium smooth
	carbon steel	0.0001	smooth

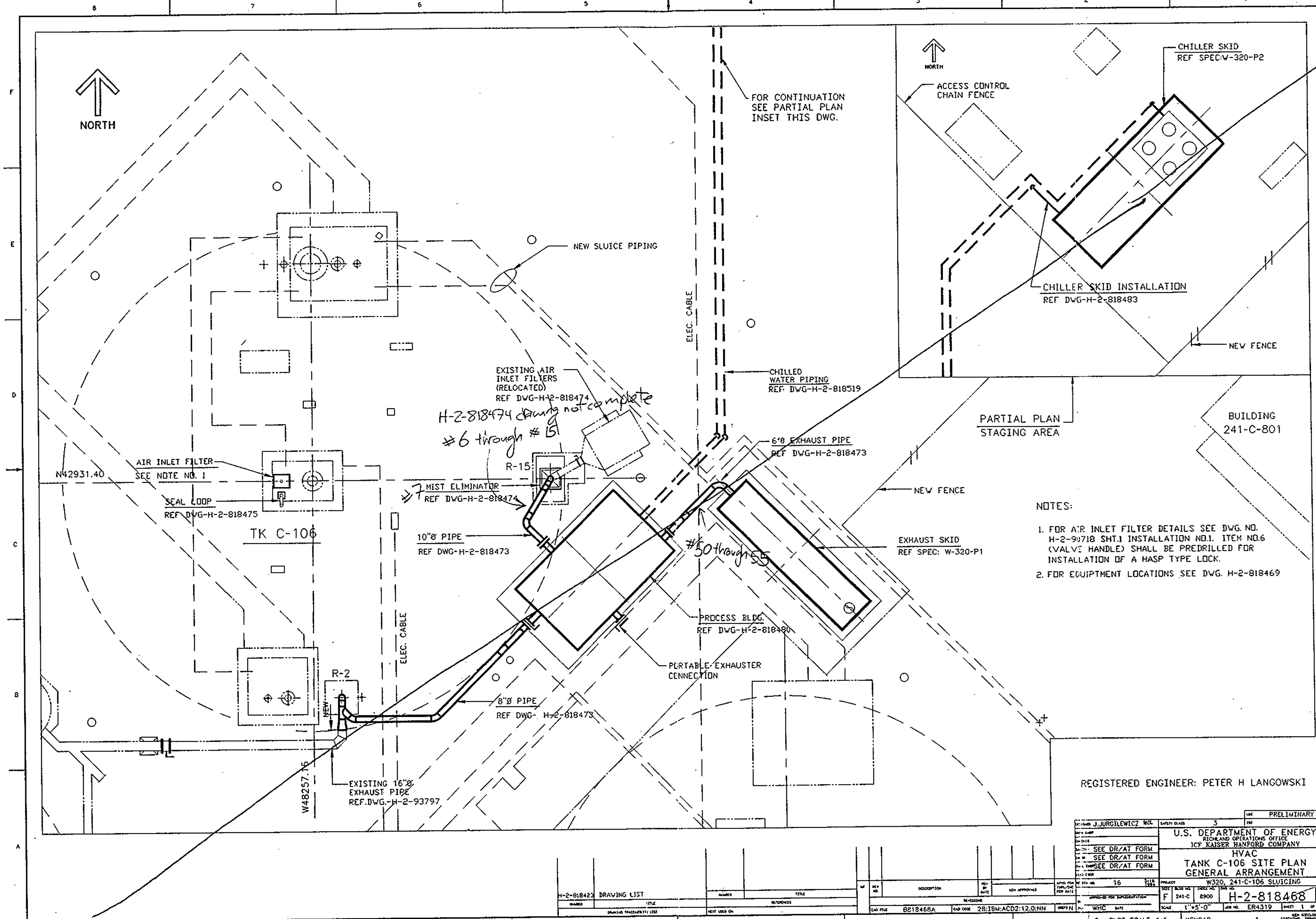
kinematic viscosity	temp(F)	ft2/s
Mechanical Engineering	0.00	1.26E-04
Reference Manual Eighth	20.00	1.36E-04
Edition, p.3-36.	40.00	1.46E-04
	60.00	1.58E-04
	68.00	1.60E-04
	80.00	1.69E-04
	100.00	1.80E-04
	120.00	1.89E-04
	250.00	2.73E-04

A2a Rev 1 [initials] 2-14-95 [initials] 2/27/95


DETAIL OF 4" PIPE THRU DOME: SEE PLAN FOR LOCATION
192 Reqd.
Scale- 3/4"=1'-0"
DETAIL OF 12" PIPE THRU DOME: SEE PLAN FOR LOCATION
192 Reqd.
Scale- 3/4"=1'-0"
DETAILS OF DOME VENTS
Located on Tanks 101 to 106, inclusive, as shown on Drwg. D-1.
Scale: 1/2"=1'-0"
DETAILS FOR HATCHWAY
MISCEL
W320-H-015


See drawing D-1 for location
DETAILS OF NOZZLES
4"x4"x3/8" ∠ Frame
Tack Weld
SECTION X-X
Scale 1"=1'-0"
Before concrete is poured 3/4" bolts to be inserted to extend about 1" below nuts. Remove bolts after concrete has set.
16 spaces between holes @ 4 5/8" = 6'-2"
12"
3'-3"
12"
5'-9"
11 spaces @ 4"=3'-8"
X
X
PLAN VIEW OF HATCHWAY
Scale 1/2"=1'-0"
4"x4"x3/8" ∠ Frame Butt weld at corners.
1/2"x0'-8" anchors staggered 12"± ctrs.
54- 13/16" drilled holes with 3/4" hex. nuts tack welded to under side of curb angle. Use template.
4F1
1/2"φ bars 12"± ctrs.
1/2"φ bars @ 15" ctrs 415-6
4G1
1/2"φ bars 12"± ctrs.
4E1
4E2
4E2
410-6
Slope floor 1" to pipe inv.
417-3
405-2
404-6
404-3
405-9
408-4
415-6
4G1
416-6
416
4F1
Chemical
Pipe
1'-0"
2'-10 1/2"
7'-9"
2'-10 1/2"
1'-0"
Dia.=24 5/8"
SECTION A-A
Scale 1/2"=1'-0"
3'-0"
6'-8 3/8"
1'-7 1/2"
1'-7 1/2"
12"
3'-3"
12"
4 1/2"
5'-3"
6'-3"
38'-7" to ℄ of Tank
SECTION B-B
Scale 1/2"=1'-0"
HATCHWAY TRUNKS
MISCELLANEOUS DETAILS FOR 75 FOOT T
BPF 73550


DETAIL OF 4" PIPE THRU DOME - SEE PLAN FOR LOCATION
192 Reqd.
Scale - 3/4"=1'-0"
DETAIL OF 12" PIPE THRU DOME - SEE PLAN FOR LOCATION
192 Reqd.
Scale - 3/4"=1'-0"
DETAILS OF DOME VENTS
4"x4"x3/8" L Frame (See detail)
1/2"x0'8" anchors staggered 12" ctrs.
Top of backfill (See map for elev.)
Hardwood wedges
Mastic
Counter flashing 20ga. galv. iron
20ga. galv. iron reglet
Water proof membrane
Waterproofing
1/8 Bend Chemical Stoneware Pipe
Bell removed
403-4 Dowel bars
Tank Radius 38'-7"
Top of steel lining
SECTION THRU HATCHWAY TRUNK
24 Required To Be Located on Tanks 101 to 106, inclusive, as shown on Drwg. D-1.
Scale: 1/2"=1'-0"
DETAILS FOR HATCHWA
MISCE
SECTION
Scale-1/2



NOTES:

1. FOR AIR INLET FILTER DETAILS SEE DWG. NO. H-2-90718 SHT.1 INSTALLATION NO.1. ITEM NO.6 (VALVE HANDLE) SHALL BE PREDRILLED FOR INSTALLATION OF A HASP TYPE LOCK.
2. FOR EQUIPTMENT LOCATIONS SEE DWG. H-2-818469

REGISTERED ENGINEER: PETER H LANGOWSKI

PRELIMINARY

U.S. DEPARTMENT OF ENERGY
RICHLAND OPERATIONS OFFICE
ICF KAISER HANFORD COMPANY

HVAC
TANK C-106 SITE PLAN
GENERAL ARRANGEMENT
W320, 241-C-106 SLUICING

J. JURGILEWICZ
SEE DR/AT FORM
SEE DR/AT FORM
SEE DR/AT FORM

H-2-818423 DRAWING LIST

F 241-C 6900 H-2-818468 0

1"=5'-0" ER4319

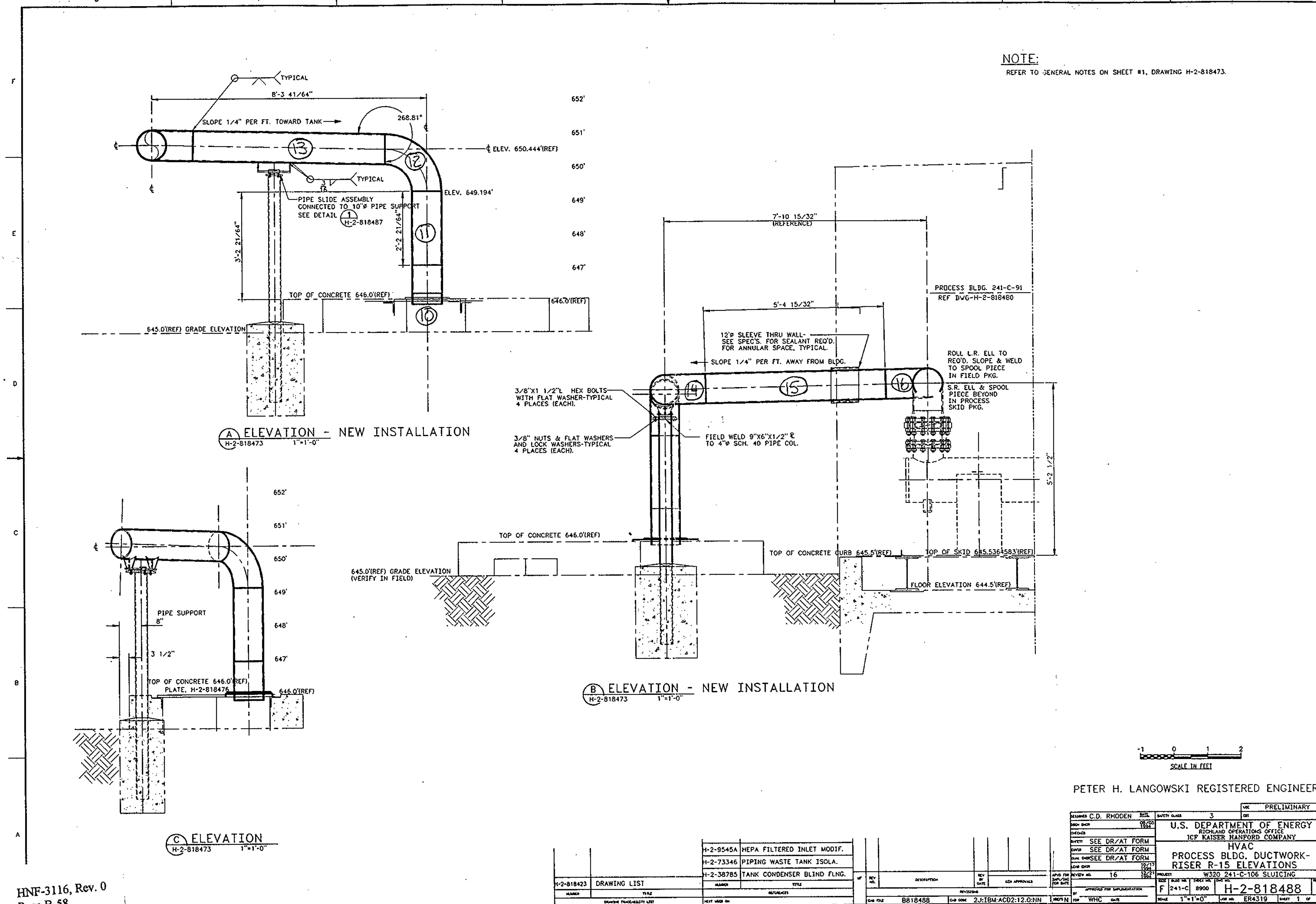
818468A 28:IBM:ACD2:12.0:NN

WHC

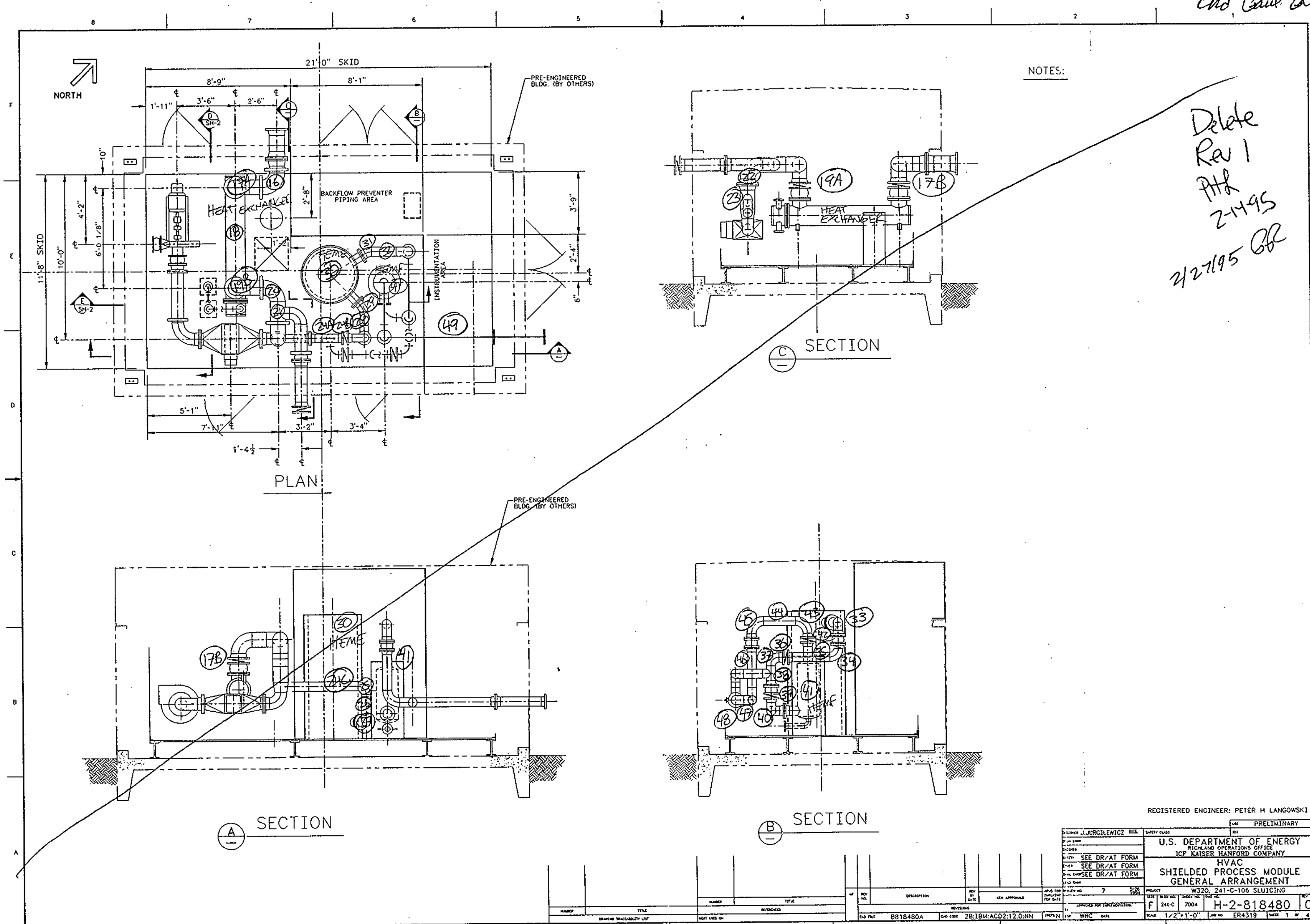
2 PLOT SCALE: 1=5 KENCAD

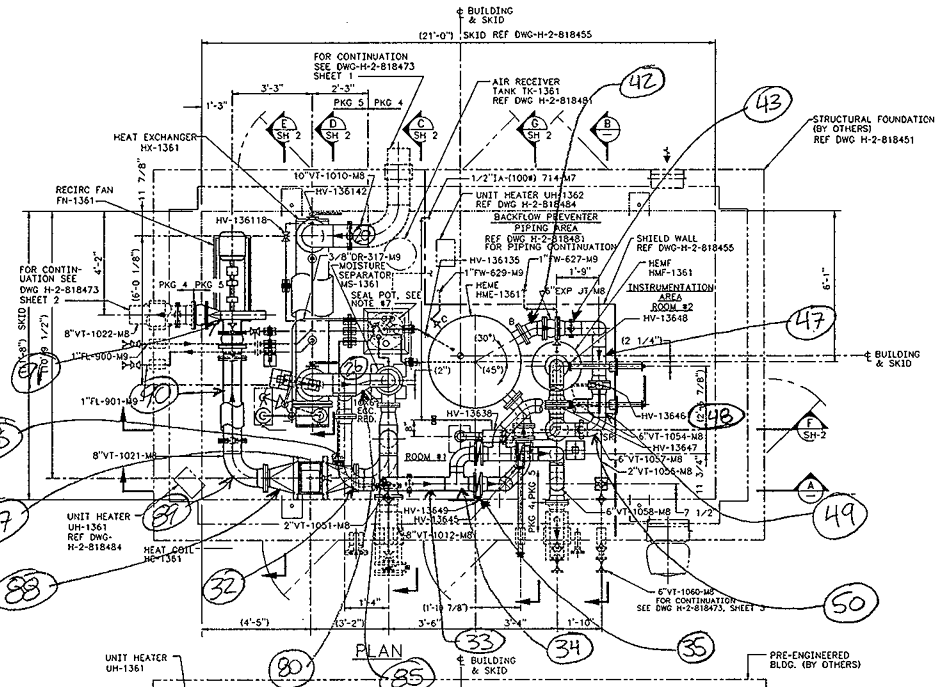
469

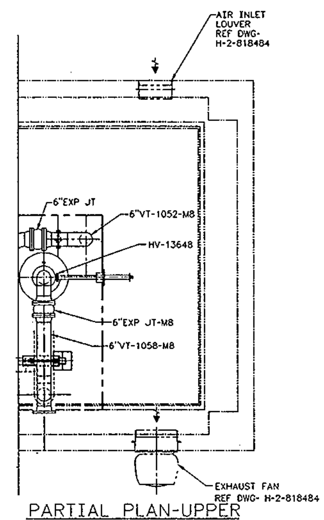
W320-J

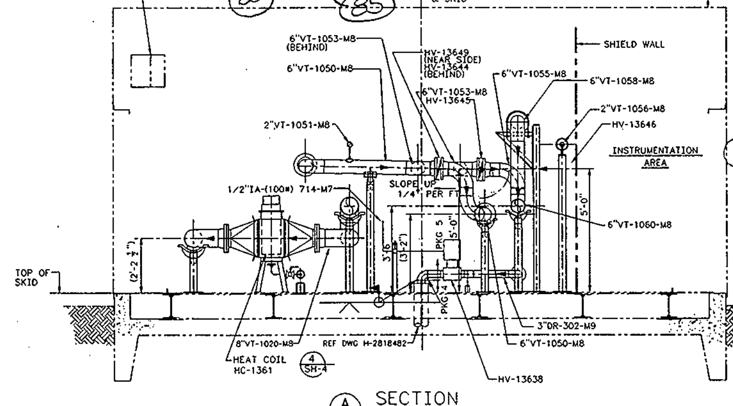

NOTE:
REFER TO GENERAL NOTES ON SHEET #1, DRAWING H-2-818473.
TYPICAL
8'-3 41/64"
SLOPE 1/4" PER FT. TOWARD TANK
268.81°
ELEV. 650.444'(REF)
TYPICAL
PIPE SLIDE ASSEMBLY CONNECTED TO 10"φ PIPE SUPPORT SEE DETAIL 1 H-2-818487
ELEV. 649.194'
3'-2 21/64"
2'-2 21/64"
TOP OF CONCRETE 646.0'(REF)
646.0'(REF)
645.0'(REF) GRADE ELEVATION
652'
651'
650'
649'
648'
647'
A ELEVATION - NEW INSTALLATION
H-2-818473 1"=1'-0"
7'-10 15/32" (REFERENCE)
PROCESS BLDG. 241-C-91 REF DWG-H-2-818480
5'-4 15/32"
12"φ SLEEVE THRU WALL- SEE SPEC'S. FOR SEALANT REQ'D. FOR ANNULAR SPACE, TYPICAL.
SLOPE 1/4" PER FT. AWAY FROM BLDG.
ROLL L.R. ELL TO REQ'D. SLOPE & WELD TO SPOOL PIECE IN FIELD PKG.
S.R. ELL & SPOOL PIECE BEYOND IN PROCESS SKID PKG.
3/8"X1 1/2"L HEX BOLTS WITH FLAT WASHER-TYPICAL 4 PLACES (EACH).
3/8" NUTS & FLAT WASHERS AND LOCK WASHERS-TYPICAL 4 PLACES (EACH).
FIELD WELD 9"X6"X1/2" ℞ TO 4"φ SCH. 40 PIPE COL.
5'-2 1/2"
TOP OF CONCRETE 646.0'(REF)
TOP OF CONCRETE CURB 645.5'(REF)
TOP OF SKID 645.536-583'(REF)
645.0'(REF) GRADE ELEVATION (VERIFY IN FIELD)
FLOOR ELEVATION 644.5'(REF)
B ELEVATION - NEW INSTALLATION
H-2-818473 1"=1'-0"
PIPE SUPPORT 8"
3 1/2"
TOP OF CONCRETE 646.0'(REF) PLATE, H-2-818476
646.0'(REF)
C ELEVATION
H-2-818473 1"=1'-0"
SCALE IN FEET
PETER H. LANGOWSKI REGISTERED ENGINEER
PRELIMINARY
C.D. RHODEN
SEE DR/AT FORM
SEE DR/AT FORM
SEE DR/AT FORM
U.S. DEPARTMENT OF ENERGY
RICHLAND OPERATIONS OFFICE
ICF KAISER HANFORD COMPANY
HVAC
PROCESS BLDG. DUCTWORK-
RISER R-15 ELEVATIONS
W320 241-C-106 SLUICING
F 241-C 8900 H-2-818488 0
1"=1'-0" ER4319 SHEET 1 OF 1
H-2-9545A HEPA FILTERED INLET MODIF.
H-2-73346 PIPING WASTE TANK ISOLA.
H-2-38785 TANK CONDENSER BLIND FLNG.
H-2-818423 DRAWING LIST
B818488
2J:IBM:ACD2:12.0:NN
WHC
PLOT SCALE: 1=12
KEHCAD

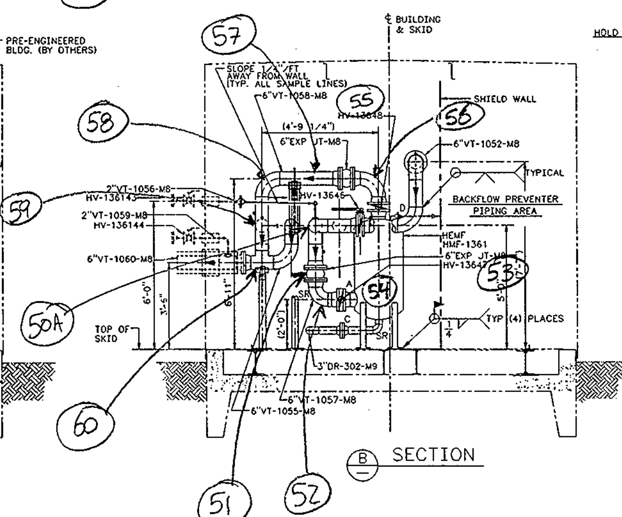
Chd Carl Rice 6/23/99











NOTES:

1. HEME AND HEMF SHIELDING DESIGN IS BASED ON A 1.185 CURIE SOURCE TERM DEPOSITED IN EITHER THE HEME OR THE HEMF AND YIELDS 10 MILLIREM/HOUR OUTSIDE EITHER THE HEME OR THE HEMF.
2. FOR MATERIALS, FABRICATION, INSPECTION & TESTING SEE CONSTRUCTION SPECIFICATION W-320-C6.
VENT PIPE (DUCT) AND SHEET METAL DUCT SHALL BE WELDED AIR TIGHT CONSTRUCTION AND FLANGED AS SHOWN TO FACILITATE EQUIPMENT REMOVAL. ALL PIPE ELBOWS ARE LONG RADIUS, EXCEPT AS DENOTED BY SR, WHICH SHALL BE SHORT RADIUS ELLS.
FOR VENT PIPE SUPPORTS IDENTIFICATION AND LOCATION SEE DRAWING H-2-818480 SHEETS 6 & 7.
3. FOR SHIELD WALL PIPE PENETRATION DETAILS SEE DRAWING H-2-818480 SHEET 2.
EQUIPMENT WATER SUPPLY & DRAINAGE PIPING & SUPPORT DETAILS ARE LOCATED ON DRAWING H-2-818480 SHEET 6.
4. ALL EQUIPMENT, COMPONENTS & VALVES TO BE IDENTIFIED WITH A WIRED ON STAINLESS STEEL TAG INCLUDING ITS IDENTIFICATION NO. STAMPED IN 1/4" HIGH LETTERS.
5. ALL M9 PIPING SHOWN ON THIS DRAWING SHALL BE BUTT WELDED WITH BUTT WELD END VALVES & FITTINGS.
6. VALVE STEM EXTENSION THAT PENETRATES BLDG. SHALL BE STORED & IDENTIFIED WITH VALVE NO. FOR LATER INSTALLATION IN PKG.4.
7. FIELD CUT DRAIN RISERS FROM SEAL POT & FIELD WELD DRAIN ELLS AT ELEVATION REQUIRED TO PERMIT MIN. SLOPE OF 1/4" PER FT. FOR ELBOWLET CONNECTION OF AIR VENT DRAIN TO DRAIN PIPE, SEE DETAIL 1, SHEET 4.
8. SEE SHEET 5 FOR INSTRUMENT CONECTIONS & LOCATIONS.
9. PIPE BENDS (5 X NOMINAL PIPE DIA.) MAY BE USED IN LIEU OF BUTT WELDED ELBOWS WHERE SPACE ALLOWS.
10. ALL EXPOSED CARBON STEEL SURFACES SHALL BE PAINTED IN ACCORDANCE WITH CONSTRUCTION SPECIFICATION W-320-C6.
11. TOLERANCES.
FRACTIONAL ± 1/16" ANGULAR ± 1°.
12. FOR EQUIPMENT SEE THE FOLLOWING PROCUREMENT SPECIFICATIONS:
HEMF-1361_____SEE W-320-P3
HX-1361_______SEE W-320-P4
HEME-1361_____SEE W-320-P5
FN-1361_______SEE W-320-P6
HC-1361_______SEE W-320-P7
MS-1361_______SEE W-320-P8

HOLD #1. DESIGN DIMENSIONS ARE ON HOLD PENDING FINAL APPROVED VENDOR EQUIPMENT SUBMITTAL.

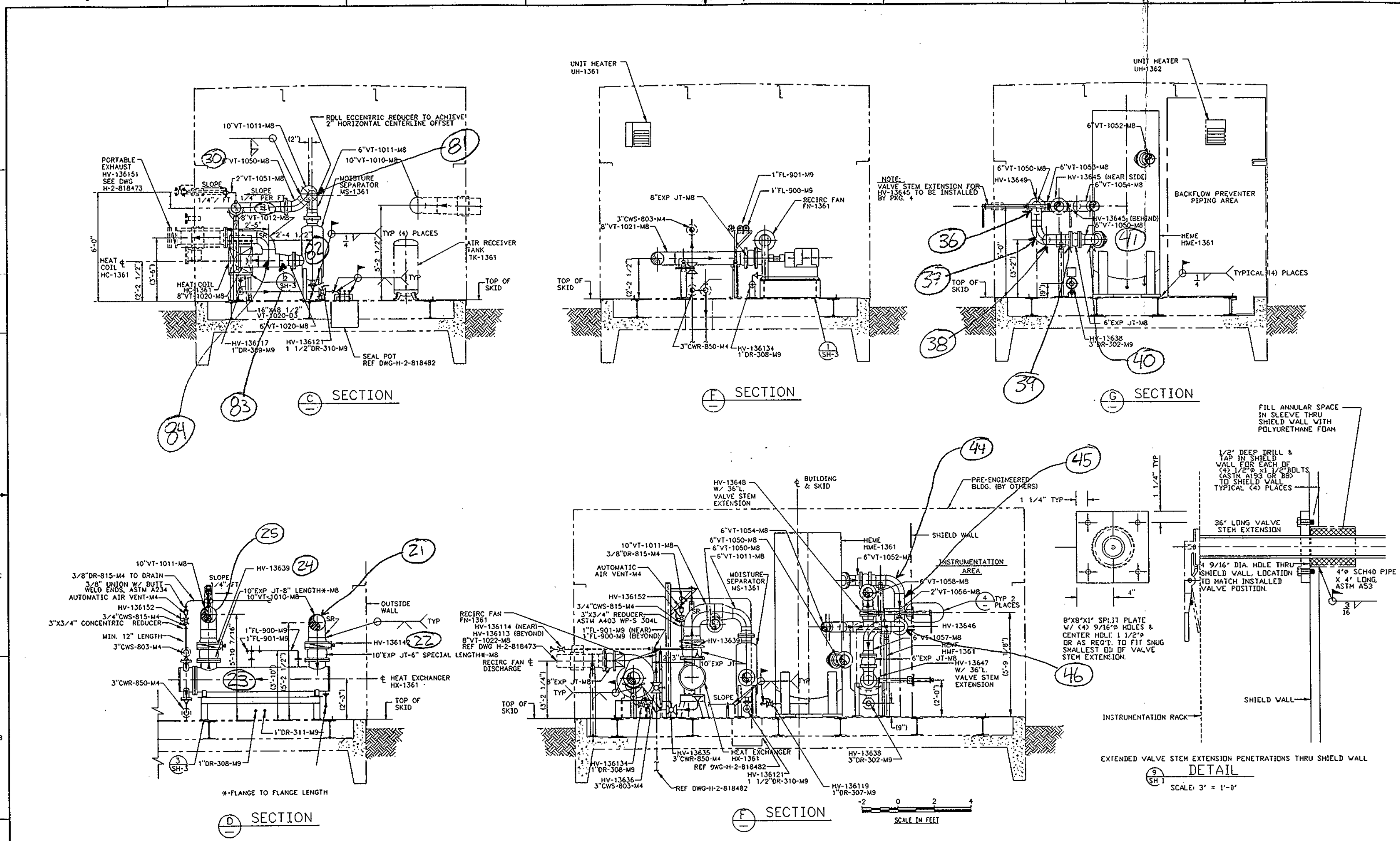
-2 0 2 4
SCALE IN FEET

REGISTERED ENGINEER: PETER H LANGOWSKI

DESIGNED CD RHODEN	SAFETY CLASS 3 — PRELIMINARY
SEE DR/AT FORM	U.S. DEPARTMENT OF ENERGY RICHLAND OPERATIONS OFFICE ICF KAISER HANFORD COMPANY
SEE DR/AT FORM	HVAC PROCESS BUILDING PLAN & SECTIONS
SEE DR/AT FORM	W320, TANK 241-C-106 SLUICING
33	F 241-C-91 7004 H-2-818480 0
WHC	1/2"=1'-0" ER4319 SHEET 1 OF 6

H-2-818423 DRAWING LIST
B818480A 28:IBM:ACD2:12.0:NN
PLOT SCALE: 1:24 KEMCAD

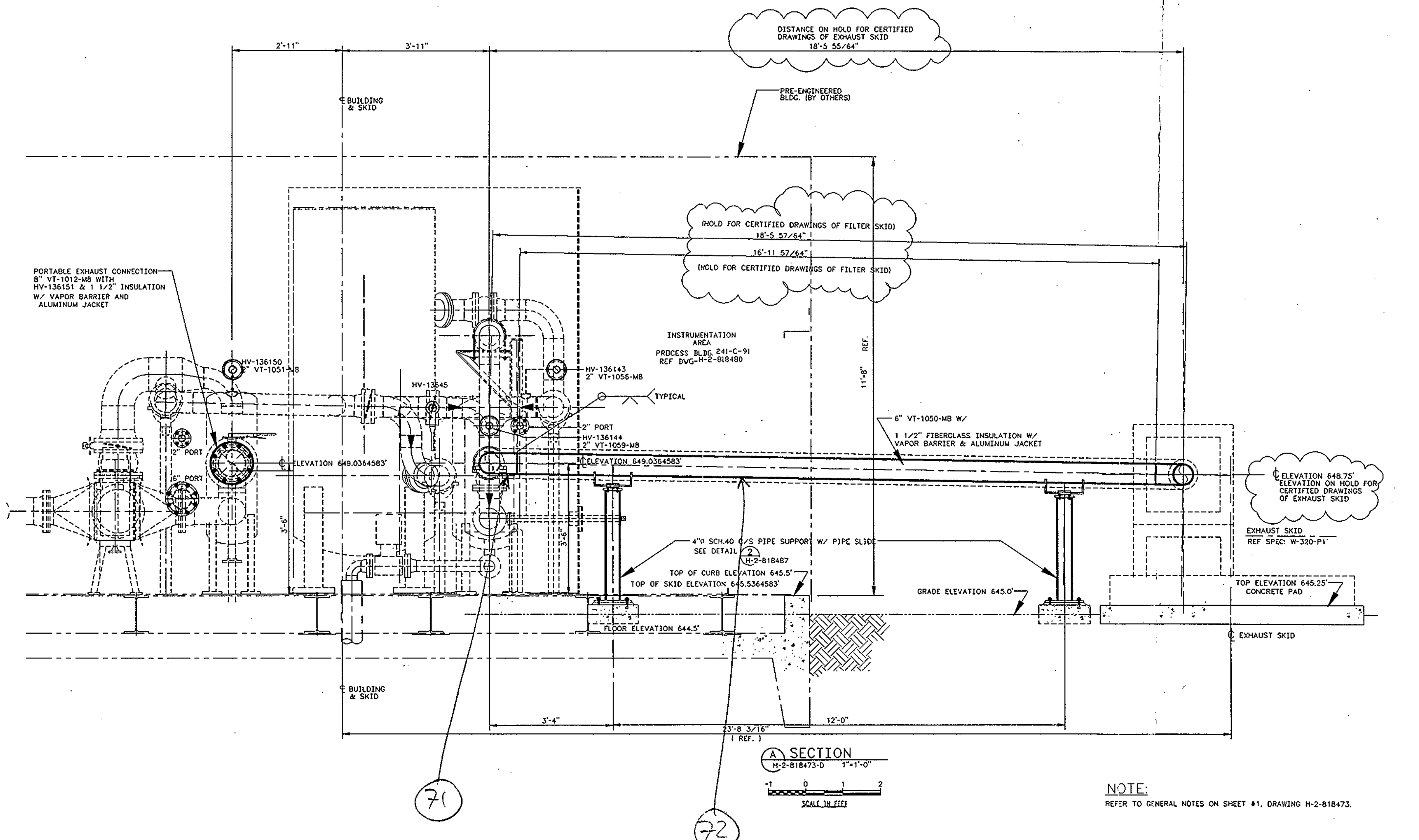
2/27/95
PHK 2-14-95
Rev 1
p. A5



REGISTERED ENGINEER: PETER H LANGOWSKI

DESIGNER: CD RHODEN	SAFETY CLASS: 3
SAFETY: SEE DR/AT FORM	PRELIMINARY
ENVIR: SEE DR/AT FORM	U.S. DEPARTMENT OF ENERGY RICHLAND OPERATIONS OFFICE ICF KAISER HANFORD COMPANY
QUAL DSN: SEE DR/AT FORM	HVAC PROCESS BUILDING SECTIONS & DETAILS
REVIEW NO.: 15	W320 TANK 241-C-106 SLUICING
SIZE: F	241-C-91 / 7004 / H-2-818480 / 0
FOR: WHC	SCALE: 1/2"=1'-0" / ER4319 / SHEET 2 OF 6

B818480B | 2B:IBM:ACD2:12.0:NN



A SECTION H-2-818473-D 1"=1'-0"

-1 0 1 2
SCALE IN FEET

NOTE:
REFER TO GENERAL NOTES ON SHEET #1, DRAWING H-2-818473.

PETER H. LANGOWSKI REGISTERED ENGINEER

H-2-818423	DRAWING LIST
W-326-P2	HEPA FILTER/EXHAUST FAN SKID
H-2-818473	6"ø EXHAUST DUCT PLAN
H-2-818480	PROCESS BLDG. DETAILS
NUMBER	TITLE
	REFERENCES

H-2-818423	DRAWING LIST
NUMBER	TITLE
	DRAWING TRACEABILITY LIST

DESIGNED	CD RHODEN 08/15/1994
CHECKED	
SAFETY	SEE DR/AT FORM
DESIGN	SEE DR/AT FORM
QUAL	SEE DR/AT FORM
REVIEW NO.	18
APPROVED FOR IMPLEMENTATION	
BY	WHC DATE 08-15-94

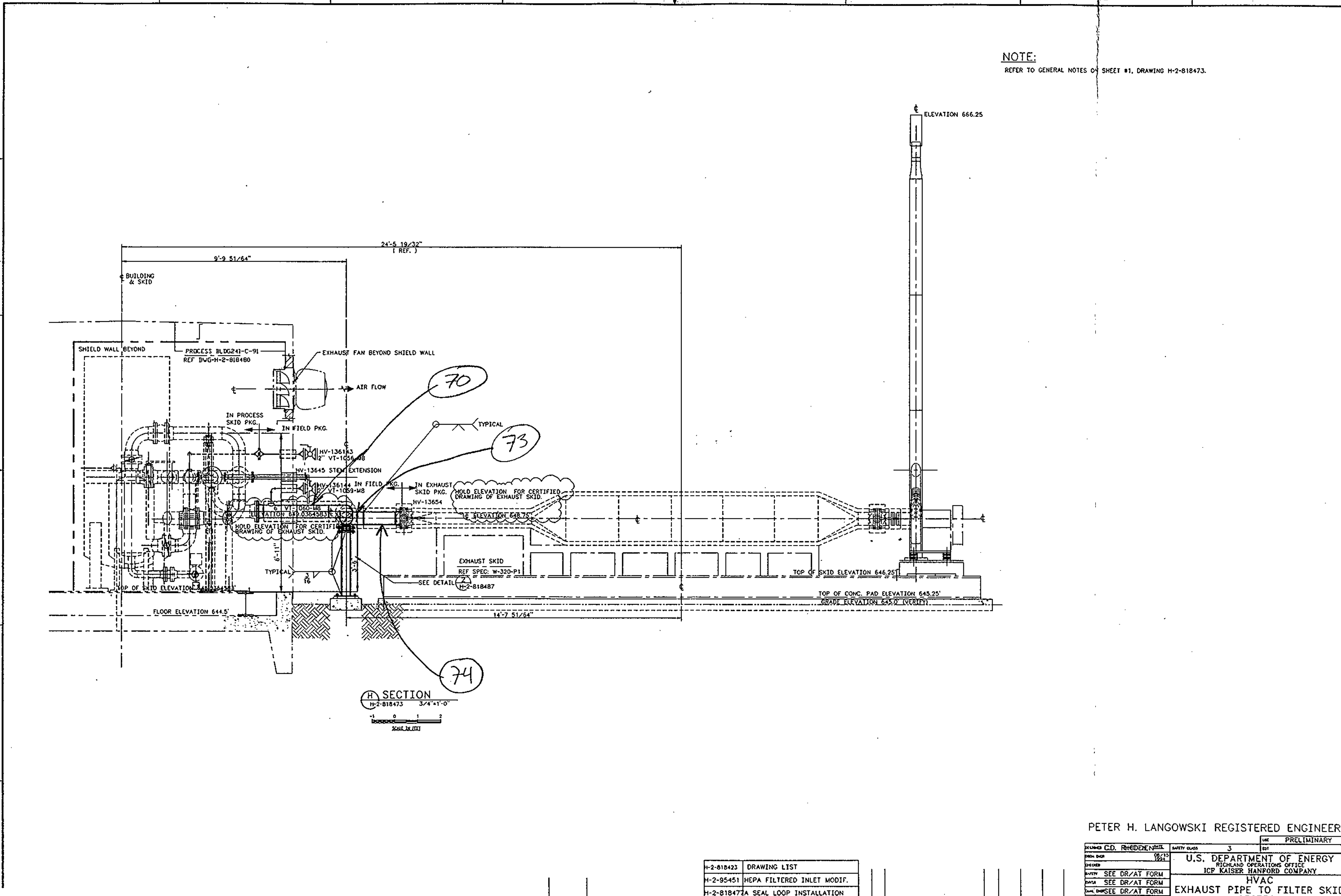
USE: PRELIMINARY
SAFETY CLASS: 3

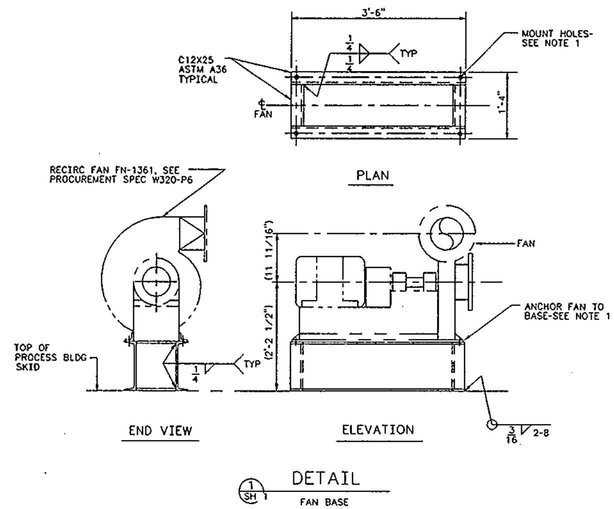
U.S. DEPARTMENT OF ENERGY
RICHLAND OPERATIONS OFFICE
ICF KAISER HANFORD COMPANY

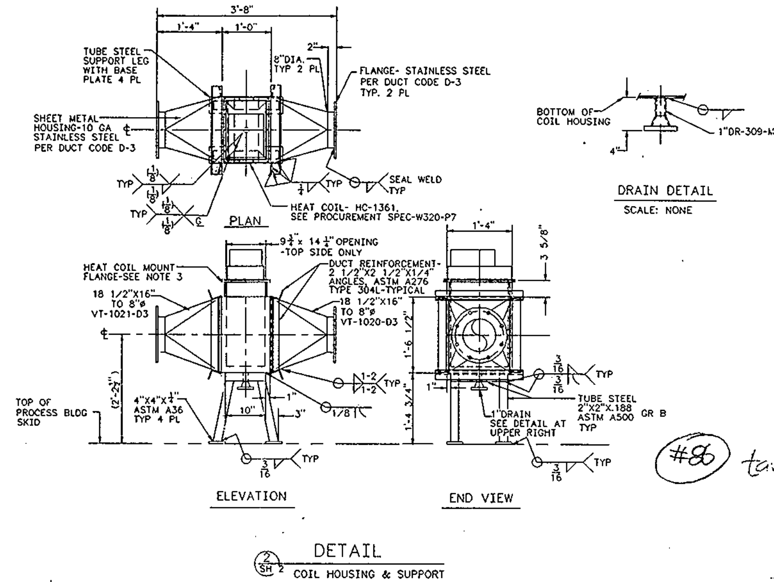
HVAC
EXHAUST PIPE TO FILTER SKID
SECTION

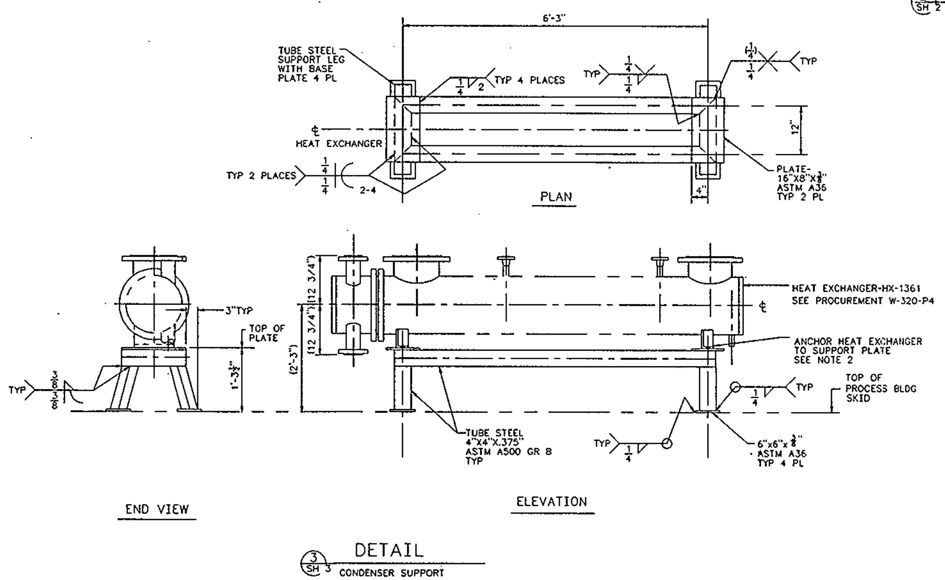
PROJECT: W320 TANK 241-C-106 SLUICING
SIZE: F | BLDG NO. 241-C | INDEX NO. 8900 | DWG NO. H-2-818489 | REV 0
SCALE: 1"=1'-0" | JOB NO. ER4319 | SHEET 1 OF 1

CAD FILE: B818489 | CAD CODE: 2J:IBM:ACD2:12.0:NN
PLOT SCALE: 1=12 | KENCAD


NOTE:
REFER TO GENERAL NOTES ON SHEET #1, DRAWING H-2-818473.
ELEVATION 666.25
24'-5 19/32" (REF.)
9'-9 51/64"
BUILDING & SKID
SHIELD WALL BEYOND
PROCESS BLDG241-C-91
REF DWG-H-2-818480
EXHAUST FAN BEYOND SHIELD WALL
AIR FLOW
IN PROCESS SKID PKG.
IN FIELD PKG.
HV-136143
2" VT-1056-M8
HV-13645 STEM EXTENSION
HV-136144
VT-1059-M8
IN FIELD PKG.
IN EXHAUST SKID PKG.
HV-13654
HOLD ELEVATION FOR CERTIFIED DRAWING OF EXHAUST SKID.
ELEVATION 648.75'
TYPICAL
HOLD ELEVATION FOR CERTIFIED DRAWING OF EXHAUST SKID.
EXHAUST SKID
REF SPEC: W-320-P1
SEE DETAIL 2 H-2-818487
TOP OF SKID ELEVATION 646.25'
TOP OF CONC. PAD ELEVATION 645.25'
GRADE ELEVATION 645.0 (VERIFY)
FLOOR ELEVATION 644.5'
14'-7 51/64"
6'-11"
3'-6"
70
73
74
H SECTION
H-2-818473 3/4"=1'-0"
H-2-818423 DRAWING LIST
H-2-95451 HEPA FILTERED INLET MODIF.
H-2-818477 A SEAL LOOP INSTALLATION
H-2-818476 TOP HATCH DETAILS
PETER H. LANGOWSKI REGISTERED ENGINEER
PRELIMINARY
C.D. RHODEN
SEE DR/AT FORM
SEE DR/AT FORM
SEE DR/AT FORM
U.S. DEPARTMENT OF ENERGY
RICHLAND OPERATIONS OFFICE
ICF KAISER HANFORD COMPANY
HVAC
EXHAUST PIPE TO FILTER SKID
SECTION
W320 TANK 241-C-106 SLUICING
F 241-C 8900 H-2-818490 0
WHC DATE 08-15-94
3/4"=1'-0" ER4319 SHEET 1 OF 1
8818490
2J:IBM:ACD2:12.0:NN
PLOT SCALE: 1=16
2/27/95
Rev 1
P. AB







$A_{rect} = (18.5)(16) = 296\ in^2$

$A_{round} = \frac{\pi (7.981)^2}{4} = 50\ in^2$

$A_1/A_0 = 6$

(#86) $\tan(\theta/2) = (1.13\sqrt{(18.5)(16)} - 7.981)/2(16)$
$= 0.358$
$\theta = 39.4°$
use $C_0 = 0.70$ (from 4-3)

NOTES:

1. MATCH DRILL WITH RECIRCULATING FAN FN-1361 SUPPORT BASE. SHIM AND SECURE PER MANUFACTURER'S RECOMENDATIONS.
2. MATCH DRILL & TAP WITH HEAT EXCHANGER HX-1361 SUPPORT BASE. SHIM AND SECURE PER MANUFACTURERS RECOMMENDATIONS.
3. MATCH DRILL WITH HEATER HC-1361 MOUNT FLANGE, USE SELF TAPPING SCREWS PER MANUFACTURER'S RECOMENDATION. INSTALL FLANGE GASKET SUPPLIED WITH HEATER FOR AN AIR TIGHT SEAL
4. FOR GENERAL BUILDING NOTES SEE SHEET 1.
5. SHIM AS REQUIRED FOR LEVEL INSTALLATION WITH 5/16 TYPE B BEVELED WASHERS, ANSI B18.23.1, 18-8 SST

(#88) $\tan(\theta/2) = (7.981 - 1.13\sqrt{(18.5)(16)})/2(16)$
$= -39.4°$
use $C_0 = 0.04$ (from 5-1)

HOLD #1-HOLD DESIGN DIMENSIONS ON HOLD PENDING FINAL EQUIPMENT VENDOR APPROVED EQUIPMENT SUBMITTALS.

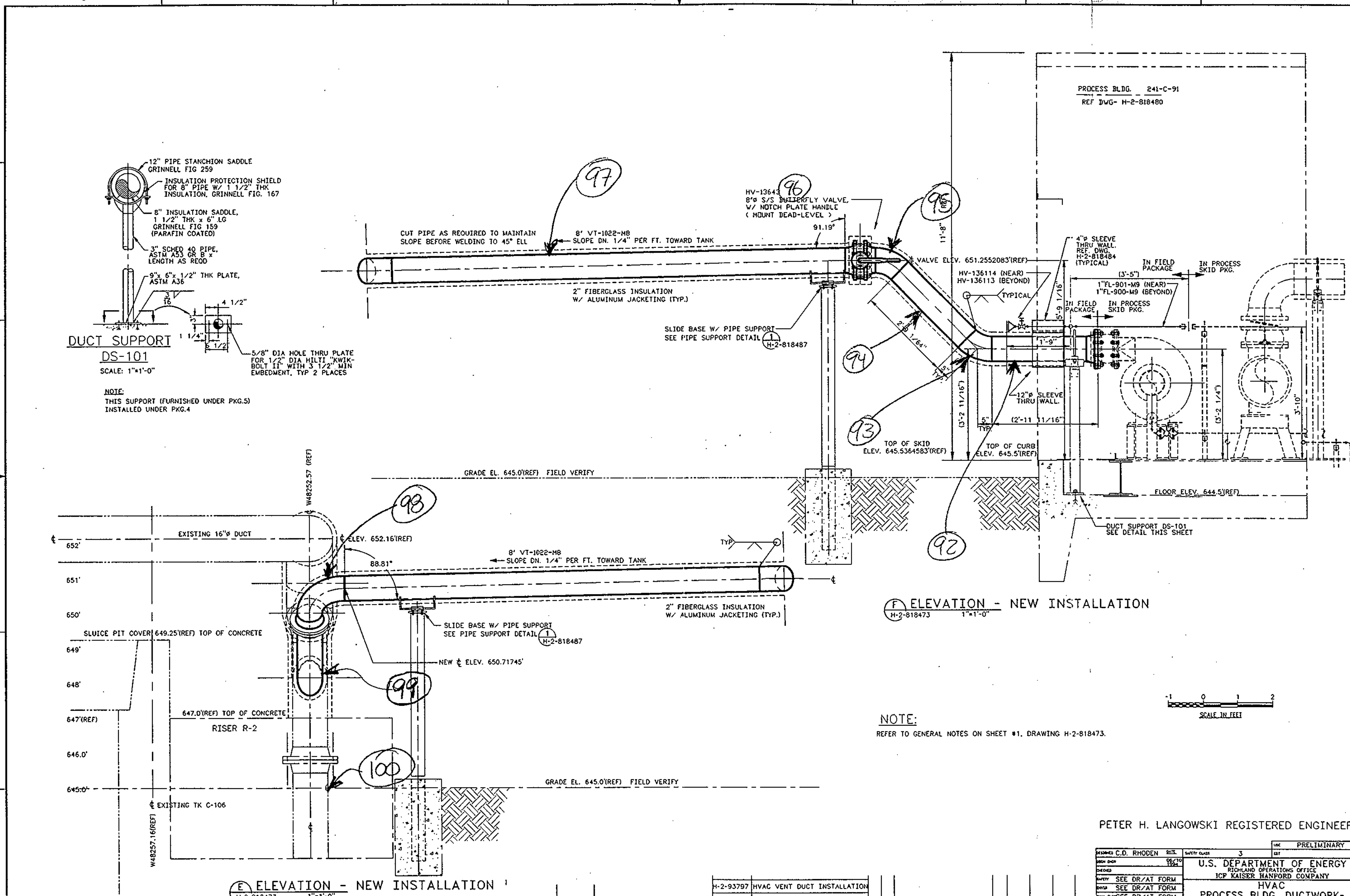
2/27/95 GB

PHR 2-14-95

Rev1 p. A9

PRELIMINARY

DESIGNED J. JURGILEWICZ — SAFETY CLASS 3
SAFETY SEE DR/AT FORM
QUALITY SEE DR/AT FORM
DES ENGR SEE DR/AT FORM
REVIEW NO. 9
U.S. DEPARTMENT OF ENERGY
RICHLAND OPERATIONS OFFICE
ICF KAISER HANFORD COMPANY
HVAC
PROCESS BUILDING
DETAILS
PROJECT W320 TANK 241-C-106 SLUICING
F 241-C-91 7004 H-2-818480 0
SCALE 1"=1'-0" JOB NO. ER4319 SHEET 3 of 6
WHC
CAD FILE B818480C CAD CODE 28:IBM:ACD2:12.0:NN



NOTE:
REFER TO GENERAL NOTES ON SHEET #1, DRAWING H-2-818473.

PETER H. LANGOWSKI REGISTERED ENGINEER

H-2-818423	DRAWING LIST
H-2-93797	HVAC VENT DUCT INSTALLATION
H-2-93800	STRUCTURAL PLAN & DETAILS
H-2-93799	VENTILATION 16"ø DUCT SPOOL

PRELIMINARY

DESIGNED C.D. RHODEN — SAFETY CLASS 3

SEE DR/AT FORM

U.S. DEPARTMENT OF ENERGY
RICHLAND OPERATIONS OFFICE
ICF KAISER HANFORD COMPANY

HVAC
PROCESS BLDG. DUCTWORK-
RISER R-2 -SECTIONS

W320 241-C-106 SLUICING

F 241-C 8900 H-2-818486 0

AS NOTED ER4319 SHEET 1 OF 1

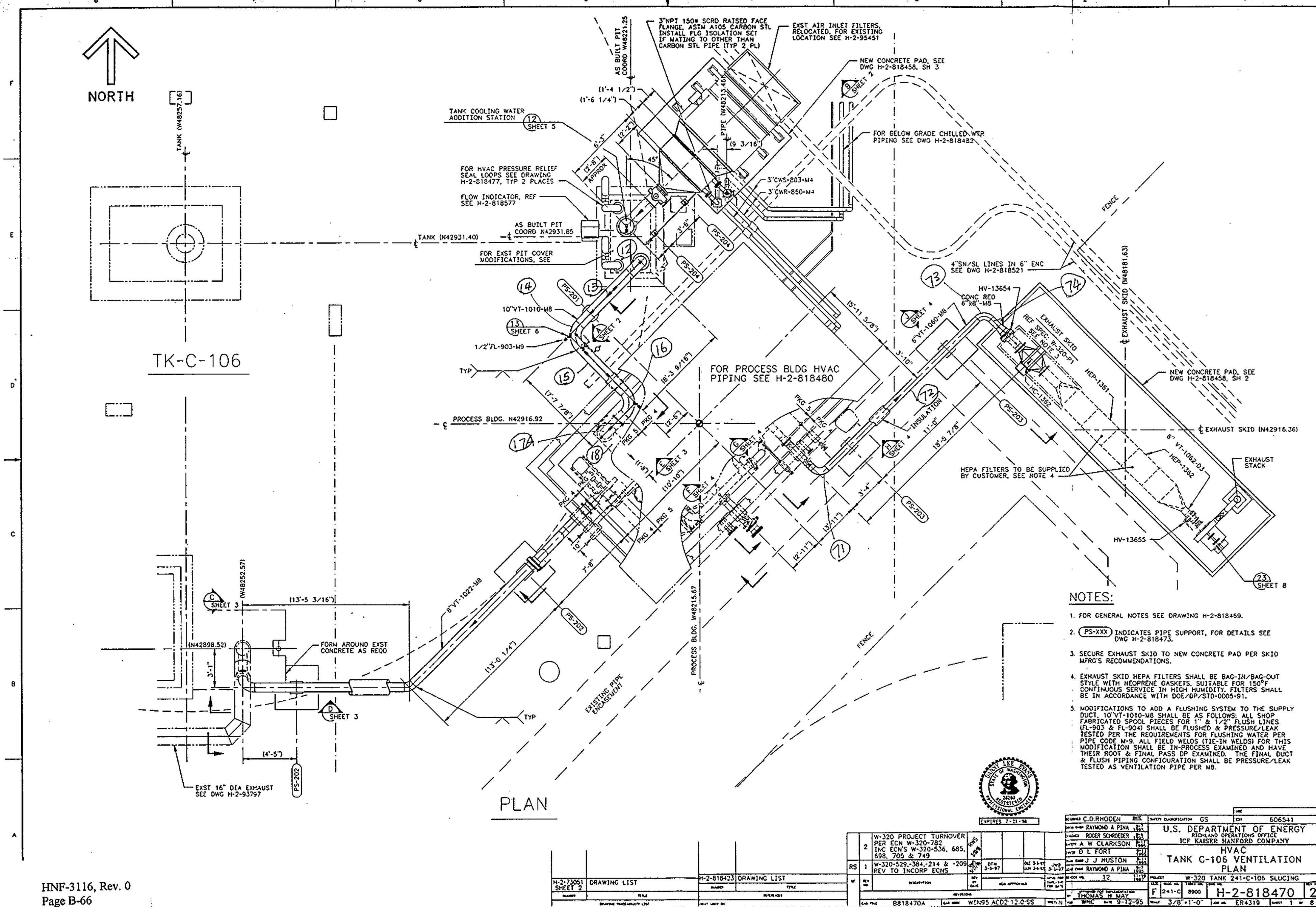
B818486 2J:IBM:ACD2:12.0:NN

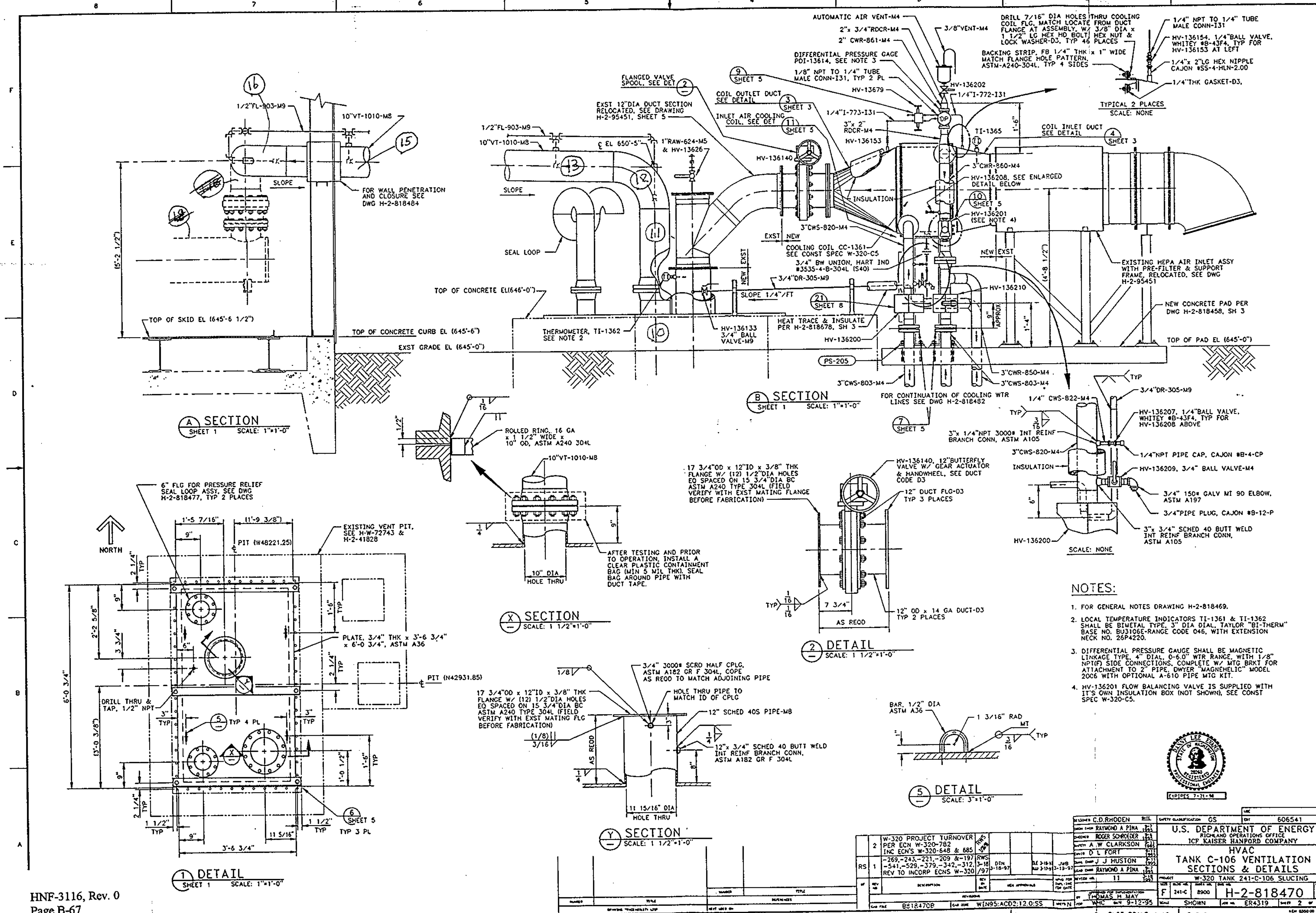
PLOT SCALE: 1=12 KEHCAD

2/27/95

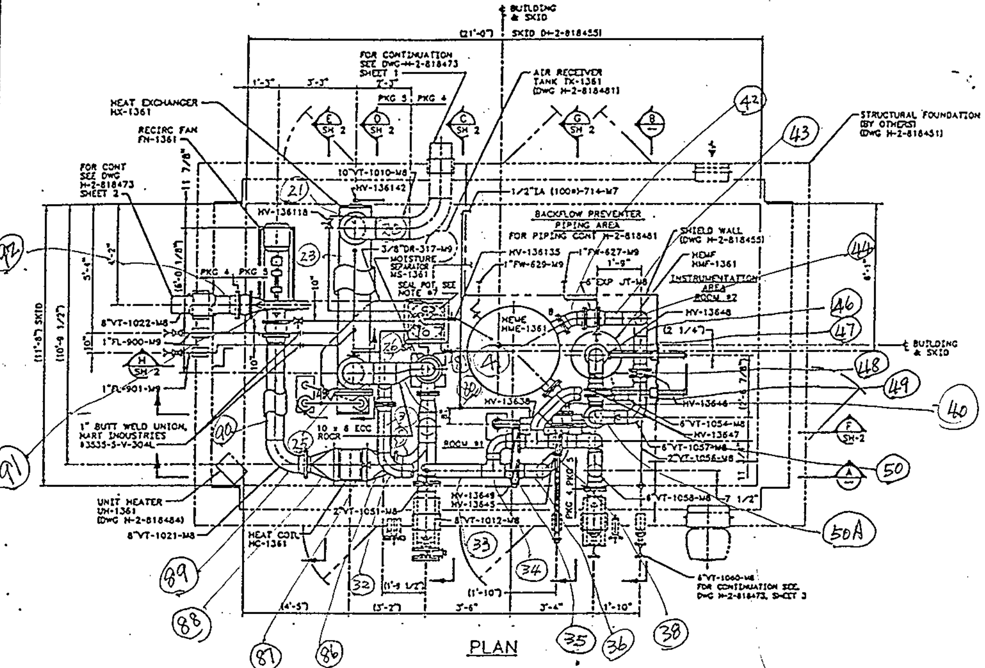
PHR 2-14-95

Rev 1 p. A10

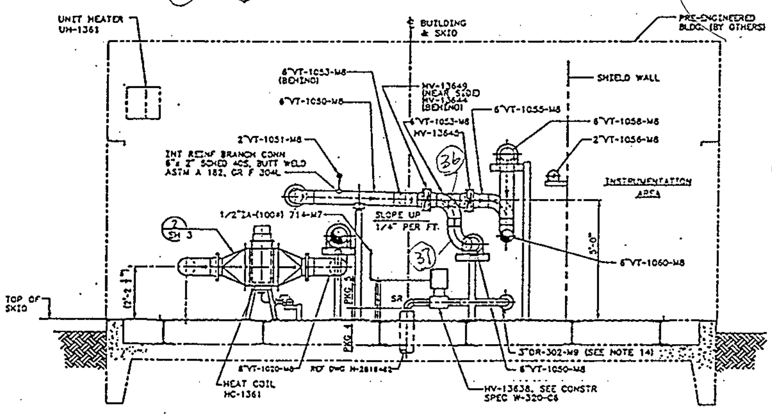

NORTH
TK-C-106
PLAN
FOR PROCESS BLDG HVAC PIPING SEE H-2-818480
3"NPT 150# SCRD RAISED FACE FLANGE, ASTM A105 CARBON STL INSTALL FLG ISOLATION SET IF MATING TO OTHER THAN CARBON STL PIPE (TYP 2 PL)
EXST AIR INLET FILTERS, RELOCATED. FOR EXISTING LOCATION SEE H-2-95451
NEW CONCRETE PAD, SEE DWG H-2-818458, SH 3
FOR BELOW GRADE CHILLED WTR PIPING SEE DWG H-2-818482
TANK COOLING WATER ADDITION STATION
FOR HVAC PRESSURE RELIEF SEAL LOOPS SEE DRAWING H-2-818477, TYP 2 PLACES
FLOW INDICATOR, REF SEE H-2-818577
AS BUILT PIT COORD N42931.85
FOR EXST PIT COVER MODIFICATIONS, SEE
TANK (N42931.40)
PROCESS BLDG. N42916.92
4"SN/SL LINES IN 6" ENC SEE DWG H-2-818521
EXHAUST SKID REF SPEC W-320-P1 SEE NOTE 3
NEW CONCRETE PAD, SEE DWG H-2-818458, SH 2
EXHAUST SKID (N42916.36)
EXHAUST STACK
HEPA FILTERS TO BE SUPPLIED BY CUSTOMER, SEE NOTE 4
FORM AROUND EXST CONCRETE AS REQD
EXST 16" DIA EXHAUST SEE DWG H-2-93797
EXISTING PIPE ENCASEMENT
FENCE
NOTES:
1. FOR GENERAL NOTES SEE DRAWING H-2-818469.
2. (PS-XXX) INDICATES PIPE SUPPORT, FOR DETAILS SEE DWG H-2-818473.
3. SECURE EXHAUST SKID TO NEW CONCRETE PAD PER SKID MFRG'S RECOMMENDATIONS.
4. EXHAUST SKID HEPA FILTERS SHALL BE BAG-IN/BAG-OUT STYLE WITH NEOPRENE GASKETS, SUITABLE FOR 150°F CONTINUOUS SERVICE IN HIGH HUMIDITY. FILTERS SHALL BE IN ACCORDANCE WITH DOE/OP/STD-0005-91.
5. MODIFICATIONS TO ADD A FLUSHING SYSTEM TO THE SUPPLY DUCT, 10"VT-1010-M8 SHALL BE AS FOLLOWS: ALL SHOP FABRICATED SPOOL PIECES FOR 1" & 1/2" FLUSH LINES (FL-903 & FL-904) SHALL BE FLUSHED & PRESSURE/LEAK TESTED PER THE REQUIREMENTS FOR FLUSHING WATER PER PIPE CODE M-9. ALL FIELD WELDS (TIE-IN WELDS) FOR THIS MODIFICATION SHALL BE IN-PROCESS EXAMINED AND HAVE THEIR ROOT & FINAL PASS DP EXAMINED. THE FINAL DUCT & FLUSH PIPING CONFIGURATION SHALL BE PRESSURE/LEAK TESTED AS VENTILATION PIPE PER M8.
2 W-320 PROJECT TURNOVER PER ECN W-320-782 INC ECN'S W-320-536, 685, 698, 705 & 749
1 W-320-529,-384,-214 & -209 REV TO INCORP ECNS
H-2-73051 SHEET 2 DRAWING LIST
H-2-818423 DRAWING LIST
C.D.RHODEN
RAYMOND A PINA
ROGER SCHROEDER
A W CLARKSON
D L FORT
J J HUSTON
THOMAS H MAY
WHC 9-12-95
606541
U.S. DEPARTMENT OF ENERGY
RICHLAND OPERATIONS OFFICE
ICF KAISER HANFORD COMPANY
HVAC
TANK C-106 VENTILATION PLAN
W-320 TANK 241-C-106 SLUCING
F 241-C 8900 H-2-818470 2
3/8"=1'-0" ER4319 1 of 8
B818470A WIN95 ACD2-12.0-SS
EXPIRES 7-21-98
A11



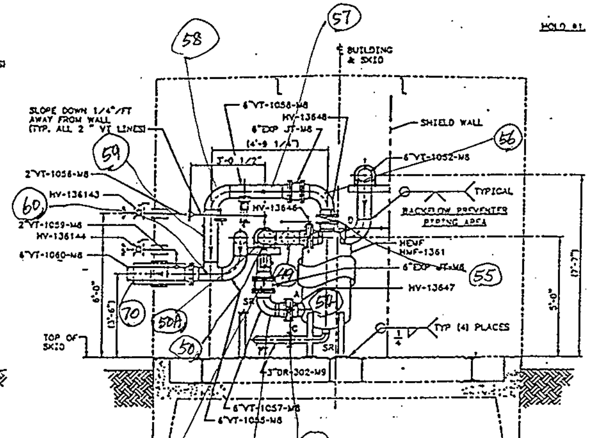
A SECTION SHEET 1 SCALE: 1"=1'-0"
B SECTION SHEET 1 SCALE: 1"=1'-0"
X SECTION SCALE: 1 1/2"=1'-0"
Y SECTION SCALE: 1 1/2"=1'-0"
1 DETAIL SHEET 1 SCALE: 1"=1'-0"
2 DETAIL SCALE: 1 1/2"=1'-0"
5 DETAIL SCALE: 3"=1'-0"
TYPICAL 2 PLACES SCALE: NONE
NOTES:
1. FOR GENERAL NOTES DRAWING H-2-818469.
2. LOCAL TEMPERATURE INDICATORS TI-1361 & TI-1362 SHALL BE BIMETAL TYPE, 3" DIA DIAL, TAYLOR "BI-THERM" BASE NO. BU3106E-RANGE CODE 046, WITH EXTENSION NECK NO. 26P4220.
3. DIFFERENTIAL PRESSURE GAUGE SHALL BE MAGNETIC LINKAGE TYPE, 4" DIAL, 0-6.0" WTR RANGE, WITH 1/8" NPT(F) SIDE CONNECTIONS, COMPLETE W/ MTG BRKT FOR ATTACHMENT TO 2" PIPE, DWYER "MAGNEHELIC" MODEL 2006 WITH OPTIONAL A-610 PIPE MTG KIT.
4. HV-136201 FLOW BALANCING VALVE IS SUPPLIED WITH IT'S OWN INSULATION BOX (NOT SHOWN), SEE CONST SPEC W-320-C5.
U.S. DEPARTMENT OF ENERGY
RICHLAND OPERATIONS OFFICE
ICF KAISER HANFORD COMPANY
HVAC
TANK C-106 VENTILATION
SECTIONS & DETAILS
W-320 TANK 241-C-106 SLUCING
H-2-818470



PLAN



SECTION A



SECTION B

NOTES:

1. HEME AND HEMF SHIELDING DESIGN IS BASED ON A 1.185 CURIE SOURCE TERM DEPOSITED IN EITHER THE HEME OR THE HEMF AND YIELDS 10 MILLIREM/HOUR OUTSIDE EITHER THE HEME OR THE HEMF. SYSTEM DESIGN IS BASED ON AN AIRSTREAM SOURCE TERM OF 202 MICROCURIE PER METER CUBED.
2. FOR MATERIALS, FABRICATION, INSPECTION & TESTING SEE CONSTRUCTION SPECIFICATION W-320-C6.
3. ALL PIPE ELBOWS ARE LONG RADIUS, EXCEPT AS DENOTED BY SR, WHICH SHALL BE SHORT RADIUS ELLS. FOR VENT PIPE SUPPORT IDENTIFICATION AND LOCATION SEE DRAWING H-2-818480 SHEETS 5 & 6.
4. ALL EQUIPMENT, COMPONENTS & VALVES TO BE IDENTIFIED PER CONSTRUCTION SPECIFICATION W-320-C6.
5. ALL M9 PIPING SHOWN ON THIS DRAWING SHALL BE BUTT WELDED WITH BUTT WELD END VALVES & FITTINGS.
6. VALVE STEM EXTENSION FOR VALVE HV-13695 SHALL BE STORED & IDENTIFIED WITH VALVE NO. FOR LATER INSTALLATION IN PKG.4.
7. FOR ELBOLET CONNECTION OF 3/8" AIR VENT DRAIN TO DRAIN PIPE, SEE DETAIL 1, SHEET 4.
8. SEE SHEET 4 FOR INSTRUMENT CONNECTIONS & LOCATIONS.
9. PIPE BENDS (5 X NOMINAL PIPE DIA) MAY BE USED IN LIEU OF BUTT WELDED ELBOWS WHERE SPACE ALLOWS.
10. ALL EXPOSED CARBON STEEL SURFACES SHALL BE PAINTED IN ACCORDANCE WITH CONSTRUCTION SPECIFICATION W-320-C6.
11. TOLERANCES: FRACTIONAL ± 1/8" ANGULAR ± 1°.
12. FOR EQUIPMENT SEE THE FOLLOWING PROCUREMENT SPECIFICATIONS:
    - HEMF-1361 ______ SEE W-320-P3
    - HX-1361 ______ SEE W-320-P4
    - HEME-1361 ______ SEE W-320-P5
    - FN-1361 ______ SEE W-320-P6
    - HC-1361 ______ SEE W-320-P7
    - MS-1361 ______ SEE W-320-P8
13. 1/2" IA-714 & 3/8" DR-311 SHALL BE FIELD ROUTED & SUPPORTED IN APPROXIMATE LOCATIONS SHOWN.
14. OBTAIN FIELD MEASUREMENTS FOR SPOOL FABRICATION OF 3" DR-302-M9, 3" CWS-803-M4, 3" CWR-850-M4 AND ALL EQUIPMENT DRAIN LINES ENTERING SEAL POT AFTER SKID PACKAGE HAS BEEN INSTALLED. FIELD TRIM DRAIN RISERS INTO SEAL POT AS REQD TO PERMIT A MIN OF 1/4"/FT SLOPE FROM EQUIPMENT TO RISER.

HOLD #1. DESIGN DIMENSIONS ARE ON HOLD PENDING FINAL APPROVED VENDOR EQUIPMENT SUBMITTAL.

KAISER ENGINEERS HANFORD CONTROLLED DOCUMENT STATION NO35
DIST
DATE APR 10 1995
PROJ/WO W-320
NO PLE-1

OFFICIAL RELEASE BY WHC
DATE MAR 30 1995

3-3-95

CO RHODENA
SEE DR/AT FORM
SEE DR/AT FORM
SEE DR/AT FORM
37

CONSTRUCTION
606533

U.S. DEPARTMENT OF ENERGY
RICHLAND OPERATIONS OFFICE
ICF KAISER HANFORD COMPANY

HVAC
PROCESS BUILDING
PLAN & SECTIONS

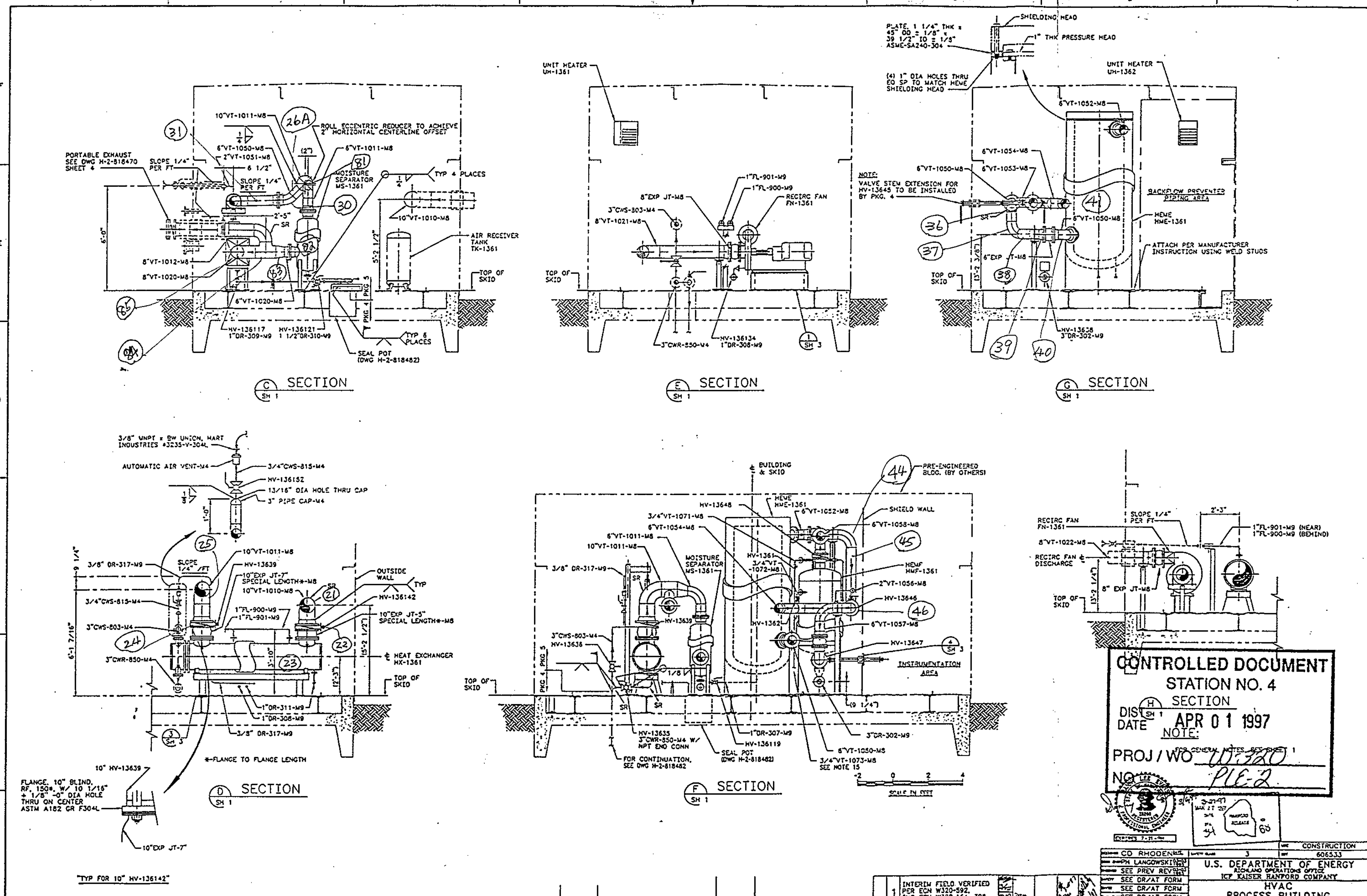
W-320 TANK 241-C-106 SLUICING

F | 241-C-41 | H-2-818480 | 0

1/2"=1'-0" | ER4319 | 1 OF 6

PLOT SCALE: 1=24 | KEHCAD

A14



CONTROLLED DOCUMENT
STATION NO. 4
SECTION H SH 1
DIST DATE APR 01 1997
NOTE:
PROJ / WO W-320
NO. PLE-2

INTERIM FIELD VERIFIED PER ECN W320-592, INC ECN W320-164, 308, 312, 343

U.S. DEPARTMENT OF ENERGY
RICHLAND OPERATIONS OFFICE
ICF KAISER HANFORD COMPANY
HVAC
PROCESS BUILDING
SECTIONS & DETAILS
W-320 TANK 241-C-106 SLUICING
H-2-818480 | 1
CONSTRUCTION 606533

Ckd Paul Rice 4/23/94

KOCH

KOCH ENGINEERING COMPANY INC

Delete Rev 1 AH 2-14- 2/27/95

FLEXICHEVRON® MIST ELIMINATOR PROPOSAL

Kaiser Engineers Hanford
P. O. Box 888, M/SE6-21
Richland, WA 99352

Attn: Mr. Peter H. Langowski

Our No. 61921A00 Rev. 1

RE: Project W-320
C-106 Sluicing

Date: December 29, 1993

We are pleased to submit the following FLEXICHEVRON® Mist Eliminator quotation for your consideration.

DESIGN CONDITIONS:

Gas Flow Rate	1089-1277 ACFM
Gas Temperature	75-125° F
Gas Pressure	-6 to -1 inch W.G.
Gas Density	0.0675 lbs./cu.ft.
Gas From	Nuclear Waste Tank
Liquid Particulate	Water, Radioactive Particulate
Amount Present	100 mg/m³

EQUIPMENT DESCRIPTION:

Quantity	One (1)
Style	II-2Y
Diameter	18″
Thickness	12″
Material of Construction	
FLEXICHEVRON®	316L
Vessel	By Others
Supports	By Others
Estimated Shipping Weight	30 lbs.
Equipment Price	$1,000.00

GUARANTEED PERFORMANCE:

Collection efficiency at design conditions will be 99+% of all particles greater than 10 microns in diameter. Pressure drop across the Koch FLEXICHEVRON® Mist Eliminator will be less than .75 inches W.G.

EQUIPMENT PRICE:

The price of the equipment as described will be F.O.B. Wichita, Kansas, domestic crating, freight collect. Terms of payment are net 30 days. This price is firm for 30 days from the date of this proposal and does not include any applicable taxes.

4111 East 37th Street North • Wichita, Kansas 67220 • P.O. Box 8127 • Wichita, Kansas 67208
316/832-5110 • FAX 316/832-8018

High temperature air duct heaters

5 to 300 kW and above

Outlet air temperatures to 1200°F

480 volt 3 phase (voltages to 600 V available)

With .475 dia. tubular elements

Types ADH and ADHT

Applications

- ☐ Heating air for various drying/curing operations up to 1200°F air temperature
- ☐ Heat treating
- ☐ Re-heating or dehumidification
- ☐ Other similar air heating applications

Features

Rugged construction. Sturdy 0.475 diameter tubular elements mounted to a heavy ¼ or ⅜ inch thick steel flange. Terminal housing made of 18 ga. aluminized steel. Element support plates of 16 ga. aluminized steel are held in place by stainless steel support rods. High temperature units have the additional feature of stainless steel material for the 3 inch insulation housing and element support plate — all of which provides superior rigidity, strength and reliability.

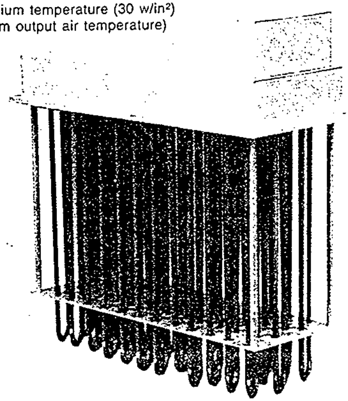
Long life metal sheath tubular elements—Corrosion/oxidation resistant sheath. High grade Incoloy® sheath material for excellent corrosion/oxidation resistance at high operating temperatures.

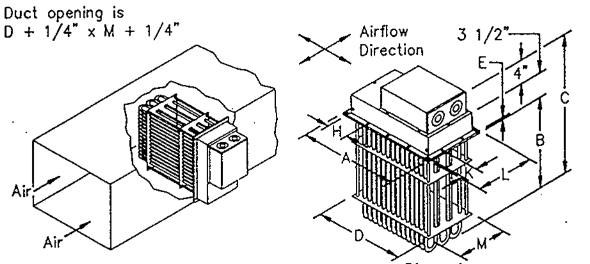
High purity magnesium oxide. The elements are filled with highest purity blends of magnesium oxide refractory (MGO) compacted to a rock hard density to insure maximum thermal conductivity and electrical insulation resistance.

Superior grade resistance wire. The heart of each heating element is made of 80% nickel-20% chromium resistance wire for maximum long life.

Low watt density resistor wire. Watt density on the heating coil is designed for low watt density operation by increasing the coil diameter, gauge and length of resistance wire to give maximum surface area and low operating coil surface temperature — providing longer coil life.

ADH—Low/medium temperature (30 w/in²)
(800°F maximum output air temperature)





Typical Installation

Dimensions

ADH—Low/medium temperature (30 w/in²)

kW	Dimensions—Inches A	B	C	D	E	H	K	L	M	No. Elem.	No. Circ.	Catalog No.	Status	PCN	Wt. Lbs.
5	5⅝	20⅛	28⅛	4	¼	2½	3½	11⅛	9½	3	1	ADH-005	S	210016	8
10	7⅝	20⅜	28⅛	6	¼	3½	3½	11⅛	9½	6	1	ADH-010	S	210024	15
15	9⅝	20⅜	28⅛	8	¼	3	3½	11⅛	9½	9	1	ADH-015	S	210032	25
20	11⅝	20⅜	28⅛	10	¼	2¾	3½	11⅛	9½	12	1	ADH-020	S	210040	35
25	13⅝	20⅜	28⅛	12	¼	3¼	3½	11⅛	9½	15	1	ADH-025	S	210059	40
30	15⅝	20⅜	28¼	14	⅜	3¾	3½	11⅛	9½	18	1	ADH-030	S	210067	55
35	17⅝	20⅜	28¼	16	⅜	4¼	3½	11⅛	9½	21	1	ADH-035	S	210075	65
40	19⅝	20⅜	28¼	18	⅜	4¾	3½	11⅛	9½	24	2	ADH-040	S	210083	70
45	21⅝	20⅜	28¼	20	⅜	5¼	3½	11⅛	9½	27	2	ADH-045	S	210091	80
50	23⅝	20⅜	28¼	22	⅜	5¾	3½	11⅛	9½	30	2	ADH-050	S	210104	90
60	27⅝	20⅜	28¼	26	⅜	4½	3½	11⅛	9½	36	2	ADH-060	S	210112	105
80	35⅝	20⅜	28¼	34	⅜	4⅜	3½	11⅛	9½	48	4	ADH-080	NS	210120	140
90	39⅝	20⅜	28¼	38	⅜	4⅞	3½	11⅛	9½	54	5	ADH-090	NS	210139	160
100	43⅝	20⅜	28¼	42	⅜	5⅜	3½	11⅛	9½	60	5	ADH-100	S	210147	175
144	35⅝	35	42⅞	34	⅜	4⅜	3½	11⅛	9½	48	4	ADH-144	NS	210155	165
162	39⅝	35	42⅞	38	⅜	4⅞	3½	11⅛	9½	54	6	ADH-162	S	210163	185
216	27⅝	35	42⅞	26	⅜	4½	3⅞	20	18⅜	72	6	ADH-216F	S	210171	240
270	33⅝	35	42⅞	32	⅜	5½	3⅞	20	18⅜	90	8	ADH-270F	S	210180	300

Specify: Quantity, catalog no., PCN, kW, air duct heaters.

Process Air

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High temperature air duct heaters (cont.)

Application Guide

Selecting heater size. Refer to Technical Section for examples on determining kW requirements. For quick estimating purposes, the following formula may be used for standard conditions:

kW = CFM x temp. diff/3000

Maximum work temperatures. Types ADH and ADHT process air heaters can generally be used at the following maximum temperatures shown, provided the minimum air velocity is maintained uniformly through the heater:

Air Velocity (ft/sec)	Max. Outlet Air Temp.°F ADH	ADHT
4	800	1050
9	800	1100
16	800	1150
25	800	1200
36	800	1200

Application assistance. Chromalox sales/application engineers are available to assist you in the design or selection of equipment. Please contact your local Chromalox Sales Office if you need engineering assistance.

Installation mounting tips

Low temperature duct heaters can be fastened directly to the sheet metal duct work with bolts or sheet metal screws.

High temperature duct heaters are generally mounted to a field fabricated stand off collar from the ductwork to position the heater such that the 3" insulation housing is in the same plane as the duct insulation.

All heaters can be mounted in any position; top, side or bottom (preferred) entry. Minimum duct size is A or L dimension plus 3/8" and B dimension plus 1 5/8".

Provide adequate heater support. Consideration should be given to installing hangers or some other means of heater support whenever there is any question about the ability of the ductwork to support the heater weight.

Overtemperature protection. All heaters should include an overtemperature (overheat) control whose temperature sensing element is located on the air discharge side of the heater as close to the heater as practical. High temperature ADHT units include an overtemperature (Type K) thermocouple as standard.

Additional protection can be achieved by installing an air flow or pressure differential switch to protect the heater against low air flow conditions.

Operational controls. Selection of these controls, thermostat, SCR units, contactors and etc., depends on the degree of accuracy required, reliability, electrical rating of heater and economic considerations. Refer to Control Section.

Field power & control circuit wiring. Must be capable of carrying the electrical load and be protected by overcurrent protective devices, such as fusing, circuit breakers or ground fault detection in accordance with the requirements of the National Electrical Code and local codes as applicable.

Tandem mounting. Multiple heaters may be mounted in tandem with each other provided the maximum recommended outlet air temperature is not exceeded.

Pressure drop. Depends on the size of heater, its orientation with respect to air flow and the velocity of the air. Curve G-227-2 in Technical Section lists pressure drops for various heaters. Note, if pressure drop must be kept to a minimum, the heater should be mounted in the duct with the narrow width of the heater perpendicular to the air flow.

Options available

Gas tight design. Achieved by the use of threaded compression fittings with fiber washers to attach heating elements to flange—prevents leakage of ducted air into terminal housing.

Overtemperature protection. Thermocouple welded to the element sheath surface and wired to a terminal block can be provided for accurate overheat protection. Standard on high temperature units.

Moisture or explosion-resistant terminal housings are available for those applications requiring special terminal protection.

Special ratings or sizes. Chromalox can custom fabricate a duct heater to your particular needs whether it be rating, physical size or other specifications.

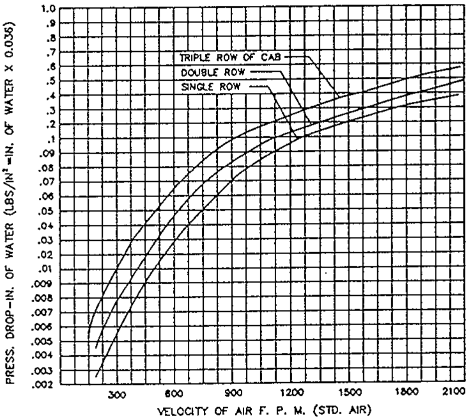
Contact your local Chromalox representative for assistance.

$$\frac{860 \text{ scfm}/60}{(18.5)(16)/144} = 7 \text{ fpm}$$

Rev! AK 2-14-95
2/27/95 GBC

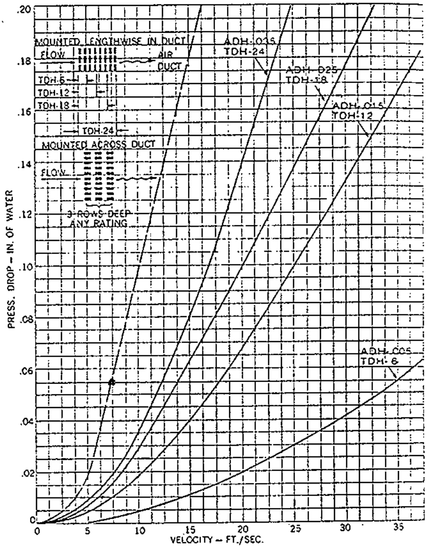
Properties of air/pressure drop curves

CURVE No. G112S1 - RESISTANCE TO AIR FLOW
over Chromalox Finstrip and CAB Air Heaters



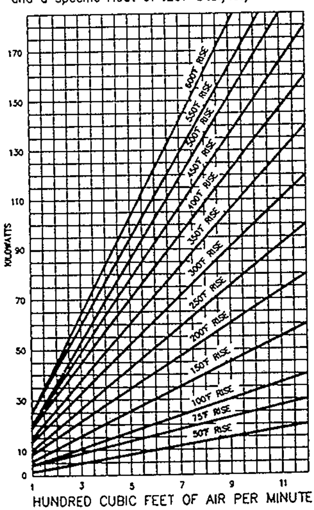
Curve No. G-227-2 —
Pressure Drop vs. Velocity
Type TDH/ADH Process Air Heater

— LENGTHWISE IN DUCT
-- ACROSS DUCT



CURVE No. G176S-

Heat Requirements for Air
Based on .08 lbs./cu. ft. Weight
and a specific Heat of .237 Btu./lb./F°



For air heating with circulation heaters

	*Suggested Watt Density for Gage Pressure under 100 PSIG					
	Steel Sheath (750°F Max.)			Alloy Sheath (1400°F Max.)		
	Velocity Ft. per Sec.			Velocity Ft. per Sec.		
Material Temp.	1	10	20	1	10	20
300°F	6	10	10	22	35	35
500°F	—	7	7	15	25	25
700°F	—	—	—	10	18	18

*NOTE—Standard heaters have ratings of 22 watts per square inch. For conditions where other watt density ratings are permissable, use formula below.

$$kW = kW\ (\text{standard}) \times \frac{\text{suggested watts/sq. in. (from table)}}{\text{22 watts/sq. in. (standard)}}$$

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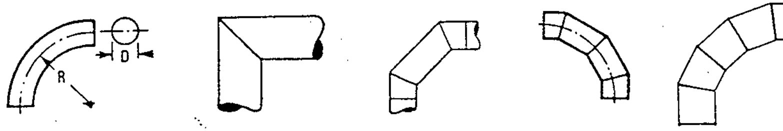
Industrial Ventilation Workbook
Third Edition

Chart 13

Elbow Loss Factor, K
(Round 90° ducts at STP)

				K			
TYPE:	Smooth Transition (1)	Smooth Transition (2)	Mitre	3-piece	4-piece	5-piece
Round Duct *R/D						
0.50	--	0.80	1.20	1.15	1.10	0.90
0.75	--	--	--	0.60	0.55	0.50
1.00	--	0.35	--	0.45	0.40	0.38
1.25	0.55	0.30	--	0.42	0.38	0.33
1.50	0.39	0.27	--	0.39	0.34	0.28
2.00	0.27	0.24	--	0.41	0.33	0.28
2.5	0.22	0.24	--	--	0.37	0.30

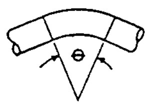
* Notes: R = radius of curvature as number of duct diameters, radius to center-line of duct.

(1) and (2) above represent range of sources.

Loss Factor K includes friction loss

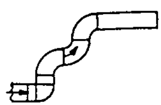
$SP_{loss} = K \times VP_d$.

For angles < 90°, $K_\theta = \left(\frac{\theta}{90}\right) \times K_{90}$



For combined elbows in continuous ductwork:

$K_t = 1.25 \times$ (Sum of individual K factors)



SOURCE: (1,2,9)

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APPENDIX C

Low Flow, [illegible]

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KAISER ENGINEERS HANFORD CO.
DUCT PRESSURE LOSS
CALCULATION SHEET

JOB NO./ W.O. NO.: W-320/ER4319
BLDG NO./ AREA : 241-C-106/200E
DUCT SYSTEM : Exhaust system up to the exhaust skid

PREPARED BY: Peter H. Langowski
DATE: 6/3/94
CHECKED BY:

NOTES: Calculation W320-H-018. (28 handwritten over H)
Pressure loss per 1993 Fundamentals p.32.4 Darcy Equation (19).
Hydraulic diameter per 1993 Fundamentals p.32.6 Equation (24).
Reynold's Number per 1993 Fundamentals p.32.5 Equation (22).
Alphanumeric ASHRAE fitting numbers from 1993 Fundamentals. Numeric fitting numbers from 1985 Fundamentals. Pipe sizes for schedule 10S.

Long Radius (LR) elbows: r/D = 1.5, fitting loss = 0.15; Short Radius (SR) elbows: r/D = 1.0, fitting loss = 0.22, losses per 1991 Applications, p. 27.9, Table 4.

NOTE: COLUMNS UNDER SHADED AREAS REQUIRE USER INPUT

#	TYPE OF FITTING (ASHRAE #)	AIR FLOW SCFM	TEMP DEG F	AIR FLOW ACFM	AIR FLOW TAKEOFF SCFM	DUCTSIZE either round or rectangular WIDTH IN.	HEIGHT IN.	DIA. IN.	PRESS. LOSS IN. WG	FITTING LOSS COEFF. Co	EQUIV DUCT LENGTH FT.	DUCT AREA SQ. IN.	PERI METER IN.	HYDRAL DIA IN.	REY	FPRIME	F	VEL. FPM	VEL. PRESS. Vp IN. WG
		Initial only								fittings only	duct only								
1	tank pressure	1090	95	1141	0				1.500			0.00	0.00	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
2	inlet to hatchway (ED1-1)	1090	95	1141	0			24.375	0.004	0.50		466.64	76.58	24.38	81,674	0.019	0.019	352	0.008
3	hatchway elbow (CD3-12)	1090	95	1141	0			24.375	0.003	0.42		466.64	76.58	24.38	81,674	0.019	0.019	352	0.008
4	hatchway pipe	1090	95	1141	0			24.375	0.000		6	466.64	76.58	24.38	81,674	0.019	0.019	352	0.008
5A	hatchway exit (SD4-1)	1090	95	1141	0	69	39		0.006	25.00		2691.00	216.00	49.83	28,955	0.024	0.024	61	0.000
5B	hatchway loss	1090	95	1141	0	69	39		0.000		10	2691.00	216.00	49.83	28,955	0.024	0.024	61	0.000
6	inlet to mist eliminator (ED1-1)	1090	95	1141	0			16.876	0.017	0.50		223.68	53.02	16.88	117,967	0.018	0.018	735	0.034
7	mist eliminator	1090	95	1141	0			16.876	0.750			223.68	53.02	16.88	117,967	0.018	0.018	735	0.034
8	transition to 12" (ED4-1)	1090	95	1141	0			12.390	0.023	0.20		120.57	38.92	12.39	160,679	0.017	0.017	1,363	0.116
9	pipe section	1090	95	1141	0			12.390	0.006		3	120.57	38.92	12.39	160,679	0.017	0.017	1,363	0.116
10	transition to 10" (ED4-1)	1090	95	1141	0			10.420	0.046	0.20		85.28	32.74	10.42	191,057	0.016	0.017	1,927	0.232
11	deleted	1090	95	1141	0			10.420	0.000	0.00		85.28	32.74	10.42	191,057	0.016	0.017	1,927	0.232
12	elbow, 45 (LR)	1040	95	1089	0			10.420	0.019	0.09		85.28	32.74	10.42	182,293	0.016	0.017	1,839	0.211
13	pipe section	1040	95	1089	0			10.420	0.034		8	85.28	32.74	10.42	182,293	0.016	0.017	1,839	0.211
14	elbow, 45 (LR)	1040	95	1089	0			10.420	0.019	0.09		85.28	32.74	10.42	182,293	0.016	0.017	1,839	0.211
15	pipe section	1040	95	1089	0			10.420	0.021		5	85.28	32.74	10.42	182,293	0.016	0.017	1,839	0.211
16	elbow, 90 (SR), in Process Bldg	1040	95	1089	0			10.420	0.046	0.22		85.28	32.74	10.42	182,293	0.016	0.017	1,839	0.211
17A	elbow, 90 (SR)	1040	95	1089	0			10.420	0.046	0.22		85.28	32.74	10.42	182,293	0.016	0.017	1,839	0.211
17B	shutoff valve (7-5)	1040	95	1089	0			10.420	0.105	0.50		85.28	32.74	10.42	182,293	0.016	0.017	1,839	0.211
18	heat exchanger	1040	95	1089	0			10.420	10.000			85.28	32.74	10.42	182,293	0.016	0.017	1,839	0.211
19A	shutoff valve	1040	40	981	0			10.420	0.086	0.50		85.28	32.74	10.42	164,228	0.017	0.017	1,657	0.171
19B	elbow, 90 (SR)	1040	40	981	0			10.420	0.038	0.22		85.28	32.74	10.42	164,228	0.017	0.017	1,657	0.171
20	elbow, 90 (SR)	1040	40	981	0			10.420	0.038	0.22		85.28	32.74	10.42	164,228	0.017	0.017	1,657	0.171
21	tee, portable takeoff (6-3)	1040	40	981	0			10.420	0.000	0.00		85.28	32.74	10.42	164,228	0.017	0.017	1,657	0.171
22	elbow, 90 (SR)	1040	40	981	0			10.420	0.038	0.22		85.28	32.74	10.42	164,228	0.017	0.017	1,657	0.171
23	tee, transition (SD5-2)	1040	40	981	0			10.420	0.084	0.49		85.28	32.74	10.42	164,228	0.017	0.017	1,657	0.171
24A	tee (6-3)	180	40	170	860			6.357	0.000	0.00		31.74	19.97	6.36	46,591	0.022	0.022	770	0.037
24B	bypass valve (7-5)	180	40	170	0			6.357	0.019	0.50		31.74	19.97	6.36	46,591	0.022	0.022	770	0.037
24C	pipe section	180	40	170	0			6.357	0.010		6	31.74	19.97	6.36	46,591	0.022	0.022	770	0.037
25	elbow, 90 (SR)	180	40	170	0			6.357	0.008	0.22		31.74	19.97	6.36	46,591	0.022	0.022	770	0.037
26	pipe section	180	40	170	0			6.357	0.003		2	31.74	19.97	6.36	46,591	0.022	0.022	770	0.037
27	elbow, 90 (SR)	180	40	170	0			6.357	0.008	0.22		31.74	19.97	6.36	46,591	0.022	0.022	770	0.037
28	pipe section	180	40	170	0			6.357	0.003		2	31.74	19.97	6.36	46,591	0.022	0.022	770	0.037
29	elbow, 45 (SR)	180	40	170	0			6.357	0.005	0.13		31.74	19.97	6.36	46,591	0.022	0.022	770	0.037
30	HEME	180	40	170	0			6.357	10.000			31.74	19.97	6.36	46,591	0.022	0.022	770	0.037
31	elbow, 45 (SR)	180	40	170	0			6.357	0.005	0.13		31.74	19.97	6.36	46,591	0.022	0.022	770	0.037
32	pipe section	180	40	170	0			6.357	0.007		4	31.74	19.97	6.36	46,591	0.022	0.022	770	0.037
33	elbow, 90 (SR)	180	40	170	0			6.357	0.008	0.22		31.74	19.97	6.36	46,591	0.022	0.022	770	0.037
34	elbow, 90 (SR)	180	40	170	0			6.357	0.008	0.22		31.74	19.97	6.36	46,591	0.022	0.022	770	0.037
35	pipe section	180	40	170	0			6.357	0.007		4	31.74	19.97	6.36	46,591	0.022	0.022	770	0.037
36	bypass valve (7-5)	180	40	170	0			6.357	0.019	0.50		31.74	19.97	6.36	46,591	0.022	0.022	770	0.037
37	elbow, 90 (SR)	180	40	170	0			6.357	0.008	0.22		31.74	19.97	6.36	46,591	0.022	0.022	770	0.037
38	tee (6-3)	180	40	170	0			6.357	0.000	0.00		31.74	19.97	6.36	46,591	0.022	0.022	770	0.037
39	bypass valve (7-5)	180	40	170	0			6.357	0.019	0.50		31.74	19.97	6.36	46,591	0.022	0.022	770	0.037
40	elbow, 90 (SR)	180	40	170	0			6.357	0.008	0.22		31.74	19.97	6.36	46,591	0.022	0.022	770	0.037
41	HEMF	180	40	170	0			6.357	10.000			31.74	19.97	6.36	46,591	0.022	0.022	770	0.037
42	bypass valve (7-5)	180	40	170	0			6.357	0.019	0.50		31.74	19.97	6.36	46,591	0.022	0.022	770	0.037

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KAISER ENGINEERS HANFORD CO.
DUCT PRESSURE LOSS
CALCULATION SHEET

JOB NO./ W.O. NO. : W-320/ER4319
BLDG NO./ AREA : 241-C-106/200E
DUCT SYSTEM : Exhaust system up to the exhaust skid

PREPARED BY: Peter H. Langowski
DATE: 6/3/94
CHECKED BY:

NOTES: Calculation W320-H-018.
Pressure loss per 1993 Fundamentals p.32.4 Darcy Equation (19).
Hydraulic diameter per 1993 Fundamentals p.32.6 Equation (24).
Reynold's Number per 1993 Fundamentals p.32.5 Equation (22).
Alphanumeric ASHRAE fitting numbers from 1993 Fundamentals. Numeric fitting numbers from 1985 Fundamentals. Pipe sizes for schedule 10S.

Long Radius (LR) elbows: r/D = 1.5, fitting loss = 0.15; Short Radius (SR) elbows: r/D = 1.0, fitting loss = 0.22, losses per 1991 Applications, p. 27.9, Table 4.

NOTE: COLUMNS UNDER SHADED AREAS REQUIRE USER INPUT

#	TYPE OF FITTING (ASHRAE #)	AIR FLOW	TEMP	AIR FLOW	AIR FLOW TAKEOFF	DUCTSIZE either round or rectangular WIDTH	HEIGHT	DIA.	PRESS. LOSS	FITTING LOSS COEFF.	EQUIV DUCT LENGTH	DUCT AREA	PERI METER	HYDRAL DIA	REY	FPRIME	F	VEL.	VEL. PRESS. Vp
		SCFM	DEG F	ACFM	SCFM	IN.	IN.	IN.	IN. WG	Co	FT.	SQ. IN.	IN.	IN.				FPM	IN. WG
		Initial only								fittings only	duct only								
43	elbow, 90 (SR)	180	40	170	0			6.357	0.008	0.22		31.74	19.97	6.36	46,591	0.022	0.022	770	0.037
44	pipe section	180	40	170	0			6.357	0.007		4	31.74	19.97	6.36	46,591	0.022	0.022	770	0.037
45	elbow, 90 (SR)	180	40	170	0			6.357	0.008	0.22		31.74	19.97	6.36	46,591	0.022	0.022	770	0.037
46	pipe section	180	40	170	0			6.357	0.007		4	31.74	19.97	6.36	46,591	0.022	0.022	770	0.037
47	elbow, 90	180	40	170	0			6.357	0.006	0.15		31.74	19.97	6.36	46,591	0.022	0.022	770	0.037
48	tee (6-3)	180	40	170	0			6.357	0.000	0.00		31.74	19.97	6.36	46,591	0.022	0.022	770	0.037
49	pipe section/flange process bldg	180	40	170	0			6.357	0.013		8	31.74	19.97	6.36	46,591	0.022	0.022	770	0.037
50	elbow, 45 (LR)	180	40	170	0			6.357	0.003	0.09		31.74	19.97	6.36	46,591	0.022	0.022	770	0.037
51	pipe section	180	40	170	0			6.357	0.008		5	31.74	19.97	6.36	46,591	0.022	0.022	770	0.037
52	elbow, 45 (LR)	180	40	170	0			6.357	0.003	0.09		31.74	19.97	6.36	46,591	0.022	0.022	770	0.037
53	pipe section	180	40	170	0			6.357	0.016		10	31.74	19.97	6.36	46,591	0.022	0.022	770	0.037
54	elbow, 90 (LR)	180	40	170	0			6.357	0.006	0.15		31.74	19.97	6.36	46,591	0.022	0.022	770	0.037
55	pipe section/flange exhaust skid	180	40	170	0			6.357	0.005		3	31.74	19.97	6.36	46,591	0.022	0.022	770	0.037
								total	33.18										

DATA USED ABOVE
roughness = 0.0001
density = 0.079 lbm/ft3 40F saturated air 12.696 ft3/lbm
kinematic viscosity = 0.000146 ft2/s

friction factors		
galvanized	0.0003	medium smooth
carbon steel	0.0001	smooth

kinematic viscosity	temp(F)	ft2/s
Mechanical Engineering	0.00	1.26E-04
Reference Manual Eighth	20.00	1.36E-04
Edition, p.3-36.	40.00	1.46E-04
	60.00	1.58E-04
	68.00	1.60E-04
	80.00	1.69E-04
	100.00	1.80E-04
	120.00	1.89E-04
	250.00	2.73E-04

Deleted Rev 1 PHK 2-14-95 BBC 2/27/95

LOW FLOW, [illegible]

KAISER ENGINEERS HANFORD CO.
DUCT PRESSURE LOSS
CALCULATION SHEET

JOB NO./ W.O. NO. : W-320/ER4319
BLDG NO./ AREA : 241-C-106/200E
DUCT SYSTEM :

PREPARED BY: Peter H. Langowski
DATE: 2/8/95
CHECKED BY:

NOTES: Calculation W320-~~H~~28 018 rev 1.
Pressure loss per 1993 Fundamentals p.32.4 Darcy Equation (19).
Hydraulic diameter per 1993 Fundamentals p.32.6 Equation (24).
Reynold's Number per 1993 Fundamentals p.32.5 Equation (22).
Alphanumeric ASHRAE fitting numbers from 1993 Fundamentals. Numeric fitting numbers from 1985 Fundamentals. Pipe sizes for schedule 40S.

Long Radius (LR) elbows: r/D=1.5, fitting loss=0.15; Short Radius (SR) elbows: r/D=1.0, fitting loss=0.22, losses per 1991 Applications, p. 27.9, Table 4. Combined elbow factor of 1.25 per p. 8-14.

NOTE: COLUMNS UNDER SHADED AREAS REQUIRE USER INPUT

#	TYPE OF FITTING (ASHRAE #)	AIR FLOW	TEMP	AIR FLOW	AIR FLOW TAKEOFF	DUCTSIZE either round or rectangular			PRESS. LOSS	FITTING LOSS COEFF.	EQUIV DUCT LENGTH	DUCT AREA	PERI METER	HYDRAL DIA	REY	FPRIME	F	VEL.	VEL. PRESS. Vp
						WIDTH	HEIGHT	DIA.											
		SCFM	DEG F	ACFM	SCFM	IN.	IN.	IN.	IN. WG	Co	FT.	SQ. IN.	IN.	IN.				FPM	IN. WG
		initial only								fittings onl	duct only								
1	tank pressure	1090	95	1141	0				1.500			0.00	0.00	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
2	inlet to hatchway (ED1-1)	1090	95	1141	0			24.375	0.004	0.50		466.64	76.58	24.38	81,674	0.019	0.019	352	0.008
3	hatchway elbow (CD3-12)	1090	95	1141	0			24.375	0.003	0.42		466.64	76.58	24.38	81,674	0.019	0.019	352	0.008
4	hatchway pipe	1090	95	1141	0			24.375	0.000		6	466.64	76.58	24.38	81,674	0.019	0.019	352	0.008
5	hatchway exit (SD4-1)	1090	95	1141	0	69	39		0.006	25.00		2691.00	216.00	49.83	28,955	0.024	0.024	61	0.000
6	hatchway loss	1090	95	1141	0	69	39		0.000		10	2691.00	216.00	49.83	28,955	0.024	0.024	61	0.000
10	inlet to piping (ED1-1)	1090	95	1141	0			10.020	0.135	0.50		78.85	31.48	10.02	198,684	0.016	0.017	2,084	0.271
11	piping	1090	95	1141	0			10.020	0.023		4	78.85	31.48	10.02	198,684	0.016	0.017	2,084	0.271
12	elbow, 90 (LR)	1090	95	1141	0			10.020	0.041	0.15		78.85	31.48	10.02	198,684	0.016	0.017	2,084	0.271
13	pipe section	1090	95	1141	0			10.020	0.029		5	78.85	31.48	10.02	198,684	0.016	0.017	2,084	0.271
14	elbow, 90 (LR)	1090	95	1141	0			10.020	0.041	0.15		78.85	31.48	10.02	198,684	0.016	0.017	2,084	0.271
15	pipe section	1090	95	1141	0			10.020	0.029		5	78.85	31.48	10.02	198,684	0.016	0.017	2,084	0.271
16	elbow, 90 (LR), in Process Bldg	1090	95	1141	0			10.020	0.041	0.15		78.85	31.48	10.02	198,684	0.016	0.017	2,084	0.271
20	pipe section	1090	95	1141	0			10.020	0.006		1	78.85	31.48	10.02	198,684	0.016	0.017	2,084	0.271
21	elbow, 90 (SR)	1090	95	1141	0			10.020	0.060	0.22		78.85	31.48	10.02	198,684	0.016	0.017	2,084	0.271
22	shutoff valve (7-5) HV-136142	1090	95	1141	0			10.020	0.135	0.50		78.85	31.48	10.02	198,684	0.016	0.017	2,084	0.271
23	heat exchanger HX-1361	1090	95	1141	0			10.020	11.000			78.85	31.48	10.02	198,684	0.016	0.017	2,084	0.271
24	shutoff valve (7-5) HV-13639	1090	40	1028	0			10.020	0.110	0.50		78.85	31.48	10.02	178,995	0.016	0.017	1,878	0.220
25	elbow, 90 (SR)	1090	40	1028	0			10.020	0.048	0.22		78.85	31.48	10.02	178,995	0.016	0.017	1,878	0.220
26A	tee, flow split, branch (6-3)	1090	40	1028	0			10.020	0.134	0.61		78.85	31.48	10.02	178,995	0.016	0.017	1,878	0.220
30	elbow, 45 (LR)	230	40	217	860			6.065	0.007	0.09		28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
31	pipe section	230	40	217	0			6.065	0.010		3	28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
32	elbow, 90 (LR)	230	40	217	0			6.065	0.011	0.15		28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
33	pipe section	230	40	217	0			6.065	0.011		4	28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
34	tee (6-3)	230	40	217	0			6.065	0.000	0.00		28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
35	bypass valve (7-5) HV-13649	230	40	217	0			6.065	0.036	0.50		28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
36	elbow, 90 (LR)	230	40	217	0			6.065	0.014	0.19		28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
37	elbow, 90 (LR)	230	40	217	0			6.065	0.014	0.19		28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
38	elbow, 45 (LR)	230	40	217	0			6.065	0.008	0.11		28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
39	pipe section	230	40	217	0			6.065	0.007		2	28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
40	elbow, 45 (LR)	230	40	217	0			6.065	0.007	0.09		28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
41	HEME HME-1361	230	40	217	0			6.065	10.000			28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
42	elbow, 45 (LR)	230	40	217	0			6.065	0.007	0.09		28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
43	pipe section	230	40	217	0			6.065	0.007		2	28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
44	elbow, 90 (LR)	230	40	217	0			6.065	0.011	0.15		28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
45	pipe section	230	40	217	0			6.065	0.007		2	28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
46	elbow, 90 (LR)	230	40	217	0			6.065	0.011	0.15		28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
47	pipe section	230	40	217	0			6.065	0.007		2	28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
48	bypass valve (7-5) HV-13646	230	40	217	0			6.065	0.036	0.50		28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
49	tee (6-3)	230	40	217	0			6.065	0.000	0.00		28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
50	elbow, 90 (SR)	230	40	217	0			6.065	0.020	0.27		28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
50A	elbow, 90 (LR)	230	40	217	0			6.065	0.014	0.19		28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
51	pipe section	230	40	217	0			6.065	0.007		2	28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
52	elbow, 90 (SR)	230	40	217	0			6.065	0.016	0.22		28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
53	bypass valve (7-5) HV-13648	230	40	217	0			6.065	0.036	0.50		28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
54	HEMF HMF-1361	230	40	217	0			6.065	10.000			28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
55	bypass valve (7-5) HV-13648	230	40	217	0			6.065	0.036	0.50		28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073

Rev 1 PHL 2-14-95

KAISER ENGINEERS HANFORD CO.
DUCT PRESSURE LOSS
CALCULATION SHEET

JOB NO./ W.O. NO. : W-320/ER4319
BLDG NO./ AREA : 241-C-106/200E
DUCT SYSTEM :

PREPARED BY: Peter H. Langowski
DATE: 2/8/95
CHECKED BY:

NOTES: Calculation W320-~~H-016~~ 28-018 rev 1.
Pressure loss per 1993 Fundamentals p.32.4 Darcy Equation (19).
Hydraulic diameter per 1993 Fundamentals p.32.6 Equation (24).
Reynold's Number per 1993 Fundamentals p.32.5 Equation (22).
Alphanumeric ASHRAE fitting numbers from 1993 Fundamentals. Numeric fitting numbers from 1985 Fundamentals. Pipe sizes for schedule 40S.

Long Radius (LR) elbows: r/D=1.5, fitting loss=0.15; Short Radius (SR) elbows: r/D=1.0, fitting loss=0.22, losses per 1991 Applications, p. 27.9, Table 4.
Combined elbow factor of 1.25 per p. B-14.

NOTE: COLUMNS UNDER SHADED AREAS REQUIRE USER INPUT

#	TYPE OF FITTING (ASHRAE #)	AIR FLOW SCFM	TEMP DEG F	AIR FLOW ACFM	AIR FLOW TAKEOFF SCFM	DUCTSIZE either round or rectangular WIDTH IN.	HEIGHT IN.	DIA. IN.	PRESS. LOSS IN. WG	FITTING LOSS COEFF. Co	EQUIV DUCT LENGTH FT.	DUCT AREA SQ. IN.	PERI METER IN.	HYDRAL DIA IN.	REY	FPRIME	F	VEL. FPM	VEL. PRESS. Vp IN. WG
		initial only								fittings onl	duct only								
56	elbow, 90 (LR)	230	40	217	0			6.065	0.011	0.15		28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
57	pipe section	230	40	217	0			6.065	0.013		4	28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
58	elbow, 90 (LR)	230	40	217	0			6.065	0.011	0.15		28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
59	tee (6-3)	230	40	217	0			6.065	0.000	0.00		28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
60	tee (6-3)	230	40	217	0			6.065	0.080	1.10		28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
70	pipe section/flange process bldg	230	40	217	0			6.065	0.011		4	28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
71	elbow, 90 (LR)	230	40	217	0			6.065	0.011	0.15		28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
72	pipe section	230	40	217	0			6.065	0.056		17	28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
73	elbow, 90 (LR)	230	40	217	0			6.065	0.011	0.15		28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
74	pipe section/flange exhaust skid	230	40	217	0			6.065	0.007		2	28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
								total to exhaust skid	33.89										
26A	tee, flow split, main (6-3)	860	40	811	0			10.020	0.052	0.38		78.85	31.48	10.02	141,225	0.017	0.017	1,482	0.137
80	reducer, contraction (5-1)	860	40	811	0			6.065	0.071	0.07		28.89	19.05	6.07	233,318	0.016	0.017	4,044	1.020
81	elbow, 90 (LR)	860	40	811	0			6.065	0.153	0.15		28.89	19.05	6.07	233,318	0.016	0.017	4,044	1.020
82	moisture separator MS-1361	860	40	811	0			6.065	5.500			28.89	19.05	6.07	233,318	0.016	0.017	4,044	1.020
83	reducer, expansion (4-1)	860	40	811	0			7.981	0.231	0.68		50.03	25.07	7.98	177,306	0.017	0.017	2,335	0.340
84	tee (6-3)	860	40	811	0			7.981	0.000	0.00		50.03	25.07	7.98	177,306	0.017	0.017	2,335	0.340
85	elbow, 90 (LR)	860	40	811	0			7.981	0.051	0.15		50.03	25.07	7.98	177,306	0.017	0.017	2,335	0.340
86	transition (4-3)	860	40	811	0			7.981	0.238	0.70		50.03	25.07	7.98	177,306	0.017	0.017	2,335	0.340
87	electric heating coil HC-1361	860	77	871	0			7.981	0.060	0.15		50.03	25.07	7.98	190,426	0.017	0.017	2,508	0.392
88	transition (5-1)	860	77	871	0			7.981	0.027	0.07		50.03	25.07	7.98	190,426	0.017	0.017	2,508	0.392
89	elbow, 90 (LR)	860	77	871	0			7.981	0.059	0.15		50.03	25.07	7.98	190,426	0.017	0.017	2,508	0.392
90	pipe section	860	77	871	0			7.981	0.043		4	50.03	25.07	7.98	190,426	0.017	0.017	2,508	0.392
91	recirculation fan FN-1361	860	77	871	0			7.981	0.000	0.00		50.03	25.07	7.98	190,426	0.017	0.017	2,508	0.392
92	pipe section	860	77	871	0			7.981	0.043		4	50.03	25.07	7.98	190,426	0.017	0.017	2,508	0.392
93	elbow, 45 (LR)	860	77	871	0			7.981	0.035	0.09		50.03	25.07	7.98	190,426	0.017	0.017	2,508	0.392
94	pipe section	860	77	871	0			7.981	0.032		3	50.03	25.07	7.98	190,426	0.017	0.017	2,508	0.392
95	elbow, 45 (LR)	860	77	871	0			7.981	0.035	0.09		50.03	25.07	7.98	190,426	0.017	0.017	2,508	0.392
96	bypass valve (7-5) HV-13648	860	77	871	0			7.981	0.196	0.50		50.03	25.07	7.98	190,426	0.017	0.017	2,508	0.392
97	pipe section	860	77	871	0			7.981	0.141		13	50.03	25.07	7.98	190,426	0.017	0.017	2,508	0.392
98	elbow, 90 (LR)	860	77	871	0			7.981	0.059	0.15		50.03	25.07	7.98	190,426	0.017	0.017	2,508	0.392
99	converging wye (6-2)	860	77	871	0			7.981	-0.059	-0.15		50.03	25.07	7.98	190,426	0.017	0.017	2,508	0.392
100	pipe section risor R-2	860	77	871	0			11.938	0.021		14	111.93	37.50	11.94	127,307	0.017	0.018	1,121	0.078
								up to flow split	11.71										
								split back to tank	6.99										
								total for recirc fan	18.70										

DATA USED ABOVE
roughness = 0.0001
density = 0.082 lbm/ft3 40F saturated air 12.239 ft3/lbm 0.964 altitude correction
kinematic viscosity = 0.000146 ft2/s

C2 Rev 1 PHL 2-14-95

KAISER ENGINEERS HANFORD CO.
DUCT PRESSURE LOSS
CALCULATION SHEET

JOB NO./ W.O. NO. : W-320/ER4319
BLDG NO./ AREA : 241-C-106/200E
DUCT SYSTEM :

PREPARED BY: Peter H. Langowski
DATE: 2/8/95
CHECKED BY:

NOTES: Calculation W320-28-018 rev 1.
Pressure loss per 1993 Fundamentals p.32.4 Darcy Equation (19).
Hydraulic diameter per 1993 Fundamentals p.32.6 Equation (24).
Reynold's Number per 1993 Fundamentals p.32.5 Equation (22).
Alphanumeric ASHRAE fitting numbers from 1993 Fundamentals. Numeric fitting numbers from 1985 Fundamentals. Pipe sizes for schedule 40S.

Long Radius (LR) elbows: r/D=1.5, fitting loss=0.15; Short Radius (SR) elbows: r/D=1.0, fitting loss=0.22, losses per 1991 Applications, p. 27.9, Table 4. Combined elbow factor of 1.25 per p. B-14.

NOTE: COLUMNS UNDER SHADED AREAS REQUIRE USER INPUT

#	TYPE OF FITTING (ASHRAE #)	AIR FLOW	TEMP	AIR FLOW	AIR FLOW TAKEOFF	DUCTSIZE either round or rectangular WIDTH	HEIGHT	DIA.	PRESS. LOSS	FITTING LOSS COEFF.	EQUIV DUCT LENGTH	DUCT AREA	PERI METER	HYDRAL DIA	REY	FPRIME	F	VEL.	VEL. PRESS. Vp
		SCFM	DEG F	ACFM	SCFM	IN.	IN.	IN.	IN. WG	Co	FT.	SQ. IN.	IN.	IN.				FPM	IN. WG
		initial only								fittings onl	duct only								

friction factors		
galvanized	0.0003	medium smooth
carbon steel	0.0001	smooth

kinematic viscosity	temp(F)	ft2/s
Mechanical Engineering Reference Manual Eighth Edition, p.3-36.	0.00	1.26E-04
	20.00	1.36E-04
	40.00	1.46E-04
	60.00	1.58E-04
	68.00	1.60E-04
	80.00	1.69E-04
	100.00	1.80E-04
	120.00	1.89E-04
	250.00	2.73E-04

C3 Rev 1 PHR 2-14-95

HIGH FLOW, CLEAN, HKY [illegible] 6/23/94

KAISER ENGINEERS HANFORD CO:
DUCT PRESSURE LOSS
CALCULATION SHEET

JOB NO./ W.O. NO. : W-320/ER4319
BLDG NO./ AREA : 241-C-106/200E
DUCT SYSTEM : Exhaust system up to the exhaust skid

PREPARED BY: Peter H. Langowski
DATE: 6/17/94
CHECKED BY:

NOTES: Calculation W320-H-018. (handwritten "28" above "H")
Pressure loss per 1993 Fundamentals p.32.4 Darcy Equation (19).
Hydraulic diameter per 1993 Fundamentals p.32.6 Equation (24).
Reynold's Number per 1993 Fundamentals p.32.5 Equation (22).
Alphanumeric ASHRAE fitting numbers from 1993 Fundamentals. Numeric fitting numbers from 1985 Fundamentals. Pipe sizes for schedule 10S.

Long Radius (LR) elbows: r/D = 1.5, fitting loss = 0.15; Short Radius (SR) elbows: r/D = 1.0, fitting loss = 0.22, losses per 1991 Applications, p. 27.9, Table 4.

NOTE: COLUMNS UNDER SHADED AREAS REQUIRE USER INPUT

#	TYPE OF FITTING (ASHRAE #)	AIR FLOW	TEMP	AIR FLOW	AIR FLOW TAKEOFF	DUCTSIZE either round or rectangular WIDTH	HEIGHT	DIA.	PRESS. LOSS	FITTING LOSS COEFF.	EQUIV DUCT LENGTH	DUCT AREA	PERI METER	HYDRAL DIA	REY	FPRIME	F	VEL.	VEL. PRESS. Vp
		SCFM	DEG F	ACFM	SCFM	IN.	IN.	IN.	IN. WG	Co	FT.	SQ. IN.	IN.	IN.				FPM	IN. WG
		Initial only								fittings only	duct only								
1	tank pressure	1220	95	1278	0				1.500			0.00	0.00	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
2	inlet to hatchway (ED1-1)	1220	95	1278	0			24.375	0.005	0.50		466.64	76.58	24.38	91,415	0.018	0.018	394	0.010
3	hatchway elbow (CD3-12)	1220	95	1278	0			24.375	0.004	0.42		466.64	76.58	24.38	91,415	0.018	0.018	394	0.010
4	hatchway pipe	1220	95	1278	0			24.375	0.001		6	466.64	76.58	24.38	91,415	0.018	0.018	394	0.010
5A	hatchway exit (SD4-1)	1220	95	1278	0	69	39		0.007	25.00		2691.00	216.00	49.83	32,409	0.024	0.024	68	0.000
5B	hatchway loss	1220	95	1278	0	69	39		0.000		10	2691.00	216.00	49.83	32,409	0.024	0.024	68	0.000
6	inlet to mist eliminator (ED1-1)	1220	95	1278	0			16.876	0.021	0.50		223.68	53.02	16.88	132,037	0.017	0.017	822	0.042
7	mist eliminator	1220	95	1278	0			16.876	0.750			223.68	53.02	16.88	132,037	0.017	0.017	822	0.042
8	transition to 12" (ED4-1)	1220	95	1278	0			12.390	0.029	0.20		120.57	38.92	12.39	179,843	0.016	0.017	1,526	0.145
9	pipe section	1220	95	1278	0			12.390	0.007		3	120.57	38.92	12.39	179,843	0.016	0.017	1,526	0.145
10	transition to 10" (ED4-1)	1220	95	1278	0			10.420	0.058	0.20		85.28	32.74	10.42	213,844	0.016	0.016	2,157	0.290
11	deleted	1220	95	1278	0			10.420	0.000	0.00		85.28	32.74	10.42	213,844	0.016	0.016	2,157	0.290
12	elbow, 45 (LR)	1220	95	1278	0			10.420	0.026	0.09		85.28	32.74	10.42	213,844	0.016	0.016	2,157	0.290
13	pipe section	1220	95	1278	0			10.420	0.046		8	85.28	32.74	10.42	213,844	0.016	0.016	2,157	0.290
14	elbow, 45 (LR)	1220	95	1278	0			10.420	0.026	0.09		85.28	32.74	10.42	213,844	0.016	0.016	2,157	0.290
15	pipe section	1220	95	1278	0			10.420	0.029		5	85.28	32.74	10.42	213,844	0.016	0.016	2,157	0.290
16	elbow, 90 (SR), in Process Bldg	1220	95	1278	0			10.420	0.064	0.22		85.28	32.74	10.42	213,844	0.016	0.016	2,157	0.290
17A	elbow, 90 (SR)	1220	95	1278	0			10.420	0.064	0.22		85.28	32.74	10.42	213,844	0.016	0.016	2,157	0.290
17B	shutoff valve (7-5)	1220	95	1278	0			10.420	0.145	0.50		85.28	32.74	10.42	213,844	0.016	0.016	2,157	0.290
18	heat exchanger	1220	95	1278	0			10.420	10.000			85.28	32.74	10.42	213,844	0.016	0.016	2,157	0.290
19A	shutoff valve	1220	40	1151	0			10.420	0.118	0.50		85.28	32.74	10.42	192,652	0.016	0.017	1,944	0.235
19B	elbow, 90 (SR)	1220	40	1151	0			10.420	0.052	0.22		85.28	32.74	10.42	192,652	0.016	0.017	1,944	0.235
20	elbow, 90 (SR)	1220	40	1151	0			10.420	0.052	0.22		85.28	32.74	10.42	192,652	0.016	0.017	1,944	0.235
21	tee, portable takeoff (6-3)	1220	40	1151	0			10.420	0.000	0.00		85.28	32.74	10.42	192,652	0.016	0.017	1,944	0.235
22	elbow, 90 (SR)	1220	40	1151	0			10.420	0.052	0.22		85.28	32.74	10.42	192,652	0.016	0.017	1,944	0.235
23	tee, transition (SD5-2)	1220	40	1151	0			10.420	0.115	0.49		85.28	32.74	10.42	192,652	0.016	0.017	1,944	0.235
24A	tee (6-3)	360	40	340	860			6.357	0.000	0.00		31.74	19.97	6.36	93,182	0.019	0.019	1,541	0.148
24B	bypass valve (7-5)	360	40	340	0			6.357	0.074	0.50		31.74	19.97	6.36	93,182	0.019	0.019	1,541	0.148
24C	pipe section	360	40	340	0			6.357	0.034		6	31.74	19.97	6.36	93,182	0.019	0.019	1,541	0.148
25	elbow, 90 (SR)	360	40	340	0			6.357	0.033	0.22		31.74	19.97	6.36	93,182	0.019	0.019	1,541	0.148
26	pipe section	360	40	340	0			6.357	0.011		2	31.74	19.97	6.36	93,182	0.019	0.019	1,541	0.148
27	elbow, 90 (SR)	360	40	340	0			6.357	0.033	0.22		31.74	19.97	6.36	93,182	0.019	0.019	1,541	0.148
28	pipe section	360	40	340	0			6.357	0.011		2	31.74	19.97	6.36	93,182	0.019	0.019	1,541	0.148
29	elbow, 45 (SR)	360	40	340	0			6.357	0.019	0.13		31.74	19.97	6.36	93,182	0.019	0.019	1,541	0.148
30	HEME	360	40	340	0			6.357	6.600			31.74	19.97	6.36	93,182	0.019	0.019	1,541	0.148
31	elbow, 45 (SR)	360	40	340	0			6.357	0.019	0.13		31.74	19.97	6.36	93,182	0.019	0.019	1,541	0.148
32	pipe section	360	40	340	0			6.357	0.022		4	31.74	19.97	6.36	93,182	0.019	0.019	1,541	0.148
33	elbow, 90 (SR)	360	40	340	0			6.357	0.033	0.22		31.74	19.97	6.36	93,182	0.019	0.019	1,541	0.148
34	elbow, 90 (SR)	360	40	340	0			6.357	0.033	0.22		31.74	19.97	6.36	93,182	0.019	0.019	1,541	0.148
35	pipe section	360	40	340	0			6.357	0.022		4	31.74	19.97	6.36	93,182	0.019	0.019	1,541	0.148
36	bypass valve (7-5)	360	40	340	0			6.357	0.074	0.50		31.74	19.97	6.36	93,182	0.019	0.019	1,541	0.148
37	elbow, 90 (SR)	360	40	340	0			6.357	0.033	0.22		31.74	19.97	6.36	93,182	0.019	0.019	1,541	0.148
38	tee (6-3)	360	40	340	0			6.357	0.000	0.00		31.74	19.97	6.36	93,182	0.019	0.019	1,541	0.148
39	bypass valve (7-5)	360	40	340	0			6.357	0.074	0.50		31.74	19.97	6.36	93,182	0.019	0.019	1,541	0.148
40	elbow, 90 (SR)	360	40	340	0			6.357	0.033	0.22		31.74	19.97	6.36	93,182	0.019	0.019	1,541	0.148
41	HEMF	360	40	340	0			6.357	4.500			31.74	19.97	6.36	93,182	0.019	0.019	1,541	0.148
42	bypass valve (7-5)	360	40	340	0			6.357	0.074	0.50		31.74	19.97	6.36	93,182	0.019	0.019	1,541	0.148

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C'kd Gail Grea 6/23/94

KAISER ENGINEERS HANFORD CO.
DUCT PRESSURE LOSS
CALCULATION SHEET

JOB NO./ W.O. NO. : W-320/ER4319
BLDG NO./ AREA : 241-C-106/200E
DUCT SYSTEM : Exhaust system up to the exhaust skid

PREPARED BY: Peter H. Langowski
DATE: 6/17/94
CHECKED BY:

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NOTES: Calculation W320-H-018.
Pressure loss per 1993 Fundamentals p.32.4 Darcy Equation (19).
Hydraulic diameter per 1993 Fundamentals p.32.6 Equation (24).
Reynold's Number per 1993 Fundamentals p.32.5 Equation (22).
Alphanumeric ASHRAE fitting numbers from 1993 Fundamentals. Numeric fitting numbers from 1985 Fundamentals. Pipe sizes for schedule 10S.

Long Radius (LR) elbows: r/D=1.5, fitting loss=0.15; Short Radius (SR) elbows: r/D=1.0, fitting loss=0.22, losses per 1991 Applications, p. 27.9, Table 4.

NOTE: COLUMNS UNDER SHADED AREAS REQUIRE USER INPUT

#	TYPE OF FITTING (ASHRAE #)	AIR FLOW	TEMP	AIR FLOW	AIR FLOW TAKEOFF	DUCTSIZE either round or rectangular WIDTH	HEIGHT	DIA.	PRESS. LOSS	FITTING LOSS COEFF.	EQUIV DUCT LENGTH	DUCT AREA	PERI METER	HYDRAL DIA	REY	FPRIME	F	VEL.	VEL. PRESS. Vp
		SCFM	DEG F	ACFM	SCFM	IN.	IN.	IN.	IN. WG	Co	FT.	SQ. IN.	IN.	IN.				FPM	IN. WG
		Initial only								fittings only	duct only								
43	elbow, 90 (SR)	360	40	340	0			6.357	0.033	0.22		31.74	19.97	6.36	93,182	0.019	0.019	1,541	0.148
44	pipe section	360	40	340	0			6.357	0.022		4	31.74	19.97	6.36	93,182	0.019	0.019	1,541	0.148
45	elbow, 90 (SR)	360	40	340	0			6.357	0.033	0.22		31.74	19.97	6.36	93,182	0.019	0.019	1,541	0.148
46	pipe section	360	40	340	0			6.357	0.022		4	31.74	19.97	6.36	93,182	0.019	0.019	1,541	0.148
47	elbow, 90	360	40	340	0			6.357	0.022	0.15		31.74	19.97	6.36	93,182	0.019	0.019	1,541	0.148
48	tee (6-3)	360	40	340	0			6.357	0.000	0.00		31.74	19.97	6.36	93,182	0.019	0.019	1,541	0.148
49	pipe section/flange process bldg	360	40	340	0			6.357	0.045		8	31.74	19.97	6.36	93,182	0.019	0.019	1,541	0.148
50	elbow, 45 (LR)	360	40	340	0			6.357	0.013	0.09		31.74	19.97	6.36	93,182	0.019	0.019	1,541	0.148
51	pipe section	360	40	340	0			6.357	0.028		5	31.74	19.97	6.36	93,182	0.019	0.019	1,541	0.148
52	elbow, 45 (LR)	360	40	340	0			6.357	0.013	0.09		31.74	19.97	6.36	93,182	0.019	0.019	1,541	0.148
53	pipe section	360	40	340	0			6.357	0.056		10	31.74	19.97	6.36	93,182	0.019	0.019	1,541	0.148
54	elbow, 90 (LR)	360	40	340	0			6.357	0.022	0.15		31.74	19.97	6.36	93,182	0.019	0.019	1,541	0.148
55	pipe section/flange exhaust skid	360	40	340	0			6.357	0.017		3	31.74	19.97	6.36	93,182	0.019	0.019	1,541	0.148
								total	25.23										

DATA USED ABOVE
roughness = 0.0001
density = 0.079 lbm/ft3 40F saturated air 12.696 ft3/lbm
kinematic viscosity = 0.000146 ft2/s

friction factors galvanized 0.0003 medium smooth
carbon steel 0.0001 smooth

The pressure loss up to the flow split for use in sizing the recirculation fan is 11.67 inches w.g.

kinematic viscosity	temp(F)	ft2/s
Mechanical Engineering Reference Manual Eighth Edition, p.3-36.	0.00	1.26E-04
	20.00	1.36E-04
	40.00	1.46E-04
	60.00	1.58E-04
	68.00	1.60E-04
	80.00	1.69E-04
	100.00	1.80E-04
	120.00	1.89E-04
	250.00	2.73E-04

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BB 2/27/95

HIGH FLOW, CLEAN, LAT

KAISER ENGINEERS HANFORD CO.
DUCT PRESSURE LOSS
CALCULATION SHEET

JOB NO./ W.O. NO. : W-320/ER4319
BLDG NO./ AREA : 241-C-106/200E
DUCT SYSTEM :

PREPARED BY: Peter H. Langowski
DATE: 2/8/95
CHECKED BY:

NOTES: Calculation W320-H018 rev 1. 28
Pressure loss per 1993 Fundamentals p.32.4 Darcy Equation (19).
Hydraulic diameter per 1993 Fundamentals p.32.6 Equation (24).
Reynold's Number per 1993 Fundamentals p.32.5 Equation (22).
Alphanumeric ASHRAE fitting numbers from 1993 Fundamentals. Numeric fitting numbers from 1985 Fundamentals. Pipe sizes for schedule 40S.

Long Radius (LR) elbows: r/D = 1.5, fitting loss = 0.15; Short Radius (SR) elbows: r/D = 1.0, fitting loss = 0.22, losses per 1991 Applications, p. 27.9, Table 4.
Combined elbow factor of 1.25 per p. B-14.

NOTE: COLUMNS UNDER SHADED AREAS REQUIRE USER INPUT

#	TYPE OF FITTING (ASHRAE #)	AIR FLOW SCFM	TEMP DEG F	AIR FLOW ACFM	AIR FLOW TAKEOFF SCFM	DUCTSIZE either round or rectangular WIDTH IN.	HEIGHT IN.	DIA. IN.	PRESS. LOSS IN. WG	FITTING LOSS COEFF. Co	EQUIV DUCT LENGTH FT.	DUCT AREA SQ. IN.	PERI METER IN.	HYDRAL DIA IN.	REY	FPRIME	F	VEL. FPM	VEL. PRESS. Vp IN. WG
		initial only								fittings onl	duct only								
1	tank pressure	1220	95	1278	0				1.500			0.00	0.00	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
2	inlet to hatchway (ED1-1)	1220	95	1278	0			24.375	0.005	0.50		466.64	76.58	24.38	91,415	0.018	0.018	394	0.010
3	hatchway elbow (CD3-12)	1220	95	1278	0			24.375	0.004	0.42		466.64	76.58	24.38	91,415	0.018	0.018	394	0.010
4	hatchway pipe	1220	95	1278	0			24.375	0.001		6	466.64	76.58	24.38	91,415	0.018	0.018	394	0.010
5	hatchway exit (SD4-1)	1220	95	1278	0	69	39		0.007	25.00		2691.00	216.00	49.83	32,409	0.024	0.024	68	0.000
6	hatchway loss	1220	95	1278	0	69	39		0.000		10	2691.00	216.00	49.83	32,409	0.024	0.024	68	0.000
10	inlet to piping (ED1-1)	1220	95	1278	0			10.020	0.170	0.50		78.85	31.48	10.02	222,380	0.016	0.016	2,333	0.339
11	piping	1220	95	1278	0			10.020	0.029		4	78.85	31.48	10.02	222,380	0.016	0.016	2,333	0.339
12	elbow, 90 (LR)	1220	95	1278	0			10.020	0.051	0.15		78.85	31.48	10.02	222,380	0.016	0.016	2,333	0.339
13	pipe section	1220	95	1278	0			10.020	0.036		5	78.85	31.48	10.02	222,380	0.016	0.016	2,333	0.339
14	elbow, 90 (LR)	1220	95	1278	0			10.020	0.051	0.15		78.85	31.48	10.02	222,380	0.016	0.016	2,333	0.339
15	pipe section	1220	95	1278	0			10.020	0.036		5	78.85	31.48	10.02	222,380	0.016	0.016	2,333	0.339
16	elbow, 90 (LR), in Process Bldg	1220	95	1278	0			10.020	0.051	0.15		78.85	31.48	10.02	222,380	0.016	0.016	2,333	0.339
20	pipe section	1220	95	1278	0			10.020	0.007		1	78.85	31.48	10.02	222,380	0.016	0.016	2,333	0.339
21	elbow, 90 (SR)	1220	95	1278	0			10.020	0.075	0.22		78.85	31.48	10.02	222,380	0.016	0.016	2,333	0.339
22	shutoff valve (7-5) HV-136142	1220	95	1278	0			10.020	0.170	0.50		78.85	31.48	10.02	222,380	0.016	0.016	2,333	0.339
23	heat exchanger HX-1361	1220	95	1278	0			10.020	11.000			78.85	31.48	10.02	222,380	0.016	0.016	2,333	0.339
24	shutoff valve (7-5) HV-13639	1220	40	1151	0			10.020	0.138	0.50		78.85	31.48	10.02	200,343	0.016	0.016	2,102	0.275
25	elbow, 90 (SR)	1220	40	1151	0			10.020	0.061	0.22		78.85	31.48	10.02	200,343	0.016	0.016	2,102	0.275
26A	tee, flow split, branch (6-3)	1220	40	1151	0			10.020	0.168	0.61		78.85	31.48	10.02	200,343	0.016	0.016	2,102	0.275
30	elbow, 45 (LR)	360	40	340	860			6.065	0.016	0.09		28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
31	pipe section	360	40	340	0			6.065	0.022		3	28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
32	elbow, 90 (LR)	360	40	340	0			6.065	0.027	0.15		28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
33	pipe section	360	40	340	0			6.065	0.026		4	28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
34	tee (6-3)	360	40	340	0			6.065	0.000	0.00		28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
35	bypass valve (7-5) HV-13649	360	40	340	0			6.065	0.089	0.50		28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
36	elbow, 90 (LR)	360	40	340	0			6.065	0.034	0.19		28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
37	elbow, 90 (LR)	360	40	340	0			6.065	0.034	0.19		28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
38	elbow, 45 (LR)	360	40	340	0			6.065	0.020	0.11		28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
39	pipe section	360	40	340	0			6.065	0.015		2	28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
40	elbow, 45 (LR)	360	40	340	0			6.065	0.016	0.09		28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
41	HEME HME-1361	360	40	340	0			6.065	5.000			28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
42	elbow, 45 (LR)	360	40	340	0			6.065	0.016	0.09		28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
43	pipe section	360	40	340	0			6.065	0.015		2	28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
44	elbow, 90 (LR)	360	40	340	0			6.065	0.027	0.15		28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
45	pipe section	360	40	340	0			6.065	0.015		2	28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
46	elbow, 90 (LR)	360	40	340	0			6.065	0.027	0.15		28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
47	pipe section	360	40	340	0			6.065	0.015		2	28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
48	bypass valve (7-5) HV-13646	360	40	340	0			6.065	0.089	0.50		28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
49	tee (6-3)	360	40	340	0			6.065	0.000	0.00		28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
50	elbow, 90 (SR)	360	40	340	0			6.065	0.048	0.27		28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
50A	elbow, 90 (LR)	360	40	340	0			6.065	0.034	0.19		28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
51	pipe section	360	40	340	0			6.065	0.015		2	28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
52	elbow, 90 (SR)	360	40	340	0			6.065	0.039	0.22		28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
53	bypass valve (7-5) HV-13648	360	40	340	0			6.065	0.089	0.50		28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
54	HEMF HMF-1361	360	40	340	0			6.065	4.500			28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
55	bypass valve (7-5) HV-13648	360	40	340	0			6.065	0.089	0.50		28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179

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KAISER ENGINEERS HANFORD CO.
DUCT PRESSURE LOSS
CALCULATION SHEET

JOB NO./ W.O. NO. : W-320/ER4319
BLDG NO./ AREA : 241-C-106/200E
DUCT SYSTEM :

PREPARED BY: Peter H. Langowski
DATE: 2/8/95
CHECKED BY:

NOTES: Calculation W320-~~H~~28-018 rev 1.
Pressure loss per 1993 Fundamentals p.32.4 Darcy Equation (19).
Hydraulic diameter per 1993 Fundamentals p.32.6 Equation (24).
Reynold's Number per 1993 Fundamentals p.32.5 Equation (22).
Alphanumeric ASHRAE fitting numbers from 1993 Fundamentals. Numeric fitting numbers from 1985 Fundamentals. Pipe sizes for schedule 40S.

Long Radius (LR) elbows: r/D = 1.5, fitting loss = 0.15; Short Radius (SR) elbows: r/D = 1.0, fitting loss = 0.22, losses per 1991 Applications, p. 27.9, Table 4.
Combined elbow factor of 1.25 per p. B-14.

NOTE: COLUMNS UNDER SHADED AREAS REQUIRE USER INPUT

#	TYPE OF FITTING (ASHRAE #)	AIR FLOW	TEMP	AIR FLOW	AIR FLOW TAKEOFF	DUCTSIZE either round or rectangular			PRESS. LOSS	FITTING LOSS COEFF.	EQUIV DUCT LENGTH	DUCT AREA	PERI METER	HYDRAL DIA	REY	FPRIME	F	VEL.	VEL. PRESS. Vp
		SCFM	DEG F	ACFM	SCFM	WIDTH IN.	HEIGHT IN.	DIA. IN.	IN. WG	Co	FT.	SQ. IN.	IN.	IN.				FPM	IN. WG
		initial only								fittings onl	duct only								
56	elbow, 90 (LR)	360	40	340	0			6.065	0.027	0.15		28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
57	pipe section	360	40	340	0			6.065	0.029		4	28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
58	elbow, 90 (LR)	360	40	340	0			6.065	0.027	0.15		28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
59	tee (6-3)	360	40	340	0			6.065	0.000	0.00		28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
60	tee (6-3)	360	40	340	0			6.065	0.197	1.10		28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
70	pipe section/flange process bldg	360	40	340	0			6.065	0.026		4	28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
71	elbow, 90 (LR)	360	40	340	0			6.065	0.027	0.15		28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
72	pipe section	360	40	340	0			6.065	0.124		17	28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
73	elbow, 90 (LR)	360	40	340	0			6.065	0.027	0.15		28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
74	pipe section/flange exhaust skid	360	40	340	0			6.065	0.015		2	28.89	19.05	6.07	97,668	0.019	0.019	1,693	0.179
								total to exhaust skid	24.37										
26A	tee, flow split, main (6-3)	860	40	811	0			10.020	0.052	0.38		78.85	31.48	10.02	141,225	0.017	0.017	1,482	0.137
80	reducer, contraction (5-1)	860	40	811	0			6.065	0.071	0.07		28.89	19.05	6.07	233,318	0.016	0.017	4,044	1.020
81	elbow, 90 (LR)	860	40	811	0			6.065	0.153	0.15		28.89	19.05	6.07	233,318	0.016	0.017	4,044	1.020
82	moisture separator MS-1361	860	40	811	0			6.065	5.500			28.89	19.05	6.07	233,318	0.016	0.017	4,044	1.020
83	reducer, expansion (4-1)	860	40	811	0			7.981	0.231	0.68		50.03	25.07	7.98	177,306	0.017	0.017	2,335	0.340
84	tee (6-3)	860	40	811	0			7.981	0.000	0.00		50.03	25.07	7.98	177,306	0.017	0.017	2,335	0.340
85	elbow, 90 (LR)	860	40	811	0			7.981	0.051	0.15		50.03	25.07	7.98	177,306	0.017	0.017	2,335	0.340
86	transition (4-3)	860	40	811	0			7.981	0.238	0.70		50.03	25.07	7.98	177,306	0.017	0.017	2,335	0.340
87	electric heating coil HC-1361	860	77	871	0			7.981	0.060	0.15		50.03	25.07	7.98	190,426	0.017	0.017	2,508	0.392
88	transition (5-1)	860	77	871	0			7.981	0.027	0.07		50.03	25.07	7.98	190,426	0.017	0.017	2,508	0.392
89	elbow, 90 (LR)	860	77	871	0			7.981	0.059	0.15		50.03	25.07	7.98	190,426	0.017	0.017	2,508	0.392
90	pipe section	860	77	871	0			7.981	0.043		4	50.03	25.07	7.98	190,426	0.017	0.017	2,508	0.392
91	recirculation fan FN-1361	860	77	871	0			7.981	0.000	0.00		50.03	25.07	7.98	190,426	0.017	0.017	2,508	0.392
92	pipe section	860	77	871	0			7.981	0.043		4	50.03	25.07	7.98	190,426	0.017	0.017	2,508	0.392
93	elbow, 45 (LR)	860	77	871	0			7.981	0.035	0.09		50.03	25.07	7.98	190,426	0.017	0.017	2,508	0.392
94	pipe section	860	77	871	0			7.981	0.032		3	50.03	25.07	7.98	190,426	0.017	0.017	2,508	0.392
95	elbow, 45 (LR)	860	77	871	0			7.981	0.035	0.09		50.03	25.07	7.98	190,426	0.017	0.017	2,508	0.392
96	bypass valve (7-5) HV-13648	860	77	871	0			7.981	0.196	0.50		50.03	25.07	7.98	190,426	0.017	0.017	2,508	0.392
97	pipe section	860	77	871	0			7.981	0.141		13	50.03	25.07	7.98	190,426	0.017	0.017	2,508	0.392
98	elbow, 90 (LR)	860	77	871	0			7.981	0.059	0.15		50.03	25.07	7.98	190,426	0.017	0.017	2,508	0.392
99	converging wye (6-2)	860	77	871	0			7.981	-0.059	-0.15		50.03	25.07	7.98	190,426	0.017	0.017	2,508	0.392
100	pipe section riser R-2	860	77	871	0			11.938	0.021		14	111.93	37.50	11.94	127,307	0.017	0.018	1,121	0.078
								up to flow split	11.89										
								split back to tank	6.99										
								total for recirc fan	18.88										

DATA USED ABOVE
roughness = 0.0001
density = 0.082 lbm/ft3 40F saturated air 12.239 ft3/lbm 0.964 altitude correction
kinematic viscosity = 0.000146 ft2/s

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KAISER ENGINEERS HANFORD CO.
DUCT PRESSURE LOSS
CALCULATION SHEET

JOB NO./ W.O. NO. : W-320/ER4319
BLDG NO./ AREA : 241-C-106/200E
DUCT SYSTEM :

PREPARED BY: Peter H. Langowski
DATE: 2/8/95
CHECKED BY:

NOTES: Calculation W320-28-018 rev 1.
Pressure loss per 1993 Fundamentals p.32.4 Darcy Equation (19).
Hydraulic diameter per 1993 Fundamentals p.32.6 Equation (24).
Reynold's Number per 1993 Fundamentals p.32.5 Equation (22).
Alphanumeric ASHRAE fitting numbers from 1993 Fundamentals. Numeric fitting numbers from 1985 Fundamentals. Pipe sizes for schedule 40S.

Long Radius (LR) elbows: r/D=1.5, fitting loss=0.15; Short Radius (SR) elbows: r/D=1.0, fitting loss=0.22, losses per 1991 Applications, p. 27.9, Table 4.
Combined elbow factor of 1.25 per p. B-14.

NOTE: COLUMNS UNDER SHADED AREAS REQUIRE USER INPUT

#	TYPE OF FITTING (ASHRAE #)	AIR FLOW	TEMP	AIR FLOW	AIR FLOW TAKEOFF	DUCTSIZE either round or rectangular WIDTH	HEIGHT	DIA.	PRESS. LOSS	FITTING LOSS COEFF.	EQUIV DUCT LENGTH	DUCT AREA	PERI METER	HYDRAL DIA	REY	FPRIME	F	VEL.	VEL. PRESS. Vp
		SCFM	DEG F	ACFM	SCFM	IN.	IN.	IN.	IN. WG	Co	FT.	SQ. IN.	IN.	IN.				FPM	IN. WG
		initial only								fittings onl	duct only								

friction factors			
	galvanized	0.0003	medium smooth
	carbon steel	0.0001	smooth

kinematic viscosity	temp(F)	ft2/s
Mechanical Engineering	0.00	1.26E-04
Reference Manual Eighth	20.00	1.36E-04
Edition, p.3-36.	40.00	1.46E-04
	60.00	1.58E-04
	68.00	1.60E-04
	80.00	1.69E-04
	100.00	1.80E-04
	120.00	1.89E-04
	250.00	2.73E-04

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KAISER ENGINEERS HANFORD CO.
DUCT PRESSURE LOSS
CALCULATION SHEET

JOB NO./ W.O. NO. : W-320/ER4319
BLDG NO./ AREA : 241-C-106/200E
DUCT SYSTEM : Exhaust system up to the exhaust skid

PREPARED BY: Peter H. Langowski
DATE: 6/3/94
CHECKED BY:

NOTES: Calculation W320-~~H~~28-018.
Pressure loss per 1993 Fundamentals p.32.4 Darcy Equation (19).
Hydraulic diameter per 1993 Fundamentals p.32.6 Equation (24).
Reynold's Number per 1993 Fundamentals p.32.5 Equation (22).
Alphanumeric ASHRAE fitting numbers from 1993 Fundamentals. Numeric fitting numbers from 1985 Fundamentals. Pipe sizes for schedule 10S.

Long Radius (LR) elbows: r/D = 1.5, fitting loss = 0.15; Short Radius (SR) elbows: r/D = 1.0, fitting loss = 0.22, losses per 1991 Applications, p. 27.9, Table 4.

NOTE: COLUMNS UNDER SHADED AREAS REQUIRE USER INPUT

#	TYPE OF FITTING (ASHRAE #)	AIR FLOW	TEMP	AIR FLOW	AIR FLOW TAKEOFF	DUCTSIZE either round or rectangular WIDTH	HEIGHT	DIA.	PRESS. LOSS	FITTING LOSS COEFF.	EQUIV DUCT LENGTH	DUCT AREA	PERI METER	HYDRAL DIA	REY	FPRIME	F	VEL.	VEL. PRESS. Vp
		SCFM	DEG F	ACFM	SCFM	IN.	IN.	IN.	IN. WG	Co	FT.	SQ. IN.	IN.	IN.				FPM	IN. WG
		Initial only								fittings only	duct only								
1	tank pressure	1090	95	1141	0				1.500			0.00	0.00	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
2	inlet to hatchway (ED1-1)	1090	95	1141	0			24.375	0.004	0.50		466.64	76.58	24.38	81,674	0.019	0.019	352	0.008
3	hatchway elbow (CD3-12)	1090	95	1141	0			24.375	0.003	0.42		466.64	76.58	24.38	81,674	0.019	0.019	352	0.008
4	hatchway pipe	1090	95	1141	0			24.375	0.000		6	466.64	76.58	24.38	81,674	0.019	0.019	352	0.008
5A	hatchway exit (SD4-1)	1090	95	1141	0	69	39		0.006	25.00		2691.00	216.00	49.83	28,955	0.024	0.024	61	0.000
5B	hatchway loss	1090	95	1141	0	69	39		0.000		10	2691.00	216.00	49.83	28,955	0.024	0.024	61	0.000
6	inlet to mist eliminator (ED1-1)	1090	95	1141	0			16.876	0.017	0.50		223.68	53.02	16.88	117,967	0.018	0.018	735	0.034
7	mist eliminator	1090	95	1141	0			16.876	0.750			223.68	53.02	16.88	117,967	0.018	0.018	735	0.034
8	transition to 12" (ED4-1)	1090	95	1141	0			12.390	0.023	0.20		120.57	38.92	12.39	160,679	0.017	0.017	1,363	0.116
9	pipe section	1090	95	1141	0			12.390	0.006		3	120.57	38.92	12.39	160,679	0.017	0.017	1,363	0.116
10	transition to 10" (ED4-1)	1090	95	1141	0			10.420	0.046	0.20		85.28	32.74	10.42	191,057	0.016	0.017	1,927	0.232
11	deleted	1090	95	1141	0			10.420	0.000	0.00		85.28	32.74	10.42	191,057	0.016	0.017	1,927	0.232
12	elbow, 45 (LR)	1040	95	1089	0			10.420	0.019	0.09		85.28	32.74	10.42	182,293	0.016	0.017	1,839	0.211
13	pipe section	1040	95	1089	0			10.420	0.034		8	85.28	32.74	10.42	182,293	0.016	0.017	1,839	0.211
14	elbow, 45 (LR)	1040	95	1089	0			10.420	0.019	0.09		85.28	32.74	10.42	182,293	0.016	0.017	1,839	0.211
15	pipe section	1040	95	1089	0			10.420	0.021		5	85.28	32.74	10.42	182,293	0.016	0.017	1,839	0.211
16	elbow, 90 (SR), in Process Bldg	1040	95	1089	0			10.420	0.046	0.22		85.28	32.74	10.42	182,293	0.016	0.017	1,839	0.211
17A	elbow, 90 (SR)	1040	95	1089	0			10.420	0.046	0.22		85.28	32.74	10.42	182,293	0.016	0.017	1,839	0.211
17B	shutoff valve (7-5)	1040	95	1089	0			10.420	0.105	0.50		85.28	32.74	10.42	182,293	0.016	0.017	1,839	0.211
18	heat exchanger	1040	95	1089	0			10.420	10.000			85.28	32.74	10.42	182,293	0.016	0.017	1,839	0.211
19A	shutoff valve	1040	40	981	0			10.420	0.086	0.50		85.28	32.74	10.42	164,228	0.017	0.017	1,657	0.171
19B	elbow, 90 (SR)	1040	40	981	0			10.420	0.038	0.22		85.28	32.74	10.42	164,228	0.017	0.017	1,657	0.171
20	elbow, 90 (SR)	1040	40	981	0			10.420	0.038	0.22		85.28	32.74	10.42	164,228	0.017	0.017	1,657	0.171
21	tee, portable takeoff (6-3)	1040	40	981	0			10.420	0.000	0.00		85.28	32.74	10.42	164,228	0.017	0.017	1,657	0.171
22	elbow, 90 (SR)	1040	40	981	0			10.420	0.038	0.22		85.28	32.74	10.42	164,228	0.017	0.017	1,657	0.171
23	tee, transition (SD5-2)	1040	40	981	0			10.420	0.084	0.49		85.28	32.74	10.42	164,228	0.017	0.017	1,657	0.171
24A	tee (6-3)	180	40	170	860			6.357	0.000	0.00		31.74	19.97	6.36	46,591	0.022	0.022	770	0.037
24B	bypass valve (7-5)	180	40	170	0			6.357	0.019	0.50		31.74	19.97	6.36	46,591	0.022	0.022	770	0.037
24C	pipe section	180	40	170	0			6.357	0.010		6	31.74	19.97	6.36	46,591	0.022	0.022	770	0.037
25	elbow, 90 (SR)	180	40	170	0			6.357	0.008	0.22		31.74	19.97	6.36	46,591	0.022	0.022	770	0.037
26	pipe section	180	40	170	0			6.357	0.003		2	31.74	19.97	6.36	46,591	0.022	0.022	770	0.037
27	elbow, 90 (SR)	180	40	170	0			6.357	0.008	0.22		31.74	19.97	6.36	46,591	0.022	0.022	770	0.037
28	pipe section	180	40	170	0			6.357	0.003		2	31.74	19.97	6.36	46,591	0.022	0.022	770	0.037
29	elbow, 45 (SR)	180	40	170	0			6.357	0.005	0.13		31.74	19.97	6.36	46,591	0.022	0.022	770	0.037
30	HEME	180	40	170	0			6.357	3.600			31.74	19.97	6.36	46,591	0.022	0.022	770	0.037
31	elbow, 45 (SR)	180	40	170	0			6.357	0.005	0.13		31.74	19.97	6.36	46,591	0.022	0.022	770	0.037
32	pipe section	180	40	170	0			6.357	0.007		4	31.74	19.97	6.36	46,591	0.022	0.022	770	0.037
33	elbow, 90 (SR)	180	40	170	0			6.357	0.008	0.22		31.74	19.97	6.36	46,591	0.022	0.022	770	0.037
34	elbow, 90 (SR)	180	40	170	0			6.357	0.008	0.22		31.74	19.97	6.36	46,591	0.022	0.022	770	0.037
35	pipe section	180	40	170	0			6.357	0.007		4	31.74	19.97	6.36	46,591	0.022	0.022	770	0.037
36	bypass valve (7-5)	180	40	170	0			6.357	0.019	0.50		31.74	19.97	6.36	46,591	0.022	0.022	770	0.037
37	elbow, 90 (SR)	180	40	170	0			6.357	0.008	0.22		31.74	19.97	6.36	46,591	0.022	0.022	770	0.037
38	tee (6-3)	180	40	170	0			6.357	0.000	0.00		31.74	19.97	6.36	46,591	0.022	0.022	770	0.037
39	bypass valve (7-5)	180	40	170	0			6.357	0.019	0.50		31.74	19.97	6.36	46,591	0.022	0.022	770	0.037
40	elbow, 90 (SR)	180	40	170	0			6.357	0.008	0.22		31.74	19.97	6.36	46,591	0.022	0.022	770	0.037
41	HEMF	180	40	170	0			6.357	2.200			31.74	19.97	6.36	46,591	0.022	0.022	770	0.037
42	bypass valve (7-5)	180	40	170	0			6.357	0.019	0.50		31.74	19.97	6.36	46,591	0.022	0.022	770	0.037

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KAISER ENGINEERS HANFORD CO.
DUCT PRESSURE LOSS
CALCULATION SHEET

JOB NO./ W.O. NO. : W-320/ER4319
BLDG NO./ AREA : 241-C-106/200E
DUCT SYSTEM : Exhaust system up to the exhaust skid

PREPARED BY: Peter H. Langowski
DATE: 6/3/94
CHECKED BY:

NOTES: Calculation W320-28-018.
Pressure loss per 1993 Fundamentals p.32.4 Darcy Equation (19).
Hydraulic diameter per 1993 Fundamentals p.32.6 Equation (24).
Reynold's Number per 1993 Fundamentals p.32.5 Equation (22).
Alphanumeric ASHRAE fitting numbers from 1993 Fundamentals. Numeric fitting numbers from 1985 Fundamentals. Pipe sizes for schedule 10S.

Long Radius (LR) elbows: r/D = 1.5, fitting loss = 0.15; Short Radius (SR) elbows: r/D = 1.0, fitting loss = 0.22, losses per 1991 Applications, p. 27.9, Table 4.

NOTE: COLUMNS UNDER SHADED AREAS REQUIRE USER INPUT

#	TYPE OF FITTING (ASHRAE #)	AIR FLOW	TEMP	AIR FLOW	AIR FLOW TAKEOFF	DUCTSIZE either round or rectangular WIDTH	HEIGHT	DIA.	PRESS. LOSS	FITTING LOSS COEFF.	EQUIV DUCT LENGTH	DUCT AREA	PERI METER	HYDRAL DIA	REY	FPRIME	F	VEL.	VEL. PRESS. Vp
		SCFM	DEG F	ACFM	SCFM	IN.	IN.	IN.	IN. WG	Co	FT.	SQ. IN.	IN.	IN.				FPM	IN. WG
		Initial only								fittings only	duct only								
43	elbow, 90 (SR)	180	40	170	0			6.357	0.008	0.22		31.74	19.97	6.36	46,591	0.022	0.022	770	0.037
44	pipe section	180	40	170	0			6.357	0.007		4	31.74	19.97	6.36	46,591	0.022	0.022	770	0.037
45	elbow, 90 (SR)	180	40	170	0			6.357	0.008	0.22		31.74	19.97	6.36	46,591	0.022	0.022	770	0.037
46	pipe section	180	40	170	0			6.357	0.007		4	31.74	19.97	6.36	46,591	0.022	0.022	770	0.037
47	elbow, 90	180	40	170	0			6.357	0.006	0.15		31.74	19.97	6.36	46,591	0.022	0.022	770	0.037
48	tee (6-3)	180	40	170	0			6.357	0.000	0.00		31.74	19.97	6.36	46,591	0.022	0.022	770	0.037
49	pipe section/flange process bldg	180	40	170	0			6.357	0.013		8	31.74	19.97	6.36	46,591	0.022	0.022	770	0.037
50	elbow, 45 (LR)	180	40	170	0			6.357	0.003	0.09		31.74	19.97	6.36	46,591	0.022	0.022	770	0.037
51	pipe section	180	40	170	0			6.357	0.008		5	31.74	19.97	6.36	46,591	0.022	0.022	770	0.037
52	elbow, 45 (LR)	180	40	170	0			6.357	0.003	0.09		31.74	19.97	6.36	46,591	0.022	0.022	770	0.037
53	pipe section	180	40	170	0			6.357	0.016		10	31.74	19.97	6.36	46,591	0.022	0.022	770	0.037
54	elbow, 90 (LR)	180	40	170	0			6.357	0.006	0.15		31.74	19.97	6.36	46,591	0.022	0.022	770	0.037
55	pipe section/flange exhaust skid	180	40	170	0			6.357	0.005		3	31.74	19.97	6.36	46,591	0.022	0.022	770	0.037
								total	18.98										

DATA USED ABOVE

roughness = 0.0001
density = 0.079 lbm/ft3 40F saturated air 12.696 ft3/lbm
kinematic viscosity = 0.000146 ft2/s

friction factors		
galvanized	0.0003	medium smooth
carbon steel	0.0001	smooth

kinematic viscosity	temp(F)	ft2/s
Mechanical Engineering Reference Manual Eighth Edition, p.3-36.	0.00	1.26E-04
	20.00	1.36E-04
	40.00	1.46E-04
	60.00	1.58E-04
	68.00	1.60E-04
	80.00	1.69E-04
	100.00	1.80E-04
	120.00	1.89E-04
	250.00	2.73E-04

Deleted Rev 1 PHL 2-14-95

GG 2/21/95

LOW FLOW, CLEAN, DRY

KAISER ENGINEERS HANFORD CO.
DUCT PRESSURE LOSS
CALCULATION SHEET

JOB NO./ W.O. NO. : W-320/ER4319
BLDG NO./ AREA : 241-C-106/200E
DUCT SYSTEM :

PREPARED BY: Peter H. Langowski
DATE: 2/8/95
CHECKED BY:

NOTES: Calculation W320-28-018 rev 1.
Pressure loss per 1993 Fundamentals p.32.4 Darcy Equation (19).
Hydraulic diameter per 1993 Fundamentals p.32.6 Equation (24).
Reynold's Number per 1993 Fundamentals p.32.5 Equation (22).
Alphanumeric ASHRAE fitting numbers from 1993 Fundamentals. Numeric fitting numbers from 1985 Fundamentals. Pipe sizes for schedule 40S.

Long Radius (LR) elbows: r/D=1.5, fitting loss=0.15; Short Radius (SR) elbows: r/D=1.0, fitting loss=0.22, losses per 1991 Applications, p. 27.9, Table 4.
Combined elbow factor of 1.25 per p. B-14.

NOTE: COLUMNS UNDER SHADED AREAS REQUIRE USER INPUT

#	TYPE OF FITTING (ASHRAE #)	AIR FLOW	TEMP	AIR FLOW	AIR FLOW TAKEOFF	DUCTSIZE either round or rectangular WIDTH	HEIGHT	DIA.	PRESS. LOSS	FITTING LOSS COEFF.	EQUIV DUCT LENGTH	DUCT AREA	PERI METER	HYDRAL DIA	REY	FPRIME	F	VEL.	VEL. PRESS. Vp
		SCFM	DEG F	ACFM	SCFM	IN.	IN.	IN.	IN. WG	Co	FT.	SQ. IN.	IN.	IN.				FPM	IN. WG
		initial only								fittings onl	duct only								
1	tank pressure	1090	95	1141	0				1.500			0.00	0.00	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
2	inlet to hatchway (ED1-1)	1090	95	1141	0			24.375	0.004	0.50		466.64	76.58	24.38	81,674	0.019	0.019	352	0.008
3	hatchway elbow (CD3-12)	1090	95	1141	0			24.375	0.003	0.42		466.64	76.58	24.38	81,674	0.019	0.019	352	0.008
4	hatchway pipe	1090	95	1141	0			24.375	0.000		6	466.64	76.58	24.38	81,674	0.019	0.019	352	0.008
5	hatchway exit (SD4-1)	1090	95	1141	0	69	39		0.006	25.00		2691.00	216.00	49.83	28,955	0.024	0.024	61	0.000
6	hatchway loss	1090	95	1141	0	69	39		0.000		10	2691.00	216.00	49.83	28,955	0.024	0.024	61	0.000
10	inlet to piping (ED1-1)	1090	95	1141	0			10.020	0.135	0.50		78.85	31.48	10.02	198,684	0.016	0.017	2,084	0.271
11	piping	1090	95	1141	0			10.020	0.023		4	78.85	31.48	10.02	198,684	0.016	0.017	2,084	0.271
12	elbow, 90 (LR)	1090	95	1141	0			10.020	0.041	0.15		78.85	31.48	10.02	198,684	0.016	0.017	2,084	0.271
13	pipe section	1090	95	1141	0			10.020	0.029		5	78.85	31.48	10.02	198,684	0.016	0.017	2,084	0.271
14	elbow, 90 (LR)	1090	95	1141	0			10.020	0.041	0.15		78.85	31.48	10.02	198,684	0.016	0.017	2,084	0.271
15	pipe section	1090	95	1141	0			10.020	0.029		5	78.85	31.48	10.02	198,684	0.016	0.017	2,084	0.271
16	elbow, 90 (LR), in Process Bldg	1090	95	1141	0			10.020	0.041	0.15		78.85	31.48	10.02	198,684	0.016	0.017	2,084	0.271
20	pipe section	1090	95	1141	0			10.020	0.006		1	78.85	31.48	10.02	198,684	0.016	0.017	2,084	0.271
21	elbow, 90 (SR)	1090	95	1141	0			10.020	0.060	0.22		78.85	31.48	10.02	198,684	0.016	0.017	2,084	0.271
22	shutoff valve (7-5) HV-136142	1090	95	1141	0			10.020	0.135	0.50		78.85	31.48	10.02	198,684	0.016	0.017	2,084	0.271
23	heat exchanger HX-1361	1090	95	1141	0			10.020	11.000			78.85	31.48	10.02	198,684	0.016	0.017	2,084	0.271
24	shutoff valve (7-5) HV-13639	1090	40	1028	0			10.020	0.110	0.50		78.85	31.48	10.02	178,995	0.016	0.017	1,878	0.220
25	elbow, 90 (SR)	1090	40	1028	0			10.020	0.048	0.22		78.85	31.48	10.02	178,995	0.016	0.017	1,878	0.220
26A	tee, flow split, branch (6-3)	1090	40	1028	0			10.020	0.134	0.61		78.85	31.48	10.02	178,995	0.016	0.017	1,878	0.220
30	elbow, 45 (LR)	230	40	217	860			6.065	0.007	0.09		28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
31	pipe section	230	40	217	0			6.065	0.010		3	28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
32	elbow, 90 (LR)	230	40	217	0			6.065	0.011	0.15		28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
33	pipe section	230	40	217	0			6.065	0.011		4	28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
34	tee (6-3)	230	40	217	0			6.065	0.000	0.00		28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
35	bypass valve (7-5) HV-13649	230	40	217	0			6.065	0.036	0.50		28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
36	elbow, 90 (LR)	230	40	217	0			6.065	0.014	0.19		28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
37	elbow, 90 (LR)	230	40	217	0			6.065	0.014	0.19		28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
38	elbow, 45 (LR)	230	40	217	0			6.065	0.008	0.11		28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
39	pipe section	230	40	217	0			6.065	0.007		2	28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
40	elbow, 45 (LR)	230	40	217	0			6.065	0.007	0.09		28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
41	HEME HME-1361	230	40	217	0			6.065	2.500			28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
42	elbow, 45 (LR)	230	40	217	0			6.065	0.007	0.09		28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
43	pipe section	230	40	217	0			6.065	0.007		2	28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
44	elbow, 90 (LR)	230	40	217	0			6.065	0.011	0.15		28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
45	pipe section	230	40	217	0			6.065	0.007		2	28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
46	elbow, 90 (LR)	230	40	217	0			6.065	0.011	0.15		28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
47	pipe section	230	40	217	0			6.065	0.007		2	28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
48	bypass valve (7-5) HV-13646	230	40	217	0			6.065	0.036	0.50		28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
49	tee (6-3)	230	40	217	0			6.065	0.000	0.00		28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
50	elbow, 90 (SR)	230	40	217	0			6.065	0.020	0.27		28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
50A	elbow, 90 (LR)	230	40	217	0			6.065	0.014	0.19		28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
51	pipe section	230	40	217	0			6.065	0.007		2	28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
52	elbow, 90 (SR)	230	40	217	0			6.065	0.016	0.22		28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
53	bypass valve (7-5) HV-13648	230	40	217	0			6.065	0.036	0.50		28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
54	HEMF HMF-1361	230	40	217	0			6.065	2.200			28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
55	bypass valve (7-5) HV-13648	230	40	217	0			6.065	0.036	0.50		28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073

AH 2-14-95

KAISER ENGINEERS HANFORD CO.
DUCT PRESSURE LOSS
CALCULATION SHEET

JOB NO./ W.O. NO. : W-320/ER4319
BLDG NO./ AREA : 241-C-106/200E
DUCT SYSTEM :

PREPARED BY: Peter H. Langowski
DATE: 2/8/95
CHECKED BY:

NOTES: Calculation W320-~~H~~28-018 rev 1.
Pressure loss per 1993 Fundamentals p.32.4 Darcy Equation (19).
Hydraulic diameter per 1993 Fundamentals p.32.6 Equation (24).
Reynold's Number per 1993 Fundamentals p.32.5 Equation (22).
Alphanumeric ASHRAE fitting numbers from 1993 Fundamentals. Numeric fitting numbers from 1985 Fundamentals. Pipe sizes for schedule 40S.

Long Radius (LR) elbows: r/D=1.5, fitting loss=0.15; Short Radius (SR) elbows: r/D=1.0, fitting loss=0.22, losses per 1991 Applications, p. 27.9, Table 4. Combined elbow factor of 1.25 per p. B-14.

NOTE: COLUMNS UNDER SHADED AREAS REQUIRE USER INPUT

#	TYPE OF FITTING (ASHRAE #)	AIR FLOW	TEMP	AIR FLOW	AIR FLOW TAKEOFF	DUCTSIZE either round or rectangular			PRESS. LOSS	FITTING LOSS COEFF.	EQUIV DUCT LENGTH	DUCT AREA	PERI METER	HYDRAL DIA	REY	FPRIME	F	VEL.	VEL. PRESS. Vp
						WIDTH	HEIGHT	DIA.											
		SCFM	DEG F	ACFM	SCFM	IN.	IN.	IN.	IN. WG	Co	FT.	SQ. IN.	IN.	IN.				FPM	IN. WG
		initial only								fittings onl	duct only								
56	elbow, 90 (LR)	230	40	217	0			6.065	0.011	0.15		28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
57	pipe section	230	40	217	0			6.065	0.013		4	28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
58	elbow, 90 (LR)	230	40	217	0			6.065	0.011	0.15		28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
59	tee (6-3)	230	40	217	0			6.065	0.000	0.00		28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
60	tee (6-3)	230	40	217	0			6.065	0.080	1.10		28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
70	pipe section/flange process bldg	230	40	217	0			6.065	0.011		4	28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
71	elbow, 90 (LR)	230	40	217	0			6.065	0.011	0.15		28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
72	pipe section	230	40	217	0			6.065	0.056		17	28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
73	elbow, 90 (LR)	230	40	217	0			6.065	0.011	0.15		28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
74	pipe section/flange exhaust skid	230	40	217	0			6.065	0.007		2	28.89	19.05	6.07	62,399	0.021	0.021	1,082	0.073
								total to exhaust skid	18.59										
26A	tee, flow split, main (6-3)	860	40	811	0			10.020	0.052	0.38		78.85	31.48	10.02	141,225	0.017	0.017	1,482	0.137
80	reducer, contraction (5-1)	860	40	811	0			6.065	0.071	0.07		28.89	19.05	6.07	233,318	0.016	0.017	4,044	1.020
81	elbow, 90 (LR)	860	40	811	0			6.065	0.153	0.15		28.89	19.05	6.07	233,318	0.016	0.017	4,044	1.020
82	moisture separator MS-1361	860	40	811	0			6.065	5.500			28.89	19.05	6.07	233,318	0.016	0.017	4,044	1.020
83	reducer, expansion (4-1)	860	40	811	0			7.981	0.231	0.68		50.03	25.07	7.98	177,306	0.017	0.017	2,335	0.340
84	tee (6-3)	860	40	811	0			7.981	0.000	0.00		50.03	25.07	7.98	177,306	0.017	0.017	2,335	0.340
85	elbow, 90 (LR)	860	40	811	0			7.981	0.051	0.15		50.03	25.07	7.98	177,306	0.017	0.017	2,335	0.340
86	transition (4-3)	860	40	811	0			7.981	0.238	0.70		50.03	25.07	7.98	177,306	0.017	0.017	2,335	0.340
87	electric heating coil HC-1361	860	77	871	0			7.981	0.060	0.15		50.03	25.07	7.98	190,426	0.017	0.017	2,508	0.392
88	transition (5-1)	860	77	871	0			7.981	0.027	0.07		50.03	25.07	7.98	190,426	0.017	0.017	2,508	0.392
89	elbow, 90 (LR)	860	77	871	0			7.981	0.059	0.15		50.03	25.07	7.98	190,426	0.017	0.017	2,508	0.392
90	pipe section	860	77	871	0			7.981	0.043		4	50.03	25.07	7.98	190,426	0.017	0.017	2,508	0.392
91	recirculation fan FN-1361	860	77	871	0			7.981	0.000	0.00		50.03	25.07	7.98	190,426	0.017	0.017	2,508	0.392
92	pipe section	860	77	871	0			7.981	0.043		4	50.03	25.07	7.98	190,426	0.017	0.017	2,508	0.392
93	elbow, 45 (LR)	860	77	871	0			7.981	0.035	0.09		50.03	25.07	7.98	190,426	0.017	0.017	2,508	0.392
94	pipe section	860	77	871	0			7.981	0.032		3	50.03	25.07	7.98	190,426	0.017	0.017	2,508	0.392
95	elbow, 45 (LR)	860	77	871	0			7.981	0.035	0.09		50.03	25.07	7.98	190,426	0.017	0.017	2,508	0.392
96	bypass valve (7-5) HV-13648	860	77	871	0			7.981	0.196	0.50		50.03	25.07	7.98	190,426	0.017	0.017	2,508	0.392
97	pipe section	860	77	871	0			7.981	0.141		13	50.03	25.07	7.98	190,426	0.017	0.017	2,508	0.392
98	elbow, 90 (LR)	860	77	871	0			7.981	0.059	0.15		50.03	25.07	7.98	190,426	0.017	0.017	2,508	0.392
99	converging wye (6-2)	860	77	871	0			7.981	-0.059	-0.15		50.03	25.07	7.98	190,426	0.017	0.017	2,508	0.392
100	pipe section riser R-2	860	77	871	0			11.938	0.021		14	111.93	37.50	11.94	127,307	0.017	0.018	1,121	0.078
								up to flow split	11.71										
								split back to tank	6.99										
								total for recirc fan	18.70										

DATA USED ABOVE
roughness = 0.0001
density = 0.082 lbm/ft3 40F saturated air 12.239 ft3/lbm 0.964 altitude correction
kinematic viscosity = 0.000146 ft2/s

PHL 2-14-95

KAISER ENGINEERS HANFORD CO.
DUCT PRESSURE LOSS
CALCULATION SHEET

JOB NO./ W.O. NO. : W-320/ER4319
BLDG NO./ AREA : 241-C-106/200E
DUCT SYSTEM :

PREPARED BY: Peter H. Langowski
DATE: 2/8/95
CHECKED BY:

NOTES: Calculation W320-H-018 rev 1. (H struck through, handwritten "B" above)
Pressure loss per 1993 Fundamentals p.32.4 Darcy Equation (19).
Hydraulic diameter per 1993 Fundamentals p.32.6 Equation (24).
Reynold's Number per 1993 Fundamentals p.32.5 Equation (22).
Alphanumeric ASHRAE fitting numbers from 1993 Fundamentals. Numeric fitting numbers from 1985 Fundamentals. Pipe sizes for schedule 40S.

Long Radius (LR) elbows: r/D=1.5, fitting loss=0.15; Short Radius (SR) elbows: r/D=1.0, fitting loss=0.22, losses per 1991 Applications, p. 27.9, Table 4.
Combined elbow factor of 1.25 per p. B-14.

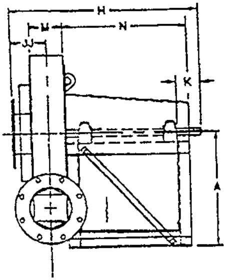
NOTE: COLUMNS UNDER SHADED AREAS REQUIRE USER INPUT

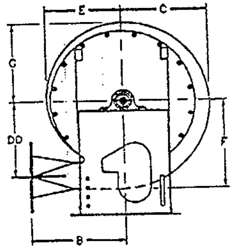
#	TYPE OF FITTING (ASHRAE #)	AIR FLOW	TEMP	AIR FLOW	AIR FLOW TAKEOFF	DUCTSIZE either round or rectangular: WIDTH	HEIGHT	DIA.	PRESS. LOSS	FITTING LOSS COEFF.	EQUIV DUCT LENGTH	DUCT AREA	PERI METER	HYDRAL DIA	REY	FPRIME	F	VEL.	VEL. PRESS. Vp
		SCFM	DEG F	ACFM	SCFM	IN.	IN.	IN.	IN. WG	Co	FT.	SQ. IN.	IN.	IN.				FPM	IN. WG
		initial only								fittings onl	duct only								

friction factors			
	galvanized	0.0003	medium smooth
	carbon steel	0.0001	smooth

kinematic viscosity	temp(F)	ft2/s
Mechanical Engineering Reference Manual Eighth Edition, p.3-36.	0.00	1.26E-04
	20.00	1.36E-04
	40.00	1.46E-04
	60.00	1.58E-04
	68.00	1.60E-04
	80.00	1.69E-04
	100.00	1.80E-04
	120.00	1.89E-04
	250.00	2.73E-04

PHK 2-14-95



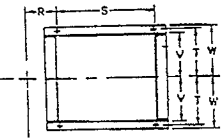


PRESSURE BLOWERS ARE ROTATABLE IN THE FIELD.

FURNISHED WITH FLANGED OUTLET WHICH FITS ANSI 150 PIPE FLANGES.

MAXIMUM TEMPERATURE:
STANDARD FAN --------200°F
HEAT FAN -----------600°F

ALL HEAT FANS INCLUDE A SHAFT COOLER, GUARD, AND MOTOR HEAT SHIELD. A STEEL WHEEL IS REQUIRED ABOVE 200°F. HIGH-TEMP. PAINT IS USED ABOVE 500°F.



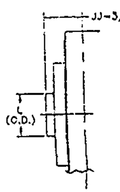
Accessories

Items checked are to be furnished.

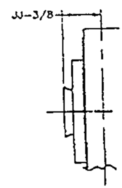
- ______ FLANGED INLET. Fits ANSI 150 pipe flanges.
- ______ VENTURI INLET, with guard.
- ______ PLAIN PIPE INLET.
- ______ STEEL WHEEL.
- ______ DRAIN, 1" tank flanges (less plug).
- ______ WAFER OUTLET DAMPER, TYPE BW, per drawing ______.
- ______ WAFER OUTLET DAMPER, TYPE BL, per drawing ______.
- ______ FLEXIBLE CONNECTOR, per drawing ______.
- ______ INLET FILTER, per drawing ______.
- ______ ISOLATION, per drawing ______.
- ______ SILENCER, per drawing ______.
- ______ FLUSH BOLTED CLEANOUT DOOR, located at ______ O'clock
- ______ ______ TYPE SPARK RESISTANT CONSTRUCTION.
- ______ SHAFT SEAL, CERAMIC FELT.
- ______ POSITIVE SCREW ADJUSTMENT.
- ______ WEATHER COVER BELT GUARD.
- ______ TEFLON SHAFT HOLE CLOSURE.
- ______ 201°F thru 500°F HEAT FAN.
- ______ 501°F thru 600°F HEAT FAN.

FOR SALES PURPOSES ONLY

This drawing has N O T been certified!

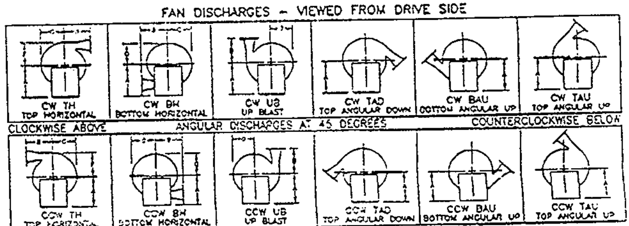


PLAIN PIPE INLET



VENTURI INLET

FAN DISCHARGES - VIEWED FROM DRIVE SIDE



CDWN BLAST AND BOTTOM ANGULAR DOWN DISCHARGES REQUIRE SPECIAL DRAWINGS

DIMENSIONS (IN INCHES)

TOLERANCE: ± 1/8"

WHEEL DIAMETER	A	C	DD	E	F	G	K	N	S	T	V	W	SHAFT DIAMETER	KEYWAY	BASE HOLES
14 THRU 18	21	13 5/8	11 3/4	12	14 3/8	12 3/4	3 1/2	22	17 3/16	9 3/8	8 1/4	10 1/4	1 7/16	3/8	9/16
~~19 THRU 22~~	~~27 5/8~~	~~16 1/2~~	~~14 7/8~~	~~14 1/2~~	~~17 1/2~~	~~15 1/2~~	~~4 1/2~~	~~26~~	~~19 7/8~~	~~12 1/4~~	~~11~~	~~13~~	~~1 7/16~~	~~5/8~~	~~3/4~~
23 THRU 26	27 7/8	19 1/2	17 5/8	17 1/8	20 5/8	18 1/4	4 1/2	26	19 7/8	12 1/4	11	13	1 11/16	3/8	3/4

WHEEL DIAMETER	OUTLET DIA.	B	H	JJ	L	M	R	FLANGES (I.D.) OUTLET	FLANGES (I.D.) INLET
14 THRU 18	4	18 1/4	31 1/8	5 5/8	6 5/8	3 7/8	4 5/16	4	6
	6	18 1/4	33 1/2	6 3/4	8 5/8	6 1/4	5 1/2	6	8
15 THRU 18	8	18 1/4	33 1/2	6 3/4	8 5/8	6 1/4	5 1/2	8	8
19 THRU 22	4	17 3/4	38 1/8	6 1/8	6 5/8	3 7/8	5 1/16	4	6
	6	17 3/4	36 1/8	6 1/8	6 5/8	3 7/8	5 1/16	6	6
	8	17 3/4	38	8 3/4	8 5/8	6 1/4	6 1/4	8	8
	10	21 3/4	38	6 3/4	8 5/8	6 1/4	6 1/4	10	10
23 THRU 26	6	19	37 5/8	7	8 5/8	5	5 5/8	6	8
	~~8~~	~~19~~	~~37 5/8~~	~~7~~	~~8 5/8~~	~~5~~	~~5 5/8~~	~~8~~	~~8~~
	10	23	39	7 1/4	10 3/4	7 1/4	6 3/4	10	10
	12	23	39	7 1/4	10 3/4	7 1/4	6 3/4	12	12

FLANGE DIMENSIONS (OUTLET-INLET)

I.D.	B.C.	O.D.	HOLES* NO.	HOLES* DIA.
~~4~~	~~7 1/2~~	~~9~~	~~8~~	~~3/4~~
6	9 1/2	11	8	7/8
~~8~~	~~11 3/4~~	~~13 1/2~~	~~8~~	~~7/8~~
10	14 1/4	16	12	1
12	17	19	12	1

*HOLES STRADDLE THE CENTERLINES

WHEEL DIAMETER	MAX. MOTOR LIMITATIONS MOTOR FRAME OPEN	MOTOR FRAME TE	LENGTH C-NW
14 THRU 18	215T	215T	16 3/8
~~19 THRU 22~~	~~256T~~	~~254T~~	~~18 5/8~~
23 THRU 26	256T	254T	18 5/8

* SIZE NOMENCLATURE (5 DIGITS)
  - FIRST & SECOND - Wheel Dia.
  - THIRD & FOURTH - Outlet Dia. (I.D.)
  - FIFTH (LETTER) - Wheel Type:
    - A = Aluminum
    - S = Steel Or Stainless Steel

DIMENSIONS SHOULD NOT BE USED FOR CONSTRUCTION PURPOSES UNLESS CERTIFIED.

DATE ______ CERTIFIED ______ CONTROL NO. ______

CUSTOMER'S NO. ______

CUSTOMER'S NAME ______

CERTIFIED DRAWING | FORM NO. B-38 A

NEMA STANDARD DIMENSIONS (Inches)

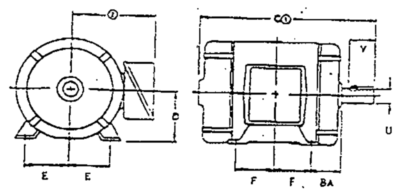
(See motor sketch, page 2)

Figure 2B

Frame	BA	D*	E	F	U★	V†	① C - TE Min	① C - TE Max	① C - ODP Min	① C - ODP Max
143T	2.25	3.50	2.75	2.00	.875	2.00	11.49	12.13	10.69	11.36
145T	2.25	3.50	2.75	2.50	.875	2.00	12.94	13.13	11.69	12.36
182T	2.75	4.50	3.75	2.25	1.125	2.50	14.50	14.56	12.69	13.58
~~184T~~	~~2.75~~	~~4.50~~	~~3.75~~	~~2.75~~	~~1.125~~	~~2.50~~	~~15.50~~	~~15.56~~	~~13.69~~	~~14.58~~
213T	3.50	5.25	4.25	2.75	1.375	3.13	17.63	19.82	15.75	17.26
~~215T~~	~~3.50~~	~~5.25~~	~~4.25~~	~~3.50~~	~~1.375~~	~~3.13~~	~~19.13~~	~~19.82~~	~~17.25~~	~~17.26~~
254T	4.25	6.25	5.00	4.12	1.625	3.75	22.38	25.31	20.50	22.31
256T	4.25	6.25	5.00	5.00	1.625	3.75	24.13	25.31	22.25	22.31
284T	4.75	7.00	5.50	4.75	1.875	4.38	25.32	28.31	23.38	24.94
284TS	4.75	7.00	5.50	4.75	1.625	3.00	23.94	26.92	22.00	23.56
286T	4.75	7.00	5.50	5.50	1.875	4.38	26.82	28.31	24.88	24.94
286TS	4.75	7.00	5.50	5.50	1.625	3.00	25.44	26.92	23.50	23.56
324T	5.25	8.00	6.25	5.25	2.125	5.00	28.12	31.70	26.00	27.56
324TS	5.25	8.00	6.25	5.25	1.875	3.50	26.63	30.20	24.50	26.06
326T	5.25	8.00	6.25	6.00	2.125	5.00	29.62	31.70	27.50	27.56
326TS	5.25	8.00	6.25	6.00	1.875	3.50	28.13	30.20	26.00	26.06
364T	5.88	9.00	7.00	5.62	2.375	5.63	32.38	33.94	28.63	29.69
364TS	5.88	9.00	7.00	5.62	1.875	3.50	30.26	31.81	26.50	27.56
365T	5.88	9.00	7.00	6.12	2.375	5.63	33.38	33.94	29.63	29.69
365TS	5.88	9.00	7.00	6.12	1.875	3.50	31.26	31.81	27.50	27.56
404T	6.63	10.00	8.00	6.12	2.875	7.00	37.25	38.81	32.50	34.06
404TS	6.63	10.00	8.00	6.12	2.125	4.00	34.25	35.81	29.50	31.06
405T	6.63	10.00	8.00	6.87	2.875	7.00	38.75	38.81	34.00	34.06
405TS	6.63	10.00	8.00	6.87	2.125	4.00	35.75	35.81	31.00	31.06
444T	7.50	11.00	9.00	7.25	3.375	8.25	41.88	44.94	37.63	39.81
444TS	7.50	11.00	9.00	7.25	2.375	4.50	38.13	41.18	33.88	36.06
445T	7.50	11.0	9.00	8.25	3.375	8.25	43.88	44.94	39.63	39.81
445TS	7.50	11.00	9.00	8.25	2.375	4.50	40.13	41.18	35.88	36.06

Figure 2A

Rating (HP)	Synchronous Speed (RPM) ③ 3600 Dripproof	3600 TEFC	1800 Dripproof	1800 TEFC	1200 Dripproof & TEFC
¾	--	--	--	--	143T
1	--	--	143T	143T	145T
1½	143T	143T	145T	145T	182T
2	145T	145T	145T	145T	184T
3	145T	182T	182T	182T	213T
5	182T	184T	184T	184T	215T
7½	184T	213T	213T	213T	254T
10	213T	215T	215T	215T	256T
15	215T	254T	254T	254T	284T
20	254T	256T	256T	256T	286T
25	256T	284TS	284T	284T	324T
30	284TS	286TS	286T	286T	326T
40	286TS	324TS	324T	324T	364T
50	324TS	326TS	326T	326T	365T
60	326TS	364TS	364T	364T	404T
70	364TS	365TS	365T	365T	405T
100	365TS	405TS	404T	405T	444T
125	404TS	444TS	405T	444T	445T



MOTOR DATA SHEET
DATA SHEET M-01

Application	Fan Driver
Location	"C" Tank Farm, 200 E
No. Required	1

EQUIPMENT NUMBER	DESCRIPTION
FN-1362	DRIVER FOR EXHAUST SKID EXHAUST FAN

SPECIFICATIONS

Electrical Type	Squirrel Cage Induction
Enclosure, Type	TEFC
Motor Rating:hp	7.5
Duty Rating	Continuous
Service Factor	1.15
v 480 Phase 3	Poles 4
Frequency	60 hz
Rated RPM	3600
Rated Temp. Rise °C	40 @ 1.0 S.F.
Ambient Temp. °C	50
Insulation Class	F
Ambient Atmosphere	115 °F
Bearings	Anti-Friction, Regreasable
Lubrication	Grease
Starter Here Furnished (If any)	By Seller
Altitude	700 ft
Drive System Furnished By	Ellis & Watts
Base Furnished By	Fan Supplier
Non Standard Mount or Extensions	NONE
Approx. Load hp (under representative load)	6.7 BHP

GENERAL INFORMATION
(To be furnished by vendor)

Manufacturer	Ellis & Watts	NEMA Motor Code Letter	B
Outline Drawing No.	N/A	Starting Current: Amps	30
Frame No.	213T	Full Load Current	10.5
Serial No.	N/A	Recommended Motor Feeder Size/Type	N/A
Net Weight lb.	152 max.		

(1) Equipment number is for the complete assembly of fan, driver and support base. (2) Motor is compatible with variable frequency drive in accordance with Spec. section 3.1.6.

THE NEW YORK BLOWER COMPANY

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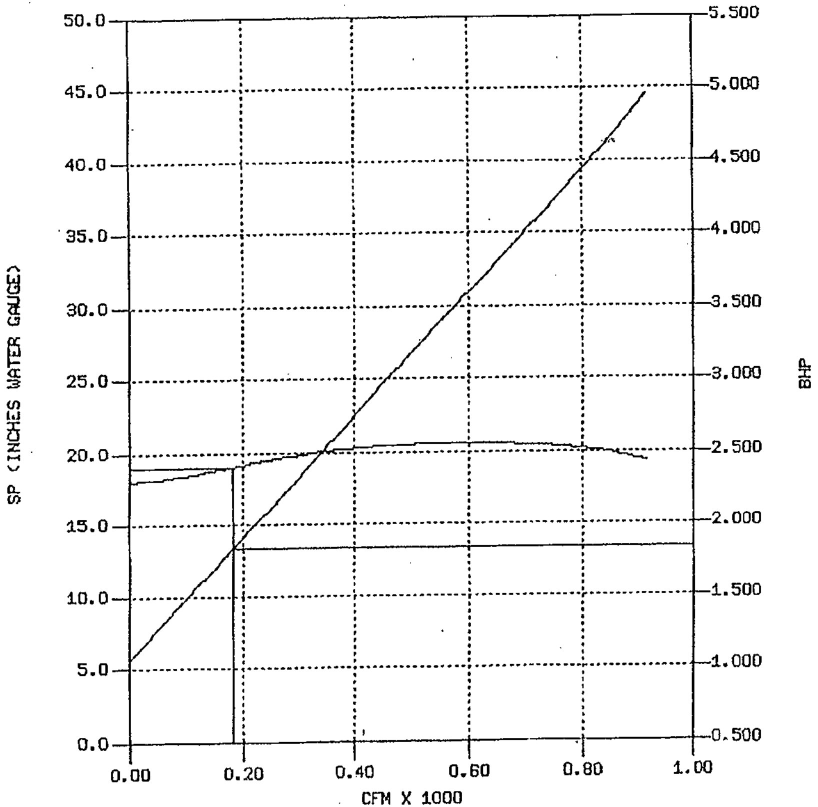

FAN INFORMATION

Pressure Blower - ST
Belt Drive MATL: Mild Steel
Size: 2306S
Tag :
Date: 5/22/1995
CFM : 180 SP : 19.00
OV : 900
RPM : 2396 BHP: 1.83
DEN : 0.0750
TEMP: 70 DEG F
SE : 29.3% ME : 29.4%

CUSTOMER

YOUR REPRESENTATIVE

CINN-QUIP, INC

P.O. BOX 6629
CINCINNATI, OH
45206
Phone: (513) 684-0044
FAX : (513) 684-0066

v1.20

THE NEW YORK BLOWER COMPANY

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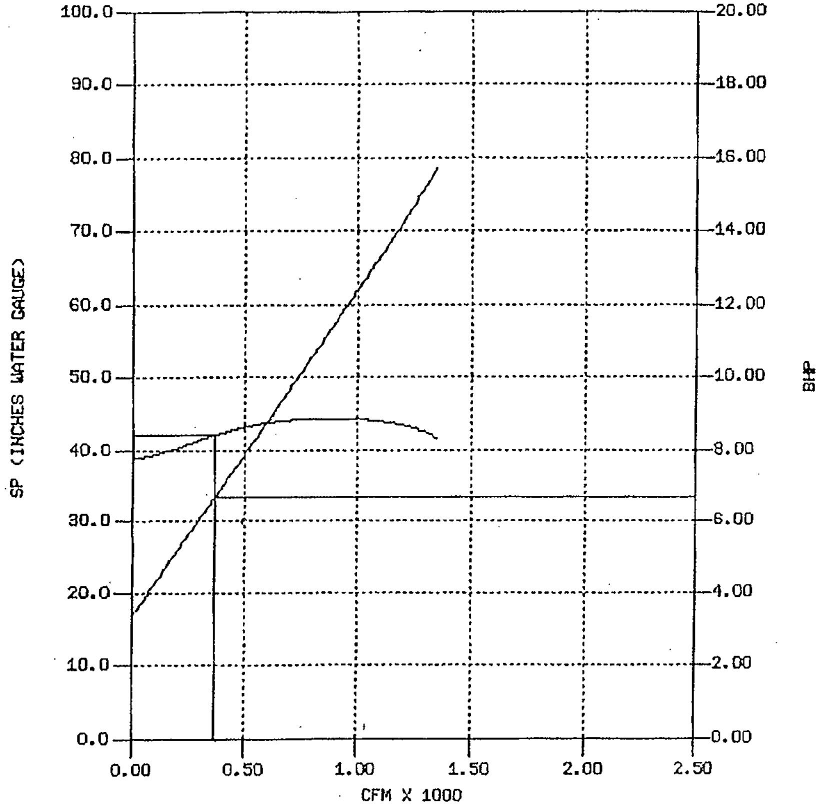


FAN INFORMATION

Pressure Blower - ST
Belt Drive MATL: Mild Steel
Size: 2306S
Tag :
Date: 5/22/1995
CFM : 360 SP : 42.00
OV : 1800
RPM : 3519 BHP: 6.66
DEN : 0.0750
TEMP: 70 DEG F
SE : 35.6% ME : 35.8%

CUSTOMER

YOUR REPRESENTATIVE

CINN-QUIP, INC

P.O. BOX 6629
CINCINNATI, OH
45206
Phone: (513) 684-0044
FAX : (513) 684-0066

v1.20

nyb The New York Blower Company® 7660 QUINCY STREET – WILLOWBROOK, ILLINOIS 60521-5696	FAN BALANCING	SALES BULLETIN **SB-504** April 15, 1994

The intent of this sales bulletin is to clarify nyb's balance standard and nyb's policy concerning customer specifications, special balancing requirements, and field balancing.

NEW YORK BLOWER BALANCE STANDARD

New York Blower's standard dictates that wheels are dynamically balanced prior to installation in the fan assembly. Wheels are balanced to ISO 1940/ANSI S2.19 Quality Grade G-6.3. (See Fan Components Catalog Sheet for further details.) The entire fan assembly is then trim balanced after wheel installation. This final balancing procedure decreases vibration which was caused by the accumulation of various manufacturing tolerances.

New York Blower's vibration standard dictates acceptable vibration levels for shipment of equipment from nyb's factory. Equipment is tested in the factory under ideal conditions. As such, vibration levels may be higher when the fan is installed in the field, in less than ideal conditions, which are beyond the control of nyb and beyond the scope of nyb's responsibility.

APPLICABLE PRODUCTS

The following products are test run and balanced after final assembly at the factory by New York Blower:

AcF/PLR (All Classes)	FRP General Purpose FE	General Purpose, GPA	Series 60
AF-Forty	FRP Pressure Blower	Plug Fan	Tubeaxial
Duct Fan	FRP Radial Fume Exhauster	Pressure Blower	Tubular AcF/PLR
FRP Fume Exhauster	GI (Series 20, 30, 45)	RTS	Vaneaxial

NOTE: While vibration levels on Junior, Compact GI, Propeller fans and Unit Heaters are not governed by this standard, they are test run after final assembly. These products are checked for speed, rotation, and general operating condition when motors and drives are installed by nyb. Any products displaying noticeable vibration will be repaired and/or balanced prior to shipment.

LIMITATIONS

Available Voltage: 110, 208, 240, 480, 575
Available Frequency: 60 cycle (50 cycle motors can not be test run)
Test Running Speeds: Fans are tested at operating speed if known. If unknown, with package nyb drive, fan is tested at midrange of drive. If unknown without packaged drive, fan is generally tested at 90% of maximum RPM. Axial bare fans are not test run.
Horsepower: Motors over 300 HP cannot be test run in nyb's shop.

PICK-UP LOCATIONS

PICK-UP TO BE PLACED IN HORIZONTAL DIRECTION

NOTE: New York Blower measures vibration of a fan assembly in the horizontal direction with "filter in". This method gives the most accurate measure of wheel imbalance. Vibration levels in the vertical and axial directions are affected by other variables and may not provide an accurate measure of wheel imbalance.

Fan	Location
Arrangement 1, 8, 9	Inboard bearing foot
Arrangement 10	Vertical side sheet in line with top of bearing platform
Arrangement 3 & 7	Drive side bearing foot

Fan	Location
Arrangement 4 (except tube fans)	Motor mounting foot (shaft end)
Axial Fans	Outer tube wall at center
Plug Fans	Base of motor platform even with inboard bearing

BALANCE WEIGHTS

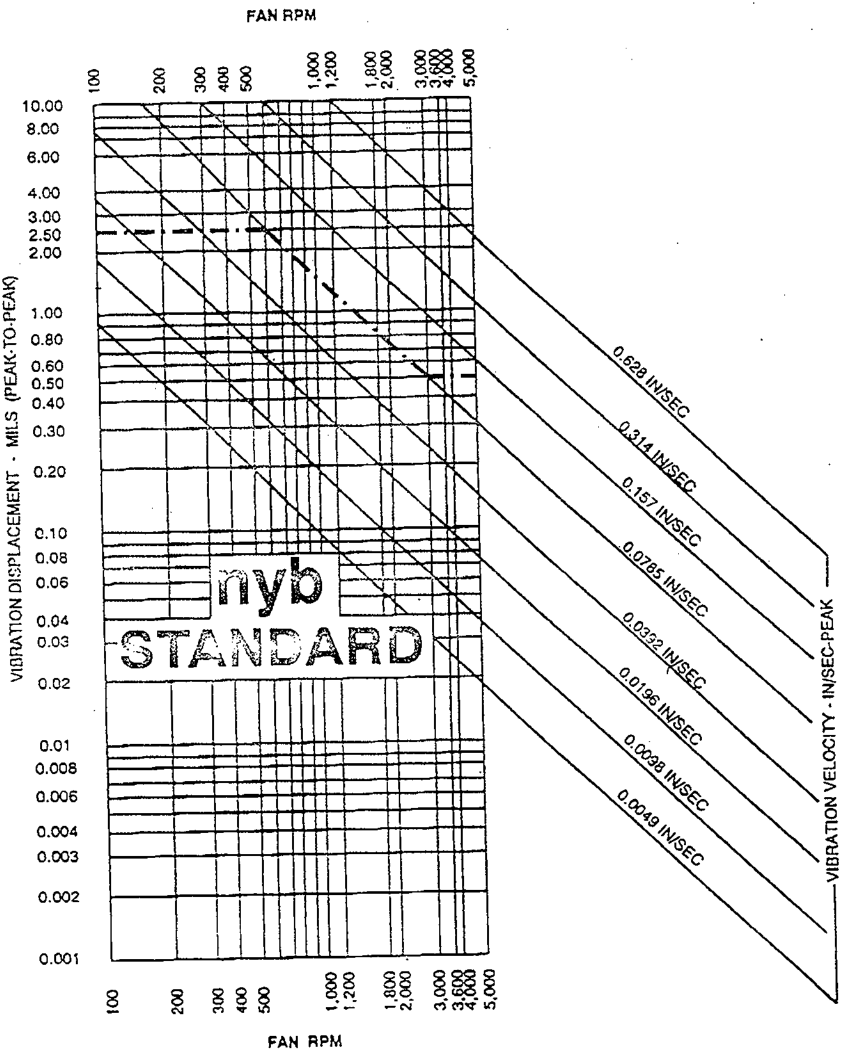
Clip-on weights are used on all clean-air, low temperature fans: Junior, AcF/PLR, General Purpose, GPA, Pressure Blower.
Weld-on weights are used on all: Material handling fans: General Industrial, RTS
High-capacity fans: Class IV, AF-Forty, Series 60
High-heat and axial flow clean air fans: Junior, Air Kit, AcF/PLR, Vaneaxial

NOTE: All stainless steel wheels receive weld-on 316L SST weights. All aluminum wheels (except Pressure Blowers) use welded aluminum weights.
Compact GI wheels have weights welded on the backplate or back of blade. Touch-up is achieved by grinding the blades or backplate.
Coated wheels are drilled through the frontplate or backplate. SST bolts, nuts, and washers are added for weight. Weights are touched-up with coating material.
Fiberglass wheels have patch of parent material added to backplate or material is ground from backplate as required. All ground surfaces are then resin coated.
Touch-up balancing is performed on purchased axial wheels. Material is ground off the hub of Tubeaxial wheels. Welded or bolted weights are added to Duct Fan wheels.

VIBRATION SEVERITY CHART

Vibration levels must fall below the broken line on the chart below prior to shipment from nyb's factory.

NOTE: These levels do not reflect field conditions such as installation and foundation. It is required that the mounting surface upon which the fan is set, is adequate to provide the support and stability necessary to maintain acceptable vibration levels. It is the user's responsibility to provide the proper foundation design and installation. Other factors such as turbulent aerodynamic conditions, background vibration, and maintenance of the equipment may affect vibration levels and are beyond the control of New York Blower.



nyb The New York Blower Company

7660 Quincy Street, Willowbrook, IL 60521

PERFORMANCE CURVE

To determine Performance at another RPM multiply
CFM x K
SP x K^2
BHP x K^3
where K is new RPM divided by RPM shown at right.

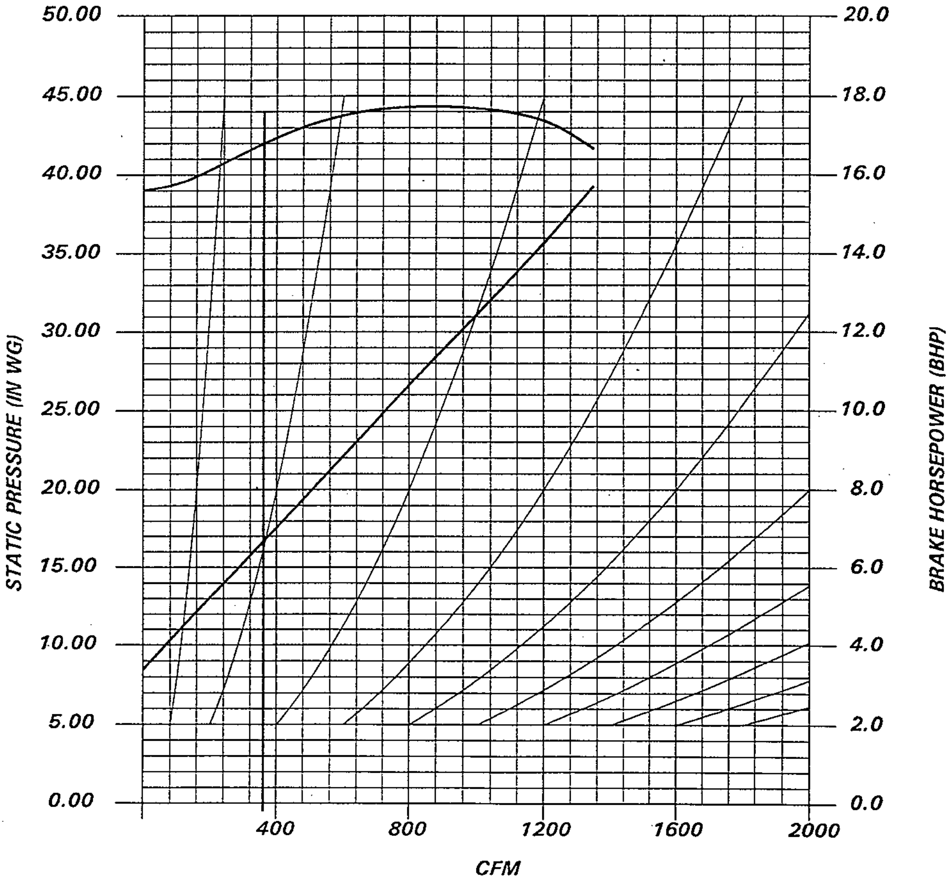
CUST. NO : 302839
CUSTOMER : ELLIS & WATTS
TAGGING :
FAN TYPE : Pressure Blower - ST
FAN SIZE : 2306S
CFM : 360
SP : 42.0
RPM : 3518
BHP : 6.66

CAPACITY TYPE: STD
TEMP : 70 deg F
DENS : 0.075 LB/FT³

DATE : Feb 5 1996

FILE : N01467 - 100 JKM

PERFORMANCE OPTIONS :



ELLIS & WATTS

PURCHASE ORDER : 302839

TAG :

FAN INFORMATION

QUANTITY : 1
FAN TYPE : Pressure Blower - ST
FAN SIZE : 2306S
FAN CLASS : NONE
ROTATION : CCW
DISCHARGE : BAU
ARRANGEMENT : 1
INLET TYPE : FLANGED

MOTOR INFORMATION

ENCLOSURE : TEHI
HORSEPOWER : 7.5
RPM : 3500
ELECT. DATA : 3-60-230/460
FRAME SIZE : 213T
MOTOR POS : Z
MOTOR BY : NYB
MOUNT BY : NYB

FAN PERFORMANCE DATA

MAX SAFE SPEED : 3800 RPM at 70 Deg.

CAP	TYPE	CFM	SP	RPM	BHP	TEMP	ALT	DENSITY
1	STD.	360.0	42.00	3518	6.66	70	0.0	0.0750

DRIVE INFORMATION

DRIVE S.F. : 1.4

FAN SHV QTY	1	FAN SHV PART NUMBER	2TA40
FAN BSH QTY	1	FAN BSH PART NUMBER	P1 X1-11/16
MTR SHV QTY	1	MTR SHV PART NUMBER	2AK44H
MTR BSH QTY	1	MTR BSH PART NUMBER	H X1-3/8
BELT QTY	2	BELT PART NUMBER	AX85

CERTIFIED DRAWING PACKET*

FAN CERTIFIED DRAWING.................................. Dwg# N01467-100-2
BELT GUARD.. Dwg# N01467-101-3
UNITARY BASE.. Dwg# N01467-102-4 Rev A
ISOLATION... Dwg# N01467-102-5

ADDITIONAL ACCESSORIES

SHAFT & BEARING GUARD
DRAIN
FLUSH BOLTED CLEAN-OUT DOOR LOCATED AT 9:00 O'CLOCK
NOMINALLY AIRTIGHT CONSTRUCTION

VI. 22668 SUP. 148
SHT. 4607-4863
Bldg. Exhaust Skid

ADDITIONAL INFORMATION

NUMBER OF DRAWING SETS : 5
ESTIMATED SHIPPING WT. : 539 lbs.
(includes fan, motor, & pertinent accessory weights)

* DRAWINGS ARE FOR CONSTRUCTION PURPOSES
SEE SECOND PAGE (Dwg 1a) FOR ADDITIONAL NOTES

nyb The New York Blower Company
7660 Quincy Street, Willowbrook, IL 60521

Pressure Blower - ST
SIZE 2306S

Date 02/20/96 Certified JKM
Drawing No. N01467-100-1 Rev. A

HDCOVER

ELLIS & WATTS

PURCHASE ORDER : 302839

TAG :

ADDITIONAL NOTES

- MOTOR MFG: SIEMENS
- ADD TO FURNISH (304 SST) TO THE AIRSTREAM AND C.O. DOOR.
- ADD TO FURNISH (316 SST) TO THE DRAIN, DRAIN PLUG, AND BUNA SHAFT SEAL.
- ADD TO FURNSIH A UNITARY BASE WITH AN OVERALL LENGTH OF 53-3/16".

REV A: CHANGED UNITARY BASE DIMENSIONS TO MEET CUSTOMER'S SPECIFICATIONS.

nyb The New York Blower Company
7660 Quincy Street, Willowbrook, IL 60521

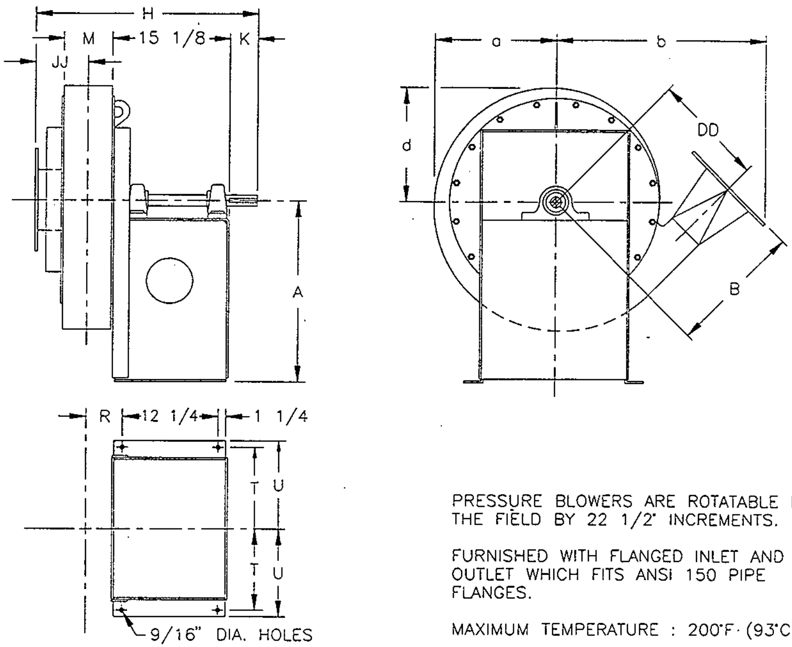
Pressure Blower - ST
SIZE 2306S

Date 02/20/96 Certified JKM
Drawing No. N01467-100-1a Rev. A

ELLIS & WATTS

PURCHASE ORDER: 302839

TAG:



PRESSURE BLOWERS ARE ROTATABLE IN THE FIELD BY 22 1/2° INCREMENTS.

FURNISHED WITH FLANGED INLET AND OUTLET WHICH FITS ANSI 150 PIPE FLANGES.

MAXIMUM TEMPERATURE : 200°F (93°C)

ITEM	DIMENSIONS in	DIMENSIONS mm
A	26 5/8	676
B	19	483
H	29 5/8	752
L	8 5/8	219
M	5	127
R	3 7/8	98
T	10 7/8	276
U	11 3/4	298
DD	17 5/8	448
JJ	7	178
a	18 7/8	479
b	29 13/16	757
d	17 11/16	449
SHAFT DIAM.	1 11/16	–
KEYWAY	3/8	–

FLANGED OUTLET	DIMENSIONS in	DIMENSIONS mm
I.D.	6	152
B.C.	9 1/2	241
O.D.	11	279
NO. HOLES	8	–
DIA. HOLES	7/8	22

FLANGED INLET	DIMENSIONS in	DIMENSIONS mm
I.D.	8	203
B.C.	11 3/4	298
O.D.	13 1/2	343
NO. HOLES	8	–
DIA. HOLES	7/8	22

TOLERANCE: ± 1/8" (± 3mm)

nyb The New York Blower Company

7660 Quincy Street, Willowbrook, IL 60521

PRESSURE BLOWER

SIZE 2306 CCW BAU

Date 02-05-96 Certified JKM

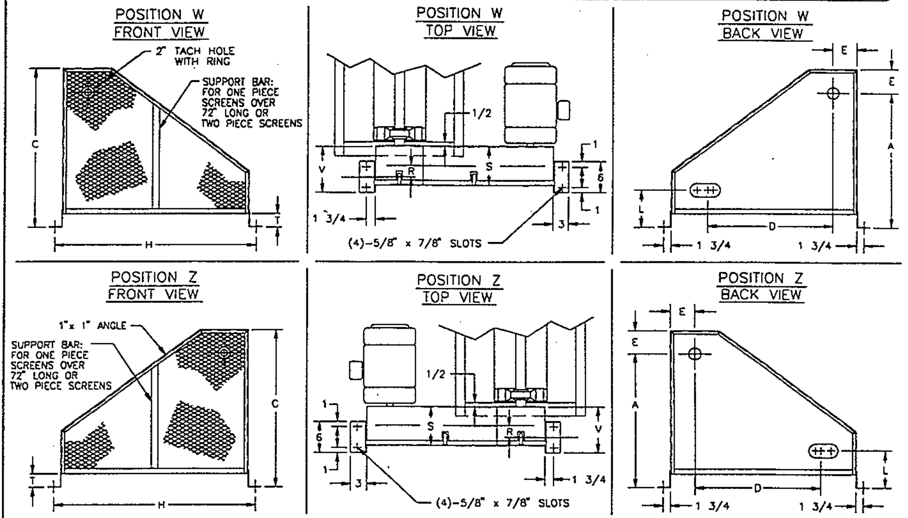
Drawing No. N01467-100-2 Rev. ____

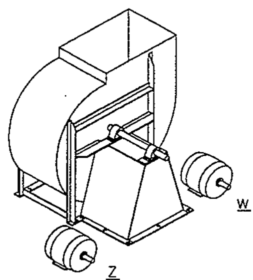
81R

ELLIS & WATTS

PURCHASE ORDER : 302839

TAG :





AMCA STANDARD MOTOR POSITIONS

MOTOR POSITIONS ARE DETERMINED BY VIEWING FAN FROM DRIVE SIDE, AND SELECTING W OR Z.

CONSTRUCTION FEATURES

1. DIM."L" IS BASED ON MOTOR MOUNTED ON NEMA SLIDE BASE AND WITH SUPPORT CHANNEL WHEN UNITARY BASE IS FURNISHED BY THE NEW YORK BLOWER COMPANY.
2. DIM."R" IS FROM CENTERLINE OF GUARD TO CENTERLINE OF FOOT.
3. GUARD FEET MAY BE OFFSET TO CLEAR BEARING PEDESTAL BASE BAR.
4. REMOVABLE FRONT IS ATTACHED WITH SPRING HOOK CLAMPS.

DIMENSIONS

A	26-5/8
C	30-7/8
D	32-1/16
E	4-1/4
H	46-3/8
L	8-7/16
R	0
S	7
T	3
V	6-1/2

TOLERANCE: ±1/8" (±3mm)

Approx. Wt.(lbs): 82

nyb | The New York Blower Company

7660 Quincy Street, Willowbrook, IL 60521

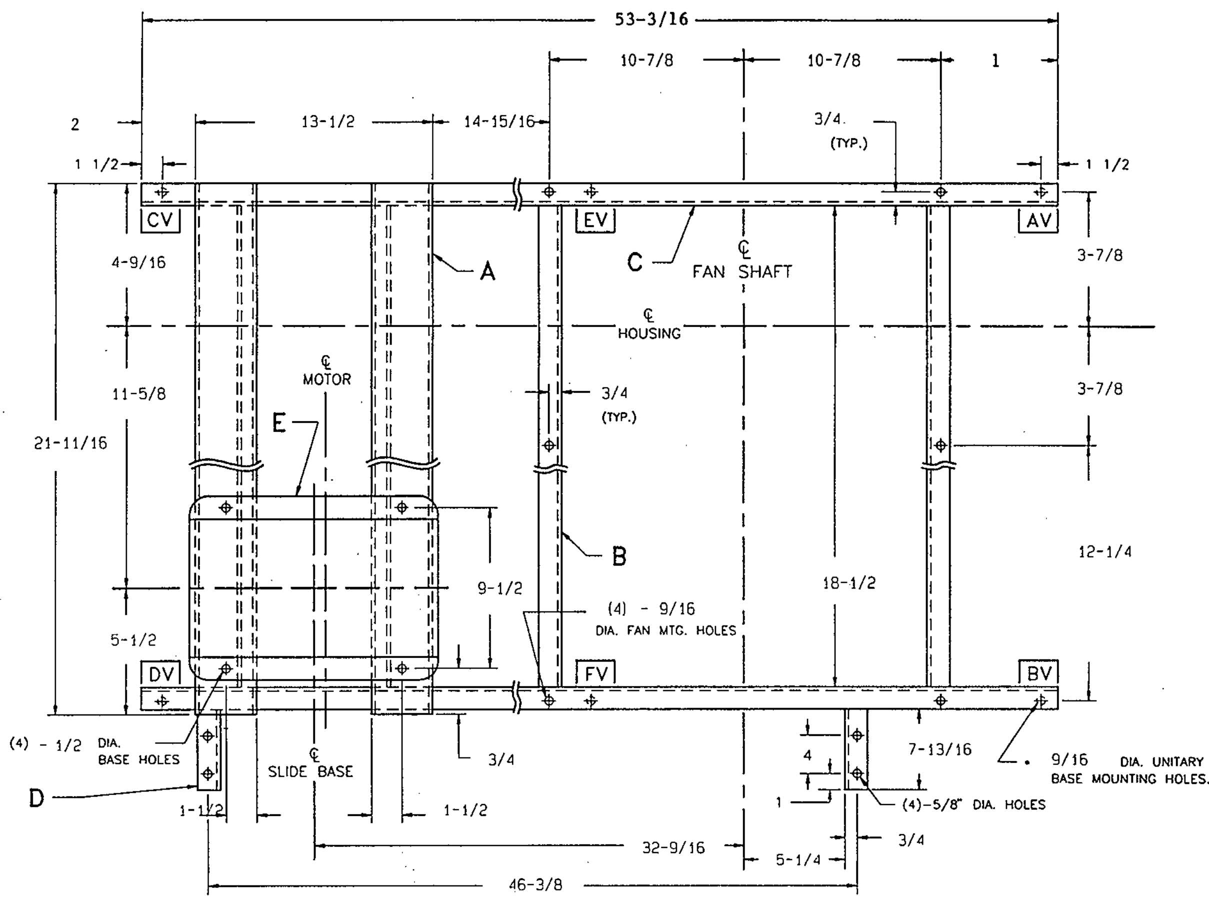
ARR. 1 BELT GUARD

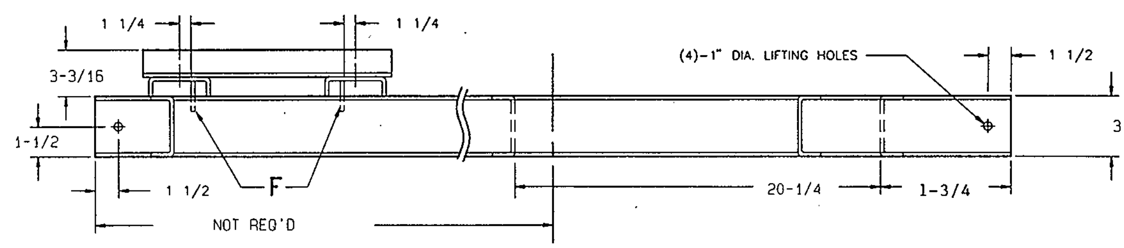
Pressure Blower - ST SIZE 2306S

Date 02/5/96 Certified JKM

Drawing No. N01467-101-3 Rev.

FM18_2





BILL OF MATERIAL

A	3"x 4.1#	x	21-11/16	LG.CHANNEL 2 REQ'D.
B	3"x 4.1#	x	18-1/2	LG.CHANNEL 2 REQ'D.
C	3"x 4.1#	x	53-3/16	LG.CHANNEL 2 REQ'D.
D	3"x 4.1#	x	7-13/16	LG.CHANNEL 2 REQ'D (USED WHEN BELT GUARD IS SPECIFIED.)
E	FRAME 213T			MOTOR SLIDE BASE BOLTED TO UNITARY BASE
F				LG.BAR 2 REQ'D (326 FRAME AND LARGER)

•WHEN BASE CHANNEL "C" IS 100" OR LESS, 4 BASE MOUNTING HOLES REQUIRED. WHEN BASE CHANNEL "C" IS MORE THAN 100", 6 BASE MOUNTING HOLES REQUIRED.

DWG. NOT TO SCALE

TOLERANCE: ±1/8"

DIMENSIONS SHOULD NOT BE USED FOR CONSTRUCTION PURPOSES UNLESS CERTIFIED.

DATE 02/05/1996 CERTIFIED JKM CONTROL NO. 102

CUSTOMER'S NO. 302839
CUSTOMER'S NAME ELLIS & WATTS
TAG

SIZE 2306S TYPE Pressure Blower - ST CLASS NONE QTY. 1
BELT CENTERS 36-7/8

ISOLATORS (WHEN REQ'D)
AV OCT-1 RED-3 DV OCT-1 RED-3
BV OCT-1 YELLOW-2 EV
CV OCT-1 YELLOW-2 FV

REV. A: CHGD. U-BASB LENGTH TO MEET CUSTOMER SPECS. jkm kw 02-21-96

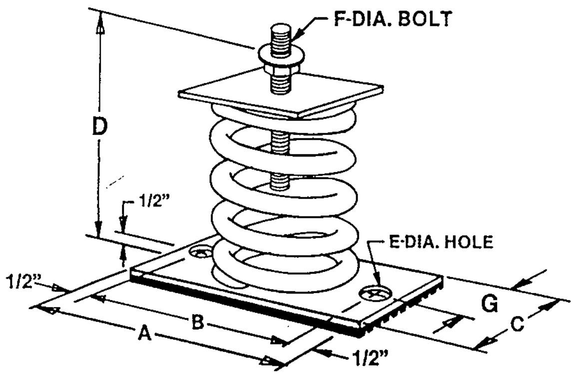
Approx. Wt.(lbs): 75 NOTE: Weight does not include weight of slide base.

CERTIFIED DRAWING | FORM NO. U-1

nyb The New York Blower Company
7660 Quincy Street-Willowbrook, IL. 60521

UNITARY BASE FOR ARR. 1 POSITION "Z" WITH STANDARD MOTOR BASE

DRAWING NUMBER
FILE N01467-102 4 A



OST1, 3, & 4

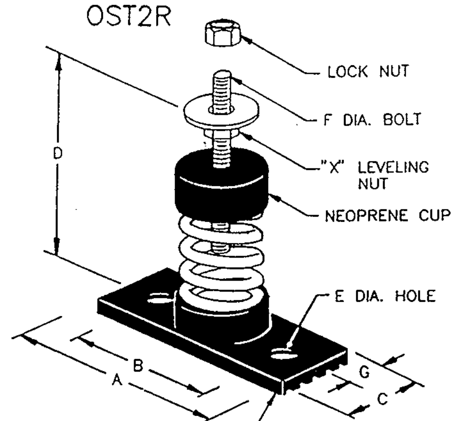
Installation Instructions:

1. Elevate base or equipment to operating height and insert blocks to hold in this position. (If jacking, lift from all brackets simultaneously - Do not place excessive load on any one bracket.)
2. Place isolators in position under bracket, base, or equipment leg. Isolators must be installed on a level surface.
3. Turn lock nut onto leveling bolt, then insert bolt down through hole in bracket or base and into threaded hole in isolator top housing.
4. Proceed to adjust isolators by turning the leveling bolt clockwise several turns at a time alternately on each isolator until load is transferred onto springs and base is raised uniformly off blocks. Remove the blocks.
5. Turn lock nut clockwise and secure firmly against the top of the bracket or base.
6. Mounts are now properly adjusted and ready for the equipment to be operated.

MODEL NUMBER	SPRING		ISOLATOR DIMENSIONS (INCHES)						
	O.D.	F.H.	A	B	C	D	E	F	G
OST1 - 1 thru 8	2 1/2	3 1/2	5	4	2 1/2	5 1/4	9/16	5/8	1 1/4
OST2R-F21 thru F26	1 3/4	3 1/8	4	3	2 1/8	4 3/4	7/16	1/2	1 1/16
OST3 -F30 thru F41	2 7/8	4 1/4	6	5	3	6	9/16	5/8	1 1/2
OST4 -F50 thru F59	4 1/2	6 1/2	7	6	4 1/2	8 1/4	9/16	3/4	2 1/4

TOLERANCE ± ⅛"

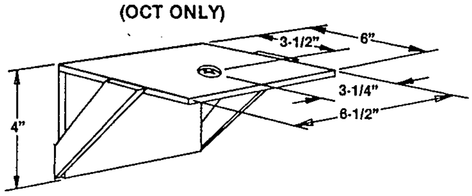
OST2R

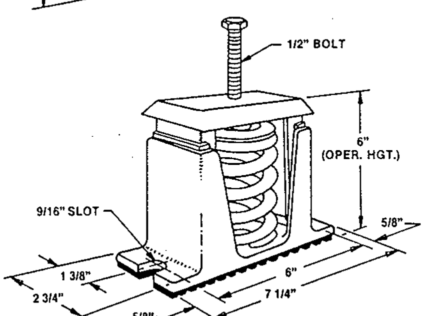


MATCHING BRACKET—OCT ONLY

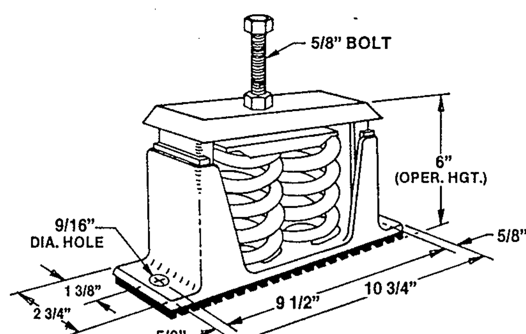
(OPTIONAL: FOR HEIGHT SAVING CLIP BASES ONLY)

MATCHING BRACKET (OCT ONLY)





OCT 1



OCT 2

Dimensions should not be used for construction purposes unless certified.

DATE 02-05-96 CERTIFIED jkm kw CONTROL NO. 102

CUSTOMER'S NO. 302839
CUSTOMER'S NAME ELLIS & WATTS
TAG

QTY.	MODEL NO.	COLOR
2	OCT 1-2	YELLOW
2	OCT 1-3	RED

CERTIFIED DRAWING | FORM NO. V-4 C

7660 Quincy Street
Willowbrook, Illinois 60521

nyb | The New York Blower Company

OCT (HOUSED), & OST SPRING ISOLATORS for FLOOR MOUNTING

DRAWING NUMBER
FILE N01467-102-5

The
New York Blower
Company®
7660 QUINCY STREET – WILLOWBROOK, ILLINOIS 60521-5596

INSTALLATION
MAINTENANCE,
OPERATING
INSTRUCTIONS

IM-140

PRESSURE BLOWERS

CAUTION

THIS MACHINE HAS MOVING PARTS THAT CAN CAUSE SERIOUS BODILY INJURY. BEFORE OPERATING OR PERFORMING MAINTENANCE, THE FOLLOWING PRECAUTIONS MUST BE TAKEN.

1. MAKE SURE ALL MOVING PARTS ARE SHIELDED FROM PERSONNEL AND FALLING OBJECTS.
2. READ THE INSTALLATION AND MAINTENANCE INSTRUCTIONS, AS WELL AS THE RECOMMENDED SAFETY PRACTICES MANUAL FURNISHED WITH THIS UNIT.
3. DO NOT OPERATE AT SPEEDS OR TEMPERATURES HIGHER THAN PUBLISHED FOR THE SPECIFIC OPERATING CONDITIONS FOR WHICH THE MACHINE WAS PURCHASED.

A FAILURE TO TAKE THESE PRECAUTIONS COULD RESULT IN SERIOUS BODILY INJURY AND PROPERTY DAMAGE.

98-0250

A WORD ABOUT SAFETY

The above CAUTION decal appears on all nyb fans. Air moving equipment involves electrical wiring, moving parts, and air velocity or pressure which can create safety hazards if the equipment is not properly installed, operated and maintained. To minimize this danger, follow these instructions as well as the additional instructions and warnings on the equipment itself.

All installers, operators and maintenance personnel should study AMCA Publication 410, "Recommended Safety Practices for Air Moving Devices", which is included as part of every shipment. Additional copies can be obtained by writing to The New York Blower Company, 7660 Quincy Street, Willowbrook, IL 60521-5596.

ELECTRICAL DISCONNECTS

Every motor driven fan should have an independent disconnect switch to isolate the unit from the electrical supply. It should be near the fan and must be capable of being locked by maintenance personnel while servicing the unit, in accordance with OSHA procedures.

MOVING PARTS

All moving parts must have guards to protect personnel. Safety requirements vary, so the number and type of guards needed to meet company, local and OSHA standards must be determined and specified by the user. Never start a fan without having all safety guards installed. Check regularly for damaged or missing guards and do not operate any fan with guards removed. Fans can also become dangerous because of potential "windmilling," even though all electrical power is disconnected. Always block the rotating assembly before working on any moving parts.

AIR PRESSURE AND SUCTION

In addition to the normal dangers of rotating machinery, fans present another hazard from the suction created at the fan inlet. This suction can draw materials into the fan where they become high velocity projectiles at the outlet. It can also be extremely dangerous to persons in close proximity to the inlet, as the forces involved can overcome the strength of most individuals. Inlets and outlets that are not ducted should be screened to prevent entry and discharge of solid objects.

ACCESS DOORS

DANGER

DO NOT OPEN UNTIL THE POWER SUPPLY HAS BEEN LOCKED OFF AND THE SHAFT HAS STOPPED ROTATING.

FAILURE TO DO THIS CAN RESULT IN SERIOUS BODILY INJURY.

98-0249

The above DANGER decal is placed on all nyb cleanout doors. These doors, as well as access doors to the duct system, should never be opened while the fan is in operation. Serious injury could result from the effects of air pressure or suction.

Bolted doors must have the door nuts or fasteners securely tightened to prevent accidental or unauthorized opening.

The fan and accessories should be inspected on receipt for any shipping damage. Turn the wheel by hand to see that it rotates freely and does not bind. If dampers are provided, check these accessories for free operation of all moving parts.

F.O.B. factory shipping terms require that the receiver be responsible for inspecting the equipment upon arrival. Note damage or shortages on the Bill of Lading and file any claims for damage or loss in transit. nyb will assist the customer as much as possible; however, claims must be originated at the point of delivery.

HANDLING AND STORAGE

Fans should be lifted by the base, mounting supports, or lifting eyes only. Never lift a fan by the wheel, shaft, motor, motor bracket, housing inlet, outlet, or any fan part not designed for lifting. A spreader should always be used to avoid damage.

On a direct drive Arrangement 8 fan, lifting holes are provided in the motor base to assist in handling the fan assembly. These lifting holes should be used in conjunction with the lifting eyes when lifting and positioning the fan onto its foundation. A heavy round steel bar or appropriate fixture can be passed through the lifting holes to simplify attachment of the lifting device. Be sure to follow all local safety codes when moving heavy equipment.

Whenever possible, fans and accessories should be stored in a clean, dry location to prevent rust and corrosion of steel components. If outdoor storage is necessary, protection should be provided. Cover the inlet and outlet to prevent the accumulation of dirt and moisture in the housing. Cover motors with waterproof material. Refer to the bearing section for further storage instructions.

Check dampers for free operation and lubricate moving parts prior to storage. Inspect the stored unit periodically. Rotate the wheel by hand every two weeks to redistribute grease on internal bearing parts.

FAN INSTALLATION

nyb wheels are dynamically balanced when fabricated. Complete fans are test run at operating speeds to check the entire assembly for conformance to nyb vibration limits. Nevertheless, all units must be adequately supported for smooth operation. Ductwork or stacks should be independently supported as excess weight may distort the fan housing and cause contact between moving parts. Where vibration isolators are used, consult the certified drawing for proper location and adjustment.

Slab-Mounted Units

A correctly designed and level concrete foundation provides the best means of installing floor-mounted fans. The mass of the base must maintain the fan/driver alignment, absorb normal vibration, and resist lateral loads. The overall dimensions of the concrete base should extend at least six inches beyond the base of the fan. The weight of the slab should be two to three times the weight of the rotating assembly, including the motor. The foundation requires firmly anchored fasteners such as the anchor bolts shown in Figure 1.

Move the fan to the mounting location and lower it over the anchor bolts, leveling the fan with shims around the bolts. Fasten the fan securely. When grout is used, shim the fan at least 3/4-inch from the concrete base. (See Figure 1.) When isolation is used, check the nyb certified drawing for installation instructions.

When an elevated or suspended structural steel platform is used, it must have sufficient bracing to support the unit load and prevent side sway. The platform should be of welded construction to maintain permanent alignment of all members.

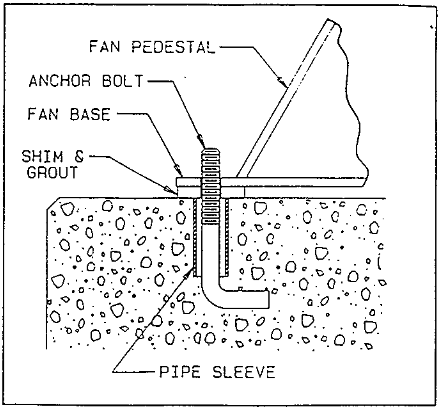


Figure 1

V-BELT DRIVE

Installation

1. Remove all foreign material from the fan and motor shafts. Coat shafts with machine oil for easier mounting. Mount the belt guard backplate at this time if partial installation is required prior to sheave mounting.
2. Mount sheaves on shafts after checking sheave bores and bushings for nicks or burrs. Avoid using force. If resistance is encountered, lightly polish the shaft with crocus cloth until the sheave slides on freely. Tighten tapered bushing bolts sequentially so that equal torque is applied to each.
3. Adjust the motor on its base to a position closest to the fan shaft. Install belts by working each one over the sheave grooves until all are in position. Never pry the belts into place. On nyb packaged fans, sufficient motor adjustment is provided for easy installation of the proper size belts.
4. Adjust sheaves and the motor shaft angle so that the sheave faces are in the same plane. Check this by placing a straightedge across the faces of the sheaves. Any gap between the edge and sheave faces indicates misalignment. Important: This method is only valid when the width of the surface between the belt edge and the sheave face is the same for both sheaves. When they are not equal, or when using adjustable-pitch sheaves, adjust so that all belts have approximately equal tension. Both shafts should be at the right angles to the center belt.

Belt Tensioning

1. Check belt tension with a tensioning gage and adjust using the motor slide base. Excess tension shortens bearing life while insufficient tension shortens belt life, can reduce fan performance and may cause vibration. The lowest allowable tension is that which prevents slippage under full load. Belts may slip during startup, but slipping should stop as soon as the fan reaches full speed. For more precise tensioning methods, consult the drive manufacturer's literature.

2. Recheck setscrews, rotate the drive by hand and check for rubbing, then complete the installation of the belt guard.
3. Belts tend to stretch somewhat after installation. Recheck tension after several days of operation. Check sheave alignment as well as setscrew and/or bushing bolt tightness.

COUPLING

Coupling alignment should be checked after installation and prior to start up. Alignment is set at the factory, but shipping, handling and installation can cause misalignment. Also check for proper coupling lubrication. For details on lubrication and for alignment tolerances on the particular coupling supplied, see the manufacturer's installation and maintenance supplement in the shipping envelope.

Installation

Most **nyb** fans are shipped with the coupling installed. In cases where the drive is assembled after shipping, install the coupling as follows:

1. Remove all foreign material from fan and motor shafts and coat with machine oil for easy mounting of coupling halves.
2. Mount the coupling halves on each shaft, setting the gap between the faces specified by the manufacturer. Avoid using force. If mounting difficulty is encountered, lightly polish the shaft with crocus cloth until the halves slide on freely.

Alignment

1. Align the coupling to within the manufacturer's limits for parallel and angular misalignment (see Figure 2). A dial indicator can also be used for alignment where greater precision is desired. Adjustments should be made by moving the motor to change shaft angle, and by the use of foot shims to change motor shaft height. Do not move the fan shaft or bearing.
2. When correctly aligned, install the flexible element and tighten all fasteners in the coupling and motor base. Lubricate the coupling if necessary.
3. Recheck alignment and gap after a short period of operation, and recheck the tightness of all fasteners in the coupling assembly.

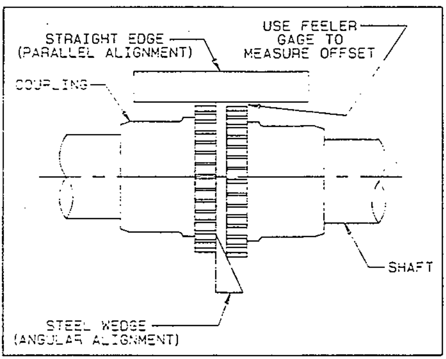


Figure 2

START-UP

Safe operation and maintenance includes the selection and use of appropriate safety accessories for the specific installation. This is the responsibility of the system designer and requires consideration of equipment location and accessibility as well as adjacent components. All safety accessories must be installed properly prior to start up.

Safe operating speed is a function of system temperature and wheel design. Do not under any circumstances exceed the maximum safe fan speed published in the **nyb** bulletin, which is available from your **nyb** field sales representative.

Procedure

1. If the drive components are not supplied by **nyb**, verify with the manufacturer that the starting torque is adequate for the speed and inertia of the fan.
2. Inspect the installation prior to starting the fan. Check for any loose items or debris that could be drawn into the fan or dislodged by the fan discharge. Check the interior of the fan as well. Turn the wheel by hand to check for binding.
3. Check drive installation and belt tension.
4. Check the tightness of all setscrews, nuts and bolts. **Wheel bushing bolts should be torqued to 9 lb.-ft.** When furnished, tighten hub setscrews with the wheel oriented so that the setscrew is positioned underneath the shaft.
5. Install all remaining safety devices and guards. Verify that the supply voltage is correct and wire the motor. "Bump" the starter to check for proper wheel rotation.
6. Use extreme caution when testing the fan with ducting disconnected. Apply power and check for unusual sounds or excessive vibration. If either exists, see the section on Common Fan Problems. To avoid motor overload, do not run the fan for more than a few seconds if ductwork is not fully installed. On larger fans, normal operating speed may not be attained without motor overload unless ductwork is attached. Check for correct fan speed and complete the installation. Ductwork and guards must be fully installed for safety.
7. Setscrews should be rechecked after a few minutes, eight hours and two weeks of operation (see Tables 1 & 2 for correct tightening torques).

WHEEL SETSCREW TORQUES

Setscrew Size Diameter (in.)	Carbon Steel Setscrew Torque*	
	lb.-in.	lb.-ft.
1/2"	600	50

Table 1

* Stainless Steel setscrews are not hardened and should not be tightened to more than 1/2 the values shown.

BEARING SETSCREW TORQUE, lb.-in.

Setscrew Diameter	Manufacturer				
	Link-Belt	Sealmaster	SKF	McGill	Dodge
1/4"	90	65	50	85	---
5/16"	185	125	165	165	160

Table 2

Note: Split pillow block bearings are fixed to the shaft with tapered sleeves and generally do not have setscrews.

FAN MAINTENANCE

nyb fans are manufactured to high standards with quality materials and components. Proper maintenance will ensure a long and trouble-free service life.

Do not attempt any maintenance on a fan unless the electrical supply has been completely disconnected and locked. In many cases, a fan can windmill despite removal of all electrical power. The rotating assembly should be blocked securely before attempting maintenance of any kind.

The key to good fan maintenance is regular and systematic inspection of all fan parts. Inspection frequency is determined by the severity of the application and local conditions. Strict adherence to an inspection schedule is essential.

Regular fan maintenance should include the following:

1. Check the fan wheel for any wear or corrosion, as either can cause catastrophic failures. Check also for the build up of material which can cause unbalance resulting in vibration, bearing wear and serious safety hazards. Clean or replace the wheel as required.

NOTE: Shut the fan down immediately if there is any sudden increase in fan vibration.

2. Check the V-belt drive for proper alignment and tension (see section on V-belt drives). If belts are worn, replace them as a set, matched to within manufacturer's tolerances. Lubricate the coupling of direct-drive units and check for alignment (see section on couplings).
3. Lubricate the bearings, but do not overlubricate (see the bearing section for detailed specifications).
4. Ceramic-felt shaft seals require no maintenance, although worn seals should be replaced. When lip-type shaft seals are provided, lubricate them with "NEVER-SEEZ" or other anti-seize compound.
5. During any routine maintenance, all setscrews and bolts should be checked for tightness. See the table for correct torques.
6. When installing a new wheel, the proper wheel-to-inlet clearance must be maintained (see Figure 3).

WHEEL BALANCE

Airstreams containing particulate or chemicals can cause abrasion or corrosion of the fan parts. This wear is often uneven and can lead to significant wheel unbalance over time. When such wear is discovered, a decision must be made as to whether to rebalance or replace the wheel.

The soundness of all parts should be determined if the original thickness of components is reduced. Be sure there is no hidden structural damage. The airstream components should also be cleaned to remove any build up of foreign material. Specialized equipment can be used to rebalance a cleaned wheel that is considered structurally sound.

Balance weights should be rigidly attached at a point that will not interfere with the housing nor disrupt airflow. Remember that centrifugal forces can be extremely high at the outer radius of a fan wheel. Welding is the preferred method of balance weight attachment. Be sure to ground the welder directly to the fan wheel. Otherwise, the welding current could pass through the fan bearings and destroy them.

WHEEL-INLET CLEARANCE

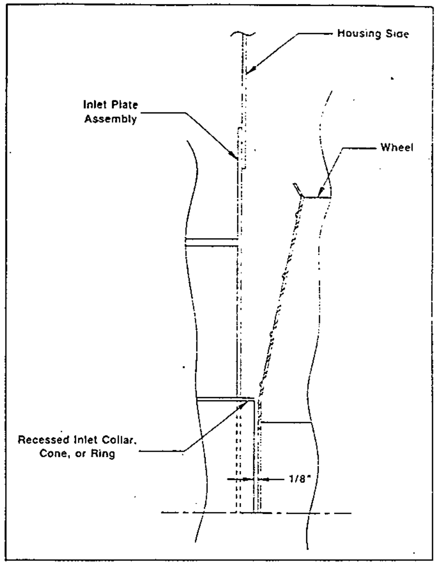


Figure 3

BEARINGS

Storage

Any stored bearing can be damaged by condensation caused by temperature variations. Therefore, nyb fan bearings are filled with grease at the factory to exclude air and moisture. Such protection is adequate for shipment and subsequent immediate installation.

For long term or outdoor storage, mounted bearings should be regreased and wrapped with plastic for protection. Rotate the fan wheel by hand at least every two weeks to redistribute grease on internal bearing parts. Each month the bearings should be purged with new grease to remove condensation, since even a filled bearing can accumulate moisture. Use caution when purging, as excessive pressure can damage the seals. Rotate the shaft while slowly adding grease.

Operation

Check setscrew torque before startup (see table for correct values). Since bearings are completely filled with grease at the factory, they may run at an elevated temperature during initial operation. Surface temperatures may reach 180°F. and grease may bleed from the bearing seals. This is normal and no attempt should be made to replace lost grease. Bearing surface temperatures will decrease when the internal grease quantity reaches a normal operating level. Relubrication should follow the recommended schedule.

Lubrication

Use the table for relubrication scheduling according to operating speed and shaft diameter. Bearings should be lubricated with a good quality lithium-based grease conforming to NLGI Grade 2 consistency. Examples are:

Mobil	—	Mobilith 22
Texaco	—	Premium RB
Standard Oil	—	Amolith #2
Gulf Oil	—	Gulf Crown #2
Shell	—	Alvania #2

Do not use "high temperature" greases, as many are not formulated for the high speeds associated with fan bearings.

Add grease to the bearing while running the fan or rotating the shaft by hand. Be sure all guards are in place if lubrication is performed while the fan is operating. Add just enough grease to cause a slight purging at the seals. Do not overlubricate.

Split pillowblock bearings (Link-Belt P-LB6800 & P-LB6900, SKF SAF 22500) should be cleaned and repacked at approximately every eighth lubrication interval. This requires removal of the bearing cap. Clean out old grease and repack the bearing with fresh grease. Pack the bearing fully and fill the housing reservoir to the bottom of the shaft on both sides of the bearing. Replace the bearing cap, being careful not to mix caps as they are not interchangeable from one bearing to another.

BEARING LUBRICATION INTERVAL

[Months]

Shaft \ RPM	1-500	501-1000	1001-1500	1501-2000	2001-2500	2501-3000	3001-3500	3501-4000
1-7/16	6 / 6	6 / 4	5-6 / 4	4-6 / 2	4-6 / 2	3-5 / 1	2-4 / 1	2-4 / 1
1-11/16	6 / 6	6 / 4	4-6 / 2	4-6 / 1	2-4 / 1	2-4 / 1	2[illegible] / 1/2	1-2 / 1/2

Upper left of diagonal: All Sealmaster & McGill; Most Link-Belt and SKF.

Lower right of diagonal: Link-Belt 22400 Series, SKF SYR Series, and Dodge S-2000 Series.

NOTE:

1. These are general recommendations only; specific manufacturer's recommendations may vary slightly.
2. Assumes clean environment, 0°F. to 120°F.
   a. Consult The New York Blower Company for operation below 0°F. ambient.
   b. Ambients greater than 120°F. may shorten bearing life.
   c. Under extremely dirty conditions, lubricate more frequently.

COMMON FAN PROBLEMS

Excessive Vibration

A common complaint regarding industrial fans is "excessive vibration." **nyb** is careful to ensure that each fan is precisely balanced prior to shipment; however, there are many other causes of fan vibration including:

1. Loose mounting bolts, setscrews, bearings or couplings.
2. Misalignment or excessive wear of bearings.
3. Misaligned or unbalanced motor.
4. Bent shaft due to mishandling or material impact.
5. Accumulation of foreign material on the wheel.
6. Excessive wear or erosion of the wheel.
7. Excessive system pressure or restriction of airflow due to closed dampers.
8. Inadequate structural support, mounting procedures or materials.
9. Externally transmitted vibration.

Inadequate Performance

1. Incorrect testing procedures or calculations.
2. Fan running too slowly.
3. Fan wheel rotating in wrong direction.
4. Wheel not properly centered relative to inlet.
5. Poor system design, closed dampers, air leaks, clogged filters or coils.
6. Obstructions or sharp elbows near inlets.
7. Sharp deflection of airstream at fan outlet.

Excessive Noise

1. Fan operating near "stall" due to incorrect system design or installation.
2. Vibration originating elsewhere in the system.
3. System resonance or pulsation.
4. Improper location or orientation of fan intake and discharge.
5. Inadequate or faulty design of supporting structures.
6. Nearby sound reflecting surfaces.
7. Loose accessories or components.
8. Loose drive belts.
9. Worn bearings.

Premature Component Failure

1. Prolonged or major vibration.
2. Inadequate or improper maintenance.
3. Abrasive or corrosive elements in the airstream or surrounding environment.
4. Misalignment or physical damage to rotating components or bearings.
5. Bearing failure from incorrect or contaminated lubricant or grounding through the bearings while arc welding.
6. Excessive fan speed.
7. Extreme ambient or airstream temperatures.
8. Improper belt tension.
9. Improper tightening of wheel bushing bolts.

REPLACEMENT PARTS

It is recommended that only factory-supplied replacement parts be used. **nyb** fan parts are built to be fully compatible with the original fan, using specific alloys and tolerances. These parts carry a standard **nyb** warranty.

When ordering replacement parts, specify the part name, **nyb** shop and control number, fan size, type, rotation (viewed from drive end), arrangement and mounting position and bearing size or bore. Most of this information is on the metal nameplate attached to the fan base.

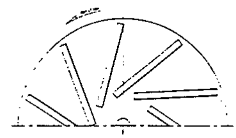
Example: Part required: Wheel
Shop/control number: B-10106-100
Fan description: Size 2206A10 Pressure Blower
Rotation: Clockwise
Arrangement: 4

Suggested spare parts include:

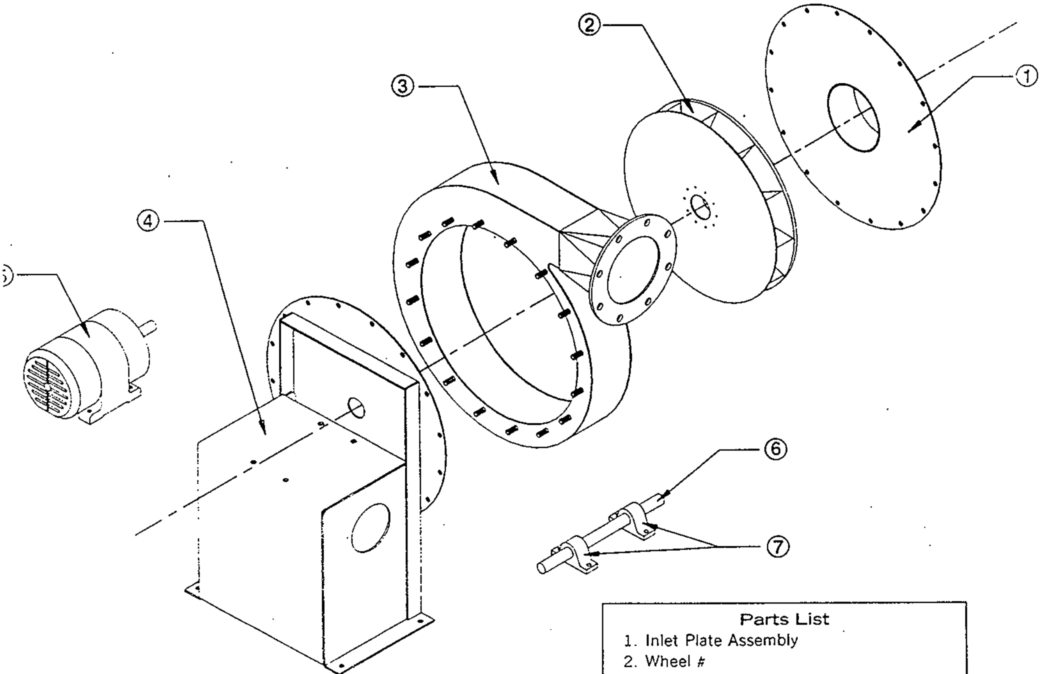
Wheel	Component parts: Damper
Shaft*	Motor
Bearings*	Coupling*
Shaft Seal*	Sheaves*
	V-Belts*

* Arrangements 1/8 only.

SPECIFY ROTATION AS VIEWED FROM DRIVE SIDE



ARROW INDICATES COUNTERCLOCKWISE ROTATION



Parts List

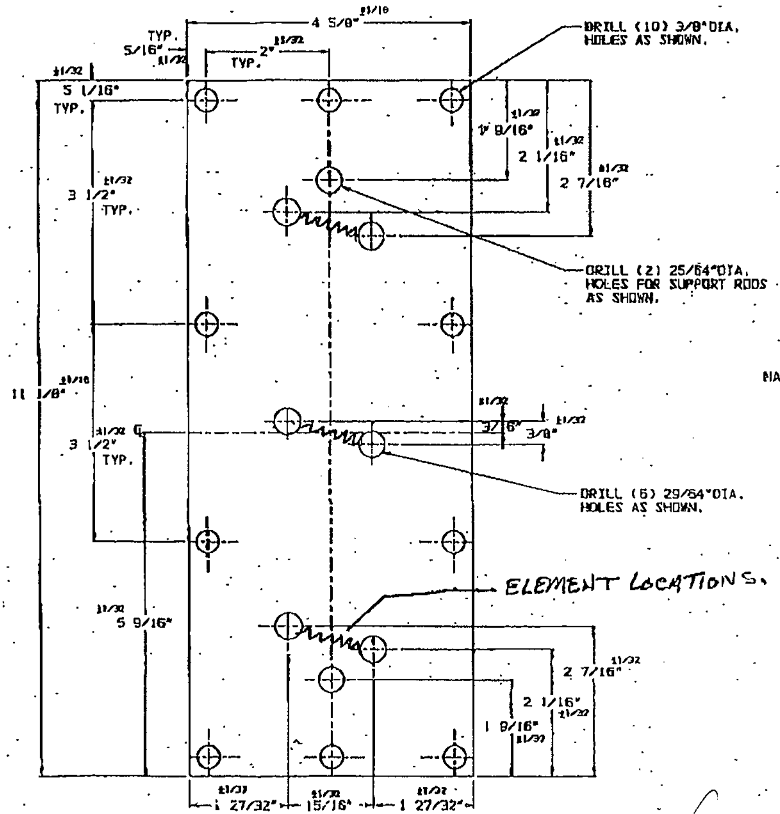
1. Inlet Plate Assembly
2. Wheel #
3. Housing #
4. Pedestal Assembly
5. Motor
6. Shaft
7. Bearings

Order for parts must specify rotation.

When ordering replacement parts supply **nyb** shop number from nameplate and complete description of parts required.

Form 291 JPR 2M ABP
Printed in U.S.A.

Revisions		
Sym.	Notes	Date



MAKE FROM: (1) #601-61-U-74
1/4" THK 304 S.STL.

ACCUTHERM INC.

Title: 1/4" THK. 304 S.STL. DUCT HTR. FLANGE DRILLING

Do not scale dwg. tolerances unless otherwise specified. Decimals .XX = ± .010 .XXX = ± .005 Angles = ± 1°. Fractions ±.

Confidential—This dwg is the exclusive property of Accu Therm Inc not to be disclosed or reproduced in whole or in part without consent of Accu Therm, Inc. and is to be returned upon request.

Scale: NOTED	Ref: SCHLEMMER	Ref. No. 423-38-156-	By
Drawn: RF Date: 1-22-96 / Approved Date	Dwg No. 376-246-11-1		Rev / Sh

DRAWING APPROVED [signature] DATE 1/26/96

APPENDIX - C

Test Pressure

PERFORMANCE CURVE

nyb The New York Blower Company

7660 Quincy Street, Willowbrook, IL 60521

To determine Performance at another RPM multiply
CFM x K
SP x K^2
BHP x K^3
where K is new RPM divided by RPM shown at right.

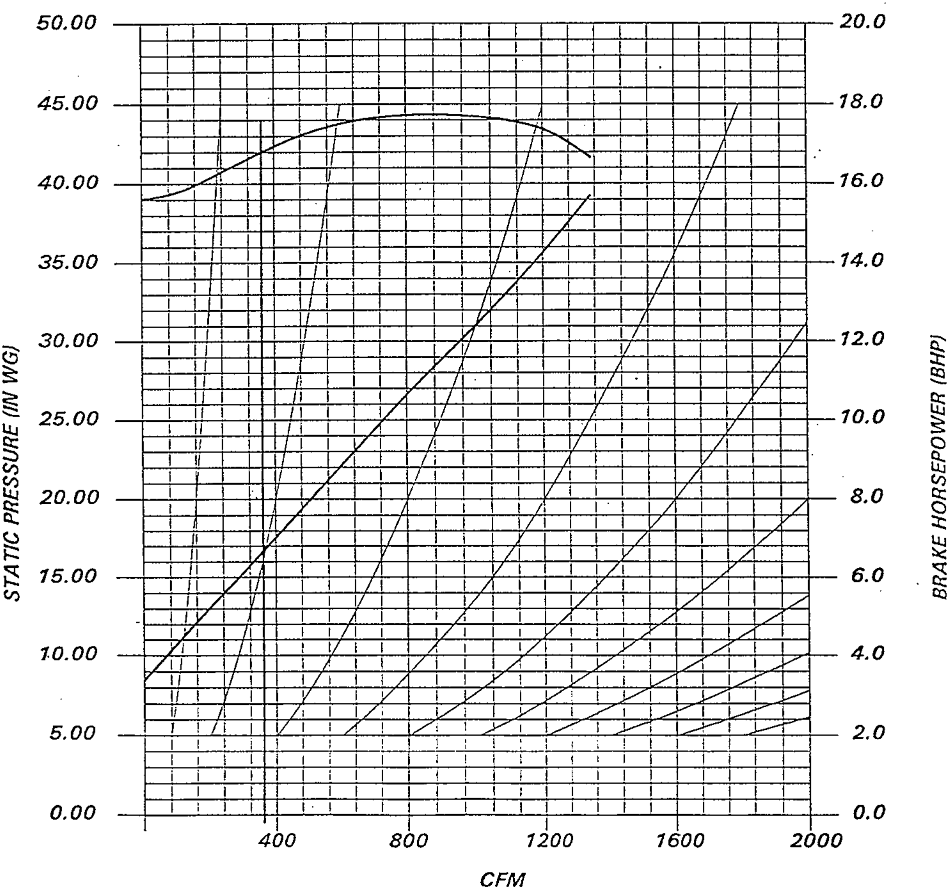
CUST. NO : *302839*
CUSTOMER : *ELLIS & WATTS*
TAGGING :
FAN TYPE : *Pressure Blower - ST*
FAN SIZE : *2306S*
CFM : *360*
SP : *42.0*
RPM : *3518*
BHP : *6.66*

CAPACITY TYPE: STD
TEMP : *70* deg F
DENS : *0.075* LB/FT³

DATE : *Feb 5 1996*

FILE : *N01467 - 100* *JKM*

PERFORMANCE OPTIONS :



ELLIS & WATTS

PURCHASE ORDER : 302839

TAG :

FAN INFORMATION

QUANTITY : 1
FAN TYPE : Pressure Blower - ST
FAN SIZE : 2306S
FAN CLASS : NONE
ROTATION : CCW
DISCHARGE : BAU
ARRANGEMENT : 1
INLET TYPE : FLANGED

MOTOR INFORMATION

ENCLOSURE : TEHI
HORSEPOWER : 7.5
RPM : 3500
ELECT. DATA : 3-60-230/460
FRAME SIZE : 213T
MOTOR POS : Z
MOTOR BY : NYB
MOUNT BY : NYB

FAN PERFORMANCE DATA

MAX SAFE SPEED : 3800 RPM at 70 Deg.

CAP	TYPE	CFM	SP	RPM	BHP	TEMP	ALT	DENSITY
1	STD.	360.0	42.00	3518	6.66	70	0.0	0.0750

DRIVE INFORMATION

DRIVE S.F. : 1.4
FAN SHV QTY : 1 FAN SHV PART NUMBER : 2TA40
FAN BSH QTY : 1 FAN BSH PART NUMBER : P1 X1-11/16
MTR SHV QTY : 1 MTR SHV PART NUMBER : 2AK44H
MTR BSH QTY : 1 MTR BSH PART NUMBER : H X1-3/8
BELT QTY : 2 BELT PART NUMBER : AX85

CERTIFIED DRAWING PACKET*

FAN CERTIFIED DRAWING.................................. Dwg# N01467-100-2
BELT GUARD.. Dwg# N01467-101-3
UNITARY BASE.. Dwg# N01467-102-4 Rev A
ISOLATION... Dwg# N01467-102-5

ADDITIONAL ACCESSORIES

SHAFT & BEARING GUARD
DRAIN
FLUSH BOLTED CLEAN-OUT DOOR LOCATED AT 9:00 O'CLOCK
NOMINALLY AIRTIGHT CONSTRUCTION

VI. 22668 SUP. 148
SHT. 4607-4863
Bldg. Exhaust Skid

ADDITIONAL INFORMATION

NUMBER OF DRAWING SETS : 5
ESTIMATED SHIPPING WT. : 539 lbs.
(includes fan, motor, & pertinent accessory weights)

*.DRAWINGS ARE FOR CONSTRUCTION PURPOSES
ECOND PAGE (Dwg 1a) FOR ADDITIONAL NOTES

nyb The New York Blower Company
7660 Quincy Street, Willowbrook, IL 60521

Pressure Blower - ST
SIZE 2306S

Date 02/20/96 Certified JKM
Drawing No. N01467-100-1 Rev. A

VER

ELLIS & WATTS

PURCHASE ORDER : 302839

TAG :

ADDITIONAL NOTES

- MOTOR MFG: SIEMENS
- ADD TO FURNISH (304 SST) TO THE AIRSTREAM AND C.O. DOOR.
- ADD TO FURNISH (316 SST) TO THE DRAIN, DRAIN PLUG, AND BUNA SHAFT SEAL.
- ADD TO FURNSIH A UNITARY BASE WITH AN OVERALL LENGTH OF 53-3/16".

REV A: CHANGED UNITARY BASE DIMENSIONS TO MEET CUSTOMER'S SPECIFICATIONS.

nyb | The New York Blower Company

7660 Quincy Street, Willowbrook, IL 60521

Pressure Blower - ST

SIZE 2306S

Date 02/20/96 Certified JKM

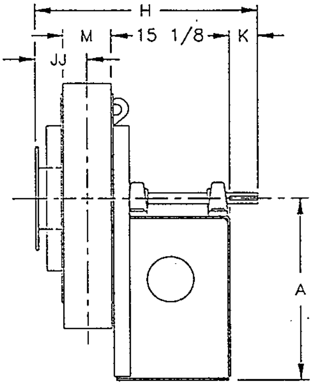
Drawing No. N01467-100-1a Rev. A

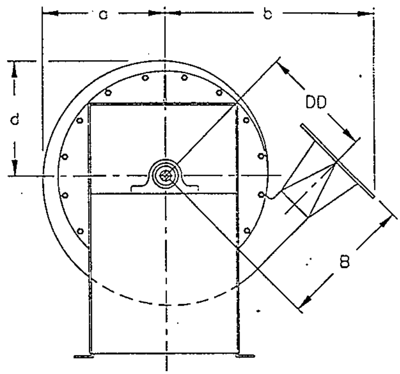
HDCOVER

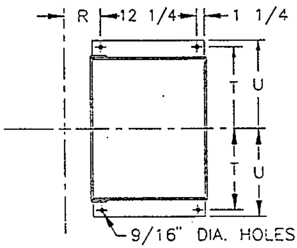
ELLIS & WATTS

PURCHASE ORDER: 302839

TAG:







PRESSURE BLOWERS ARE ROTATABLE IN THE FIELD BY 22 1/2° INCREMENTS.

FURNISHED WITH FLANGED INLET AND OUTLET WHICH FITS ANSI 150 PIPE FLANGES.

MAXIMUM TEMPERATURE : 200°F (93°C)

ITEM	DIMENSIONS	
	in	mm
A	26 5/8	676
B	19	483
H	29 5/8	752
L	8 5/8	219
M	5	127
R	3 7/8	98
T	10 7/8	276
U	11 3/4	298
DD	17 5/8	448
JJ	7	178
a	18 7/8	479
b	29 13/16	757
d	17 11/16	449
SHAFT DIAM.	1 11/16	–
KEYWAY	3/8	–

FLANGED OUTLET	DIMENSIONS	
	in	mm
I.D.	6	152
B.C.	9 1/2	241
O.D.	11	279
NO. HOLES	8	–
DIA. HOLES	7/8	22

FLANGED INLET	DIMENSIONS	
	in	mm
I.D.	8	203
B.C.	11 3/4	298
O.D.	13 1/2	343
NO. HOLES	8	–
DIA. HOLES	7/8	22

TOLERANCE: ±1/8" (±3mm)

nyb The New York Blower Company

7660 Quincy Street, Willowbrook, IL 60521

PRESSURE BLOWER
SIZE 2306 CCW BAU

Date 02-05-96 Certified JKM

Drawing No. N01467-100-2 Rev. ___

B1R

ELLIS & WATTS JOB NUMBER K0701
ELLIS & WATTS SERIAL NUMBER 15166

PARAGRAPH 5.2.20

Leak Test Records

Leak testing was performed per Ellis & Watts Procedure ENG-204, Rev. 3, Figures 1 and 2.

4 Pages Total

MANUFACTURING AND QUALITY PLAN

JOB NO: K0701 MODEL NO: ACT

CUSTOMER: Westinghouse Hanford SERIAL NO: 15166

PRODUCT NAME: Air Clean Up Train

TESTING	PERFORMED BY	DATE
1. Verify VSD/Fan/Motor Assembly Performance Testing and Run In Test per K0701-VSD, Rev. 1 (customer hold point).	EW 017K	3.22.96
2. Verify performance of electrical device and wiring check per procedure ENG-253, Rev. 0.	EW 017K	4.16.96
3. Verify performance of Housing Leak Test per procedure ENG-204, Rev. 3 (customer witness point).	EW 017K	4.15.96
4. Verify performance of Electric Heating Coil Functional Test per procedure ENG-277, Rev. 1.	EW 017K	4.16.96
5. Visual inspect unit for damage or manufacturing rework after test.	EW 017K	4.16.96
6. Verify completion of all test data sheets and forms.	EW 017K	4.16.96

FIGURE 1
HOUSING LEAK RATE TEST REPORT

E&W Job No. K0701 Customer Spec. or P.O. No. ______

Unit Serial No. 151666 Customer Name WESTINGHOUSE HANFORD

Part No. 89Y

Test Engineer (Sign/Date and Print Name) Emery S Saxton 4-15-96 EMERY S SAXTON

Inspector (Sign/Date and Print Name) [signature] 4-15-96 MEL BOGARD

Distribution:

◯ QA File ◯ Customer (if required) ◯ Other (specify) ______

Test Equip. C.I.D. No. 76026

76038

______

Test Method Used

◯ Pressure Decay, Sec. 5.1, ENG-204

◯ Direct Pressure, Sec. 5.2, ENG-204

This unit was tested in accordance with Housing Leak Rate Test Procedure ENG-204 and found to have a leak rate of 0.793 which is

☑ Less than or equal to maximum allowable leak rate of 10 CFM.

◯ Greater than the maximum allowable leak rate of ______.

If leak rate found is greater than the specified acceptance value, complete the following sections:

Leaks were located by the following method: (check one)

◯ ENG-205, Section 6.2, Bubble Method

◯ Spray D.O.P. Method

◯ Liquid Penetrant Method

◯ Other (specify) ______

The number, location and type of leaks were:

______

______

______

The defects were repaired by the removal of the defective area by:

◯ Removal of the weld and rewelding with approved Procedure ______.

◯ Other ______.

◯ Retested in accordance with E&W ENG-205, Section ______, and determined to have a leak rate of ______ which is less than or equal to maximum allowable leak rate of ______.

FIGURE 2
HOUSING LEAK RATE TEST REPORT

DATA AND CALCULATION - PRESSURE DECAY METHOD (ENG-204, Section 5.1)

E&W Job No. K0701 Customer Spec. or P.O. No. ____

Unit Serial No. 15166 Customer Name WESTINGHOUSE HANFORD CO

Part No. 89Y

Test Engineer (Sign/Date and Print Name) Emery S Saxton 4-15-96 EMERY S SAXTON

Inspector (Sign/Date and Print Name) Mel Bogard 4-15-96 MEL BOGARD

Distribution:

☐ QA File ☐ Customer (if required) ☐ Other (specify) ____

Initial Test YES Retest No. ____

I. Test Equipment Used (List description and CID No.)

1. 7626
2. 7638
3. ____

II. Conversion Factors

1" w.g.= 5.204 lb/ft²

°R = °F + 460

P_{abs} = Gage Pressure and Barometric Pressure

1" Hg= 70.73 lb/ft²

III. Test Data

V = 81.1 ft³

Barometric Pressure (BP) - 28.84 " Hg

Design Pressure (P_o) = -50 " w.g.

Time, Temperature and Pressure Readings

ti 5 min.

Ti 72 °F

Pi -50 " w.g.

Individual Pressure Readings @ 1 minute intervals

P_1 50 " w.g.	P_6 ____ " w.g.	P_{11} ____ " w.g.
P_2 46 " w.g.	P_7 ____ " w.g.	P_{12} ____ " w.g.
P_3 38 " w.g.	P_8 ____ " w.g.	P_{13} ____ " w.g.
P_4 36 " w.g.	P_9 ____ " w.g.	P_{14} ____ " w.g.
P_5 30 " w.g.	P_{10} ____ " w.g.	P_{15} ____ " w.g.

tf = 15 min. or t @ 75% P_o = 5 min.

Tf = 72⁶ °F

Pf = 30 P_{15} or 75% P_o = ____ " w.g.

FIGURE 2
HOUSING LEAK RATE TEST REPORT

DATA AND CALCULATION - PRESSURE DECAY METHOD (ENG-204, Section 5.1)

E&W Job No. K0701 Customer Spec. or P.O. No. ______

Unit Serial No. 151666 Customer Name WESTINGHOUSE HANFORD CO.

Part No. 89 Y

Test Engineer (Sign/Date and Print Name) Emery S Saxton 4-15-96 EMERY S SAXTON

Inspector (Sign/Date and Print Name) Mel Bogard 4.15.96 MEL BOGARD

Distribution:

△ QA File △ Customer (if required) △ Other (specify) ______

IV. Calculation of Leak Rate

A. Conversion of Readings

1. Convert °F to °R

Ti = 72 °F + 460 = 532 °R

Tf = 72 °F + 460 = 532 °R

2. Convert P (" w.g.) to P (lb/ft²)

Pi = -50 " w.g. x 5.204 = -260.20 lb/ft²

Pf = -30 " w.g. x 5.204 = -156.12 lb/ft²

3. Convert BP ("Hg) to BP (lb/ft²)

BP = 28.84 " Hg x 70.73 = 2039.85 lb/ft²

4. Convert P_{gage} to P_{abs}

$$Pi_{(abs)}\ (lb/ft^2) = Pi\ (lb/ft^2) + BP\ (lb/ft^2)$$

$$Pf_{(abs)}\ (lb/ft^2) = Pf\ (lb/ft^2) + BP\ (lb/ft^2)$$

B. Leak Rate

$$\overline{Q} = \left(\frac{Pi}{Ti} - \frac{Pf}{Tf}\right)\left(\frac{81.1\ V}{R_A \Delta t\ (0.075\ lb/ft^2)}\right)$$

$$\overline{Q} = \left(\frac{lb/ft^2}{°R} - \frac{lb/ft^2}{°R}\right)\left(\frac{81.1\ ft^3}{(53.35\ \frac{ft-lb}{lb\ °R})\ (min.)\ (0.075\ lb/ft^2)}\right)$$

$\overline{Q}$ = 0.793 SCFM

APPENDIX - D

Structural Capability Pressure

nyb The New York Blower Company

7660 Quincy Street, Willowbrook, IL 60521

PERFORMANCE CURVE

To determine Performance at another RPM multiply
CFM x K
SP x K^2
BHP x K^3
where K is new RPM divided by RPM shown at right.

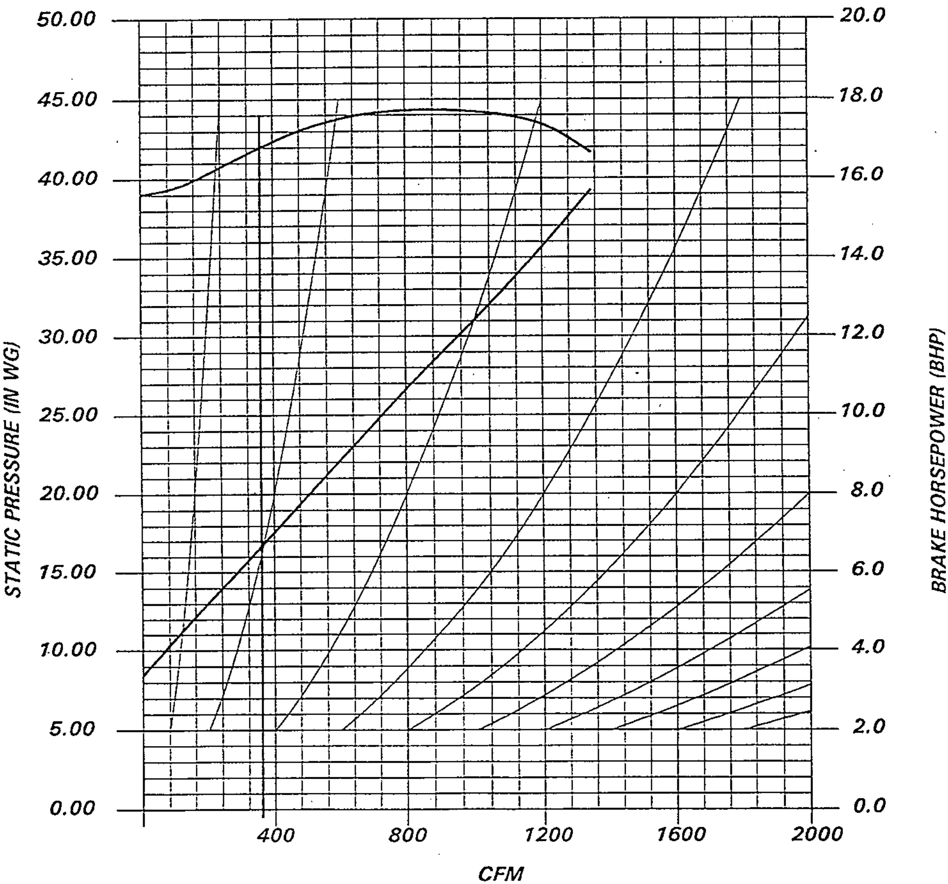
CUST. NO : *302839*
CUSTOMER : *ELLIS & WATTS*
TAGGING :
FAN TYPE : *Pressure Blower - ST*
FAN SIZE : *2306S*
CFM : *360*
SP : *42.0*
RPM : *3518*
BHP : *6.66*

CAPACITY TYPE: STD
TEMP : *70* deg F
DENS : *0.075* LB/FT^3

DATE : *Feb 5 1996*

FILE : *N01467 - 100* *JKM*

PERFORMANCE OPTIONS :



ELLIS & WATTS

PURCHASE ORDER : 302839

TAG :

FAN INFORMATION

QUANTITY : 1
FAN TYPE : Pressure Blower - ST
FAN SIZE : 2306S
FAN CLASS : NONE
ROTATION : CCW
DISCHARGE : BAU
ARRANGEMENT : 1
INLET TYPE : FLANGED

MOTOR INFORMATION

ENCLOSURE : TEHI
HORSEPOWER : 7.5
RPM : 3500
ELECT. DATA : 3-60-230/460
FRAME SIZE : 213T
MOTOR POS : Z
MOTOR BY : NYB
MOUNT BY : NYB

FAN PERFORMANCE DATA

MAX SAFE SPEED : 3800 RPM at 70 Deg.

CAP	TYPE	CFM	SP	RPM	BHP	TEMP	ALT	DENSITY
1	STD.	360.0	42.00	3518	6.66	70	0.0	0.0750

DRIVE INFORMATION

DRIVE S.F. : 1.4
FAN SHV QTY : 1
FAN BSH QTY : 1
MTR SHV QTY : 1
MTR BSH QTY : 1
BELT QTY : 2

FAN SHV PART NUMBER : 2TA40
FAN BSH PART NUMBER : P1 X1-11/16
MTR SHV PART NUMBER : 2AK44H
MTR BSH PART NUMBER : H X1-3/8
BELT PART NUMBER : AX85

CERTIFIED DRAWING PACKET*

FAN CERTIFIED DRAWING.................................... Dwg# N01467-100-2
BELT GUARD... Dwg# N01467-101-3
UNITARY BASE... Dwg# N01467-102-4 Rev A
ISOLATION.. Dwg# N01467-102-5

ADDITIONAL ACCESSORIES

SHAFT & BEARING GUARD
DRAIN
FLUSH BOLTED CLEAN-OUT DOOR LOCATED AT 9:00 O'CLOCK
NOMINALLY AIRTIGHT CONSTRUCTION

VI. 22668 SUP. 148
SHT. 4607-4863
Bldg. Exhaust Skid

ADDITIONAL INFORMATION

NUMBER OF DRAWING SETS : 5
ESTIMATED SHIPPING WT. : 539 lbs.
(includes fan, motor, & pertinent accessory weights)

* DRAWINGS ARE FOR CONSTRUCTION PURPOSES
SEE SECOND PAGE (Dwg 1a) FOR ADDITIONAL NOTES

nyb The New York Blower Company
7660 Quincy Street, Willowbrook, IL 60521

Pressure Blower - ST
SIZE 2306S

Date 02/20/96 Certified JKM
Drawing No. N01467-100-1 Rev. A

HDCOVER

ELLIS & WATTS

PURCHASE ORDER : 302839

TAG :

ADDITIONAL NOTES

- MOTOR MFG: SIEMENS
- ADD TO FURNISH (304 SST) TO THE AIRSTREAM AND C.O. DOOR.
- ADD TO FURNISH (316 SST) TO THE DRAIN, DRAIN PLUG, AND BUNA SHAFT SEAL.
- ADD TO FURNSIH A UNITARY BASE WITH AN OVERALL LENGTH OF 53-3/16".

REV A: CHANGED UNITARY BASE DIMENSIONS TO MEET CUSTOMER'S SPECIFICATIONS.

nyb The New York Blower Company

7660 Quincy Street, Willowbrook, IL 60521

Pressure Blower - ST

SIZE 2306S

Date 02/20/96 Certified JKM

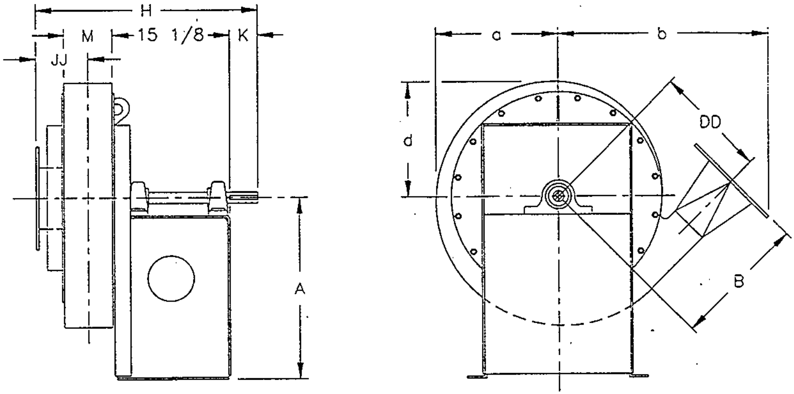
Drawing No. N01467-100-1a Rev. A

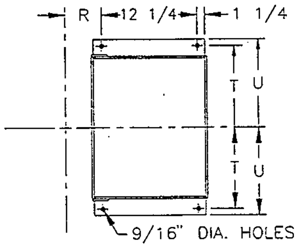
HDCOVER

ELLIS & WATTS

PURCHASE ORDER: 302839

TAG:





PRESSURE BLOWERS ARE ROTATABLE IN THE FIELD BY 22 1/2° INCREMENTS.

FURNISHED WITH FLANGED INLET AND OUTLET WHICH FITS ANSI 150 PIPE FLANGES.

MAXIMUM TEMPERATURE : 200°F (93°C)

ITEM	DIMENSIONS in	mm
A	26 5/8	676
B	19	483
H	29 5/8	752
L	8 5/8	219
M	5	127
R	3 7/8	98
T	10 7/8	276
U	11 3/4	298
DD	17 5/8	448
JJ	7	178
a	18 7/8	479
b	29 13/16	757
d	17 11/16	449
SHAFT DIAM.	1 11/16	–
KEYWAY	3/8	–

FLANGED OUTLET	DIMENSIONS in	mm
I.D.	6	152
B.C.	9 1/2	241
O.D.	11	279
NO. HOLES	8	–
DIA. HOLES	7/8	22

FLANGED INLET	DIMENSIONS in	mm
I.D.	8	203
B.C.	11 3/4	298
O.D.	13 1/2	343
NO. HOLES	8	–
DIA. HOLES	7/8	22

TOLERANCE: ± 1/8" (± 3mm)

nyb The New York Blower Company

7660 Quincy Street, Willowbrook, IL 60521

PRESSURE BLOWER
SIZE 2306 CCW BAU

Date 02-05-96 Certified JKM

Drawing No. N01467-100-2 Rev. ___

B1R

ELLIS & WATTS JOB NUMBER K0701
ELLIS & WATTS SERIAL NUMBER 15166

PARAGRAPH 5.2.20

Leak Test Records

Leak testing was performed per Ellis & Watts Procedure ENG-204, Rev. 3, Figures 1 and 2.

4 Pages Total

MANUFACTURING AND QUALITY PLAN

JOB NO: K0701 MODEL NO: ACT

CUSTOMER: Westinghouse Hanford SERIAL NO: 15166

PRODUCT NAME: Air Clean Up Train

TESTING	PERFORMED BY	DATE
1. Verify VSD/Fan/Motor Assembly Performance Testing and Run In Test per K0701-VSD, Rev. 1 (customer hold point).	EW 017 K	3-22-96
2. Verify performance of electrical device and wiring check per procedure ENG-253, Rev. 0.	EW 017 K	4-16-96
→ 3. Verify performance of Housing Leak Test per procedure ENG-204, Rev. 3 (customer witness point).	EW 017 K	4-15-96
4. Verify performance of Electric Heating Coil Functional Test per procedure ENG-277, Rev. 1.	EW 017 K	4-16-96
5. Visual inspect unit for damage or manufacturing rework after test.	EW 017 K	4-16-96
6. Verify completion of all test data sheets and forms.	EW 017 K	4-16-96

FIGURE 1
HOUSING LEAK RATE TEST REPORT

E&W Job No. K0701 Customer Spec. or P.O. No. ____________

Unit Serial No. 151 606 Customer Name WESTINGHOUSE HANFORD

Part No. 89Y

Test Engineer (Sign/Date and Print Name) Emery S Saxton 4-15-96 EMERY S SAXTON

Inspector (Sign/Date and Print Name) [signature] 4-15-96 MEL BOGARD

Distribution:

◯ QA File ◯ Customer (if required) ◯ Other (specify) ____________

Test Equip. C.I.D. No. 76026
76038
____

Test Method Used

◯ Pressure Decay, Sec. 5.1, ENG-204

◯ Direct Pressure, Sec. 5.2, ENG-204

This unit was tested in accordance with Housing Leak Rate Test Procedure ENG-204 and found to have a leak rate of 0.793 which is

☑ Less than or equal to maximum allowable leak rate of 10 CFM.

◯ Greater than the maximum allowable leak rate of ____________.

If leak rate found is greater than the specified acceptance value, complete the following sections:

Leaks were located by the following method: (check one)

◯ ENG-205, Section 6.2, Bubble Method

◯ Spray D.O.P. Method

◯ Liquid Penetrant Method

◯ Other (specify) ____________

The number, location and type of leaks were:

____

____

____

The defects were repaired by the removal of the defective area by:

◯ Removal of the weld and rewelding with approved Procedure ____________.

◯ Other ____________.

◯ Retested in accordance with E&W ENG-205, Section ____________, and determined to have a leak rate of ____________ which is less than or equal to maximum allowable leak rate of ____________.

FIGURE 2

HOUSING LEAK RATE TEST REPORT

DATA AND CALCULATION - PRESSURE DECAY METHOD (ENG-204, Section 5.1)

E&W Job No. K0701 Customer Spec. or P.O. No. ____

Unit Serial No. 15166 Customer Name WESTINGHOUSE HANFORD CO

Part No. 89Y

Test Engineer (Sign/Date and Print Name) Emery S Saxton 4-15-96 EMERY S SAXTON

Inspector (Sign/Date and Print Name) Mel Bogard 4-15-96 MEL BOGARD

Distribution:

☐ QA File ☐ Customer (if required) ☐ Other (specify) ____

Initial Test YES Retest No. ____

I. Test Equipment Used (List description and CID No.)

1. 7626
2. 7638
3. ____

II. Conversion Factors

1" w.g.= 5.204 lb/ft²

°R = °F + 460

P_{abs} = Gage Pressure and Barometric Pressure

1" Hg= 70.73 lb/ft²

III. Test Data

V = 81.1 ft³

Barometric Pressure (BP) - 28.84 " Hg

Design Pressure (P_o) = -50 " w.g.

Time, Temperature and Pressure Readings

ti 5 min.

Ti 72 °F

Pi -50 " w.g.

Individual Pressure Readings @ 1 minute intervals

P_1 50 " w.g.	P_6 ____ " w.g.	P_{11} ____ " w.g.
P_2 46 " w.g.	P_7 ____ " w.g.	P_{12} ____ " w.g.
P_3 38 " w.g.	P_8 ____ " w.g.	P_{13} ____ " w.g.
P_4 36 " w.g.	P_9 ____ " w.g.	P_{14} ____ " w.g.
P_5 30 " w.g.	P_{10} ____ " w.g.	P_{15} ____ " w.g.

tf = 15 min. or t @ 75% P_o = 5 min.

Tf = 72⁶ °F

Pf = 30 P_{15} or 75% P_o = ____ " w.g.

FIGURE 2

HOUSING LEAK RATE TEST REPORT

DATA AND CALCULATION - PRESSURE DECAY METHOD (ENG-204, Section 5.1)

E&W Job No. KO701 Customer Spec. or P.O. No. ______

Unit Serial No. 151LOLO Customer Name WESTINGHOUSE HANFORD CO.

Part No. 89Y

Test Engineer (Sign/Date and Print Name) Emery S Saxton 4-15-96 EMERY S SAXTON

Inspector (Sign/Date and Print Name) M. Bogard 4.15.96 MEL BOGARD

Distribution:

△ QA File △ Customer (if required) △ Other (specify) ______

IV. Calculation of Leak Rate

A. Conversion of Readings

1. Convert °F to °R

Ti = 72 °F + 460 = 532 °R

Tf = 72 °F + 460 = 532 °R

2. Convert P (" w.g.) to P (lb/ft²)

Pi = -50 " w.g. x 5.204 = -260.20 lb/ft²

Pf = -30 " w.g. x 5.204 = -156.12 lb/ft²

3. Convert BP ("Hg) to BP (lb/ft²)

BP = 28.84 " Hg x 70.73 = 2039.85 lb/ft²

4. Convert P_{gage} to P_{abs}

$$Pi_{(abs)}\ (lb/ft^2) = Pi\ (lb/ft^2) + BP\ (lb/ft^2)$$

$$Pf_{(abs)}\ (lb/ft^2) = Pf\ (lb/ft^2) + BP\ (lb/ft^2)$$

B. Leak Rate

$$\overline{Q} = \left(\frac{Pi}{Ti} - \frac{Pf}{Tf}\right)\left(\frac{81.1\ V}{R_A \Delta t\ (0.075\ lb/ft^2)}\right)$$

$$\overline{Q} = \left(\frac{lb/ft^2}{°R} - \frac{lb/ft^2}{°R}\right)\left(\frac{81.1\quad ft^3}{(53.35\ \frac{ft\text{-}lb}{lb\ °R})\ (min.)\ (0.075\ lb/ft^2)}\right)$$

$$\overline{Q} = 0.793\ SCFM$$

4

APPENDIX - E

Basis and Quantity for Maximim Allowable Leakage

3 REQUIREMENTS

3.1 Equipment Description: The skid mounted ACT shall include an electric heating system, 2 stages of HEPA filters, 3 HEPA filter test sections, exhaust fan and motor, variable speed drive (the variable speed drive will be mounted at a separate location), and associated housings, dampers, valves, instruments, insulation, jackets, supports, and controls, etc, to form a working unit. The skid shall have a main electrical supply (fed from the Buyer's 480 V ac, 3-phase source), via a main disconnect switch. The power shall then be distributed to supply the heater circuit (see 3.1.1) and the minipower center (see 3.1.13). A separate Buyer's 480 V ac source will supply power to the variable speed drive. The ACT shall meet the design requirements of ASME N509 (non-ESF) as detailed in the following paragraphs and the pressure decay test and in-place DOP test requirements of ASME N510, Sections 7 and 10. Interpretations and clarifications to ASME N509 are as given in Table A. Total leakage rate of ACT including fan shaft seal shall not exceed 10 ft^3/min at -50 inH_2O test pressure. The equipment configuration and dimensional requirements shall be as shown in Sketch ES-1. The equipment must be capable of supporting the stack and monitoring components provided by the Buyer as shown on Sketch ES-1.

3.1.1 Electric Heater: Heating elements shall be staggered to prevent thermal and moisture stratification. The electric heating system will normally operate with a constant inlet condition of 40°F air saturated with water vapor, and shall be required to provide a continuous minimum leaving temperature of 53°F at 60% relative humidity. The normal range of airflow will be 180 to 360 standard ft^3/min. Abnormal operating conditions may result in an inlet condition of 120°F air saturated with water vapor at a flow of 360 standard ft^3/min. Under these conditions, the leaving air temperature must be raised to 139°F in order to reduce the relative humidity to 60%. The air temperature shall not be continuously above 150°F. The heater coil shall have a zero-crossover fired silicon controlled rectifier (SCR) power controller to modulate heating capacity to reduce the relative humidity below 100% (see Sketch ES-3). A disconnecting means shall be provided for the electric heater. Heater shall be 480 V, 3-phase, 60 Hz supplied from the skid main electrical supply. Electrical design and installation work shall be in accordance with NFPA 70. The heater shall contain an internal high-high temperature switch, manual cutout switch, pneumatic type low flow switch (sail type not acceptable), and contactors. The heater shall be designed for outside use. The heater shall be shut down automatically when the fan FN-1362 is not running or trips off (interlock #14). See Data Sheet Y-324 for the associated temperature controller.

3.1.2 HEPA Filter Housings: Housings shall be bag-in, bag-out style, constructed of ASTM A 240, Type 304 Series stainless steel. Filter elements shall have 180 to 1000 ft^3/min capacity, and shall be in accordance with DOE/DP/STD-0005-91. Frame material shall be ASTM A 240, Type 304 Series stainless steel. Filters shall have neoprene gaskets, and be suitable for continuous service at 150°F, in high humidity. Pre-filters are not required. Seller shall provide filters for testing at Seller's facility. Owner will provide filters for installed operation. Service shall be from the right hand side (facing downstream).

	CALCULATION IDENTIFICATION AND INDEX	Page i of i Date 3-15-95

This sheet shows the status and description of the attached Design Analysis sheets.

Discipline 28/HVAC WO/Job No. ER4319 Calculation No. ~~W320-H-034~~ ~~W320-280~~ W320-28-034

Project No. & Name W-320 Tank 241-C-106 Waste Retrieval

Calculation Item Exhaust Skid Maximum Allowable Leakage Criteria

These calculations apply to:

Dwg. No. N/A Rev. No. N/A

Dwg. No. N/A Rev. No. N/A

Other (Study, CDR) Procurement Specifications:
W-320-P1 Exhaust Skid Rev. No. 0
preliminary

The status of these calculations is:

[] Preliminary Calculations

[x] Final Calculations

[] Check Calculations (On Calculation Dated)

[] Void Calculation (Reason Voided)

Incorporated in Final Drawings? [] Yes [X] No

This calculation verified by independent "check" calculations? [] Yes [X] No

Original and Revised Calculation Approvals:

	Rev. 0 Signature/Date	Rev. 1 Signature/Date	Rev. 2 Signature/Date
Originator	PH Lauzon(?) 3-20-95		
Checked by	[signature] 3/20/95		
Approved by	PH Lauzon(?) 3-20-95		
Checked Against Approved Vendor Data	Charles T. Li 4/16/98		

INDEX

DESIGN ANALYSIS		Calc. No. W320-H-034 Revision 0 Page No. 1 of 2
Client WHC	WO/Job No. ER4319	
Subject Exhaust Skid Maximum Allowable Leakage Criteria	Date 3-15-95	By PH Langowski
	Checked 3/20/95	By [signature]
Location 241-C/200 East	Revised	By

1.0 OBJECTIVE

The objective of this calculation is to determine the maximum allowable leakage from the Exhaust Skid per ASME N509 for input to procurement specification W320-P1.

2.0 DESIGN INPUTS

2.1 CRITERIA AND SOURCE

DOE General Order 6430.1A
Functional Design Criteria WHC-SD-W320-FDC-001, rev. 2, 1/18/94

2.2 GIVEN DATA -

1. Non-ESF (Engineered Safety Feature) per W320-P1.
2. 180 to 360 scfm exhaust flow rate per W320-P1.

2.3 ASSUMPTIONS

none.

2.4 METHODS

Hand calculations.

2.5 REFERENCES

1. W-320-P1 "Procurement Specification, Exhaust Skid Ventilation Air Cleanup Trains", rev. 0
2. ASME N509-1989 "Nuclear Power Plant Air-Cleaning Units and Components"

3.0 CALCULATIONS

Maximum allowable leakage of the Exhaust Skid is determined by following the ASME N509 (ref. 1) Appendix B information included in Appendix A of this calculation. To use Table B-3, the leakage class of the Exhaust Skid must first be determined.

The Leakage class of the Exhaust Skid is determined by Figure B-5, Scheme #10. In scheme #10, the contaminated space is the Tank 241-C-106, the interspace is the "clean" outdoors of the Tank Farm, and the protected space is also the "clean" outdoors of the Tank Farm. From Note 4, with a clean interspace and exhaust piping which is always under negative pressure for all modes of operation, the piping between the Tank and the Exhaust Skid may be leakage Class II. Figure B-5 lists the Air Cleaning Unit and the Fan as leakage Class II.

Therefore, leakage Class II, non-ESF (see given data, ref. 2) criteria will be used for Table B-3. Per Table B-3, at leakage Class II and non-ESF, a total of 6% of the rated flow is the maximum allowable leakage. Per note 1 of Table B-3, this leakage rate is applicable at operating pressure. In note 4 of Table B-3, the housing surface area to total surface area ratio is assumed to approximate the Exhaust Skid with the Exhaust Skid test sections considered as duct. Note 2 of Table B-3 gives the formula to determine the allowable leakage.

DESIGN ANALYSIS		Calc. No. W320-~~H~~-034 Revision 0 Page No. 2 of 2
Client WHC	WO/Job No. ER4319	
Subject Exhaust Skid Maximum Allowable Leakage Criteria	Date 3-15-95	By PH Langowski
	Checked 3/20/95	By [signature]
Location 241-C/200 East	Revised	By

The first component of the formula goes to unity as the surface area of the duct section (a) and the surface area of the total system ductwork per leakage class (A) are the same as when the system considered is the Exhaust Skid only. The B31.3 piping between the Tank and the Exhaust Skid does not fall under the guidelines of N509. For our purposes, the N509 system is the Exhaust Skid only. Therefore, the maximum allowable leakage rate is the product of the Table B-3 value (P) and the system rated flow (Q).

For a value of P=0.06 and Q=180 scfm, the maximum allowable leakage rate is 10.8 scfm. For a value of P=0.06 and Q=360 scfm, the maximum allowable leakage rate is 21.6 scfm.

4.0 FINDINGS & CONCLUSIONS

The Exhaust Skid maximum allowable leakage rate as specified in W320-P1 shall be 10 scfm at -50" w.g. The 10 scfm correlates to the maximum allowable at the minimum 180 scfm airflow rate. The -50" w.g. is the maximum approximate pressure at a deadheaded exhaust fan inlet and is consistent with the remainder of the Project documentation.

Vendor experience with the Ellis & Watts air cleanup train for W-030 with a maximum allowable leakage rate of 10 scfm at -32" w.g. showed an actual leakage rate of approximately 2 scfm (including the fan shaft seal). The W-030 unit is a similarly sized unit to the W-320 Exhaust Skid. Therefore, the 10 scfm criteria on the W-320 unit should not prove unobtainable.

APPENDIX A

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TCHP 3/20/95

TABLE B-3 MAXIMUM ALLOWABLE LEAKAGE[1] FOR AIR CLEANING EFFECTIVENESS (PERCENT OF RATED FLOW)

Leakage Class [Note (2)]	ESF			Non-ESF		
	Duct [Note (3)]	Housing	Total [Note (4)]	Duct [Note (3)]	Housing	Total [Note (4)]
I	0.10	0.10	...	0.50	0.10	0.6
II	1.00	0.20	1.2	5.00	1.00	6.0

NOTES:
(1) Leak rate at operating pressure
(2) Refer to Section B4 for configuration that determines leakage class. Leakage is apportioned to surface area by

$$L_S = \frac{a}{A} \times \frac{P \times Q}{100}$$

where
L_S = allowable leakage in duct section, scfm
P = allowable percent leakage
Q = system rated flow, cfm
a = surface area of the duct section, ft^2
A = surface area of the total system ductwork per leakage class, ft^2
$\frac{L_S}{a}$ = the allowable unit leakage by this criteria, cfm/ft^2

(3) All ducts under positive pressure which discharge into the plant stack for high level release credit shall be leakage Class I.
(4) Assumes housing surface area is 20% of duct surface area. Duct and housing leakages shall be adjusted for actual housing and duct surface area ratios, but the total percent leakage shall not exceed the sum of the listed percent leakages for duct and housing.

on ANSI/ASQC Z1.4 or other equivalent standard; however, this is not mandatory.

B4 NUCLEAR AIR TREATMENT SYSTEM CONFIGURATIONS AND LEAKAGE CLASSES

A nuclear air treatment system can be defined schematically in terms of three spaces and two components.

The three spaces (refer to para. 3 definitions) may be either exterior or interior and are:

(a) the contaminated space C-106
(b) the protected space the outdoors
(c) the interspace the outdoors
 (1) contaminated
 (2) clean clean

The two components are:

(d) fan
(e) air-cleaning unit

All three of the above spaces represent possible locations for the different parts of the nuclear air treatment system. The contaminated and protected spaces also include the points of system origin and termination, respectively. The interspace refers to all other spaces — contaminated or clean — where the nuclear air treatment system or its parts may be located.

Examples of contaminated space/interspace/protected space arrangements are:

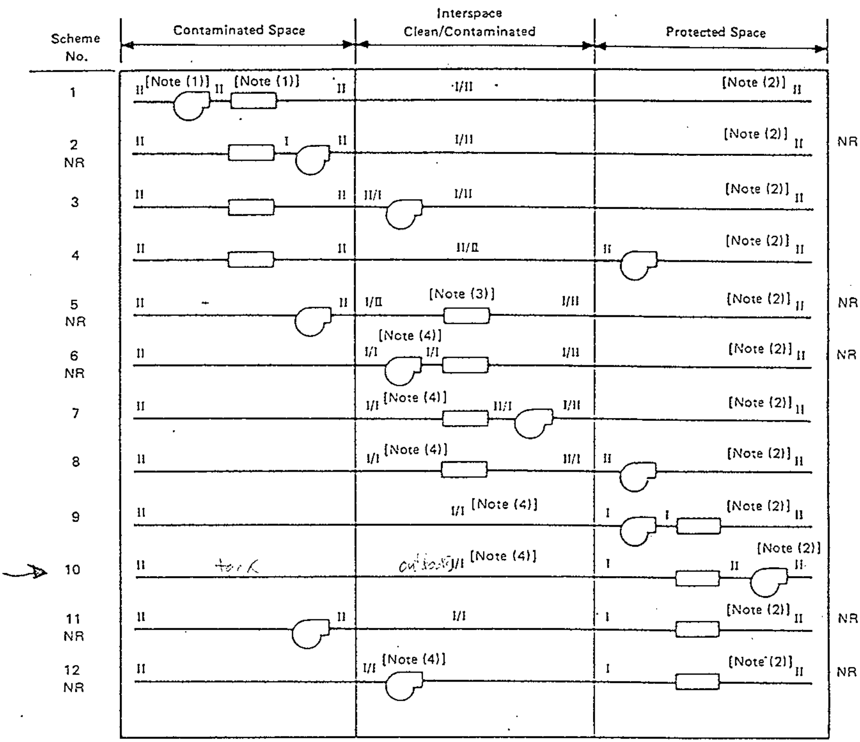
Contaminated Space	Interspace	Protected Space
Containment	Plant spaces	Offsite
Plant site	Equipment room	Control room
Secondary containment	Equipment room	Offsite

For recirculating systems, the contaminated space and protected space merge into one "contaminated and protected space."

Leakage Classes I and II have been assigned to the various sections of each nuclear air treatment system to represent the qualitative effect of leakage on the nuclear air treatment system function. Thus, Leakage Class II classification indicates that due to system configurations and location a higher leak rate may be allowable. Conversely, a Leak Class I classification indicates a more stringent leak rate is required.

Leakage Classes are noted on Figs. B-5, B-6, and B-7.

W320-28-034 rev 0 PHL 3-20-95 3/20/95



NOTES:

(1) Symbols — Air Cleaning Unit; Fan
NR — Not Recommended

(2) All ducts under positive pressure which discharge into the plant stack for high level release credit shall be leakage Class I.

(3) Space classification is based on the relative concentration of the space with respect to the duct (e.g., *Contaminated Interspace* means concentration within space is greater than duct or housing at that point). Thus, as duct concentration changes due to filtration, the space classification will change in a given area.

(4) Noted duct section which pass through a Clean Interspace and which are under a negative pressure for all modes of operation may be leakage Class II.

FIG. B-5 SINGLE PASS AIR CLEANING SYSTEM CONFIGURATIONS

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W320-H-034
rev 0
PH 3-20 95

APPENDIX - F

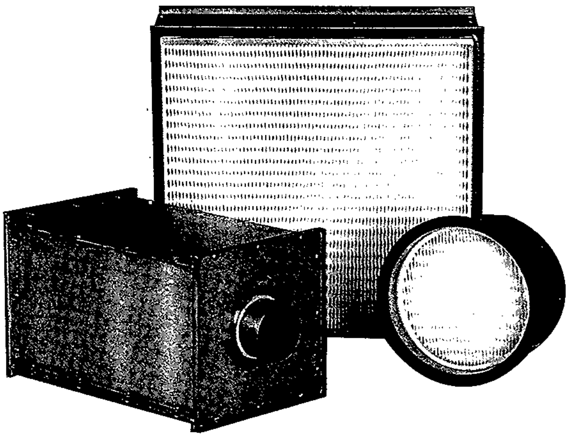
HEPA Filter Qualification Report

Bulletin No. 936B

Flanders®

Flanders Filters, Inc.

Nuclear Grade HEPA Filters



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Page F-2

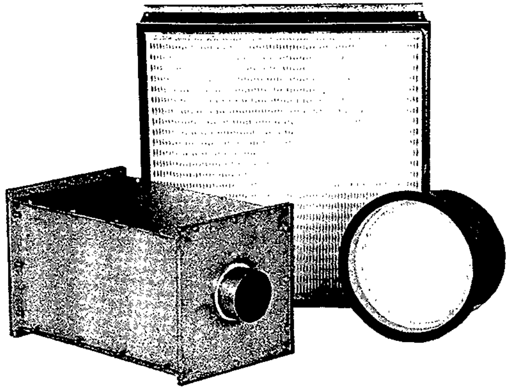
Rectangular, Square, Round, and Nipple-Connected Type B Filters Constructed and Tested in Accordance with MIL-STD-282 & IES-RP-CC-001.3

A Subsidiary of Flanders Corporation

Contents

531 Flanders Filters Road
Washington, NC 27889
TEL: (919) 946-8081 FAX: (919) 946-3425

Nuclear Grade HEPA Filters



Flanders Nuclear Grade filters are produced in square, rectangular, round, and nipple-connected designs. They are widely used in nuclear research, radioactive waste treatment, nuclear weapons facilities, fuel process plants and storage terminals, commercial reactors and DOE test reactors.

Flanders Filters, Inc. Quality Assurance

Flanders' Quality Assurance Program meets the requirements of ANSI/ASME NQA-1 and 10CFR5O APPENDIX B.

Comprehensive Factory Testing

Every Flanders Nuclear Grade filter is tested for penetration and resistance to airflow at 100% and 20% of their rated flow prior to shipment. The lower flow test ensures that there are very few defects in the filter. The maximum penetration allowed at either flow is 0.03%. In recent years, HEPA filter designs have been developed that exceed the original test method's flow capacity. Therefore Flanders uses one of two different test methods to ensure the quality of Nuclear Grade Filters. They are described below.

The test method which has been historically specified and is used by Flanders for most Nuclear Grade filters is Mil-Std 282 (method 102.9.1). In this test di-octyl phthalate (DOP) is used to generate a nearly monodisperse aerosol of approximately 0.3 micrometers diameter droplets. The penetration of the aerosol through the filter is measured with a forward light scattering photometer. The instrument specifed by Mil-Std 282 is known as a Q-107 penetrometer. It was originally developed by the U.S. Army prior to 1950. The instrument is limited by its design to testing at flows from 15 cfm to 1100 cfm. Flanders uses this instrument for all Nuclear Grade filters with rated flows from 75 cfm to 1100 cfm. Below 75 cfm, the 20% flow test cannot be performed.

An alternative test method was developed in the 1980's by Los Alamos National Laboratories under contract to the U.S. Department of Energy. It is often referred to as the HFATS test for High Flow Alternative Test System. It was developed specifically to test filters which are rated at flows higher than 1100 cfm although it can be used for lower flows also. It is only limited by the size of the system fan and aerosol generator output. This method was later standardized in the publication of a recommended practice IES-RP-CC-007.1 "Testing ULPA filters" by the Institute of Environmental Sciences. Currently ASME AG-1 section FC allows for testing by this method. It challenges the filter with a polydisperse aerosol of DOP or other acceptable material and measures the penetration through the filter with a Laser Particle Counter. The Particle Counter counts and sizes individual droplets in size ranges from around 0.1 to 3.0 micrometers in diameter. The ratio of the downstream counts to the upstream counts in each size range is the penetration. Although this value is not equal to the penetration measured by the Q-107, the research done at Los Alamos proved it to be very similar and an acceptable alternative quality control instrument. Since the system measures the penetration of each size range, and a HEPA filter penetration varies with particle size, the maximum allowable penetration is 0.03% for the most penetrating size. Flanders uses this system to test filters which are rated at flows higher than 1100cfm.

Retesting by DOE Filter Test Facilities

Nuclear facilities operated for DOE require that their HEPA filters be retested at one of the Filter Test Facilities operated for DOE. This service must be purchased by the buyer. Filters which are rejected at the test station as not conforming to the purchase specifications, and which are determined not to have been damaged in shipment, will be replaced at no cost to the buyer. Filters must be shipped directly from the factory to the retest facility. *If filters must be shipped to a retest facility, this requirement must be specified when quotations are requested. Filters requiring retest will be quoted and sold to end user only.*

Design Qualification Tests

Design qualification testing is a key element of Nuclear Grade filters. Since there is a wide variety of filter types, sizes, and construction materials, purchasers should make it clear what design qualification tests are required in any solicitation. These tests can be included but may not be limited to those specified in ASME AG-1 Section FC. Those tests are defined only for 24" by 24" by 11.5" square filters and may not be applicable to the round and nipple-connected filter designs. AG-1 requires the design qualification tests to be performed by an independent laboratory within the past 5 years of the solicitation.

Flanders has several models which meet these requirements; please **consult the factory for the latest list of models which do. In addition, Flanders has the capability to perform several of these qualification tests in-house under the Flanders quality assurance program. These tests may be helpful to the purchaser to qualify designs which do not meet the full requirements of ASME AG-1. Please consult the factory for assistance in this matter.**

Seismic Qualification

A single design of Flanders Nuclear Grade HEPA filters has been seismically qualified by test. Other designs can be qualified by analysis and similarity to the tested design. The test qualification was performed as follows. Several HEPA filters were installed in a Flanders bag-in bag-out containment housing and subjected to simulated earthquake loading while simultaneously being monitored for aerosol penetration. The penetration was measured using Flanders standard In-Place Test Housings, a polydisperse DOP aerosol challenge and a photometer instrument. No failure nor damage was observed during or subsequent to the simulated event which exceeded the current requirements for UBC zone 4 loading. ASME AG-1 requires filters to be seismically qualified and the purchaser must specify the loading to be applied.

Testing Service Available

Flanders service personnel are available for installation, supervision of installation, filter testing and certification of compliance to industry and government standards, and instruction of the owner's personnel in testing and maintenance procedures. Contact the factory for details.

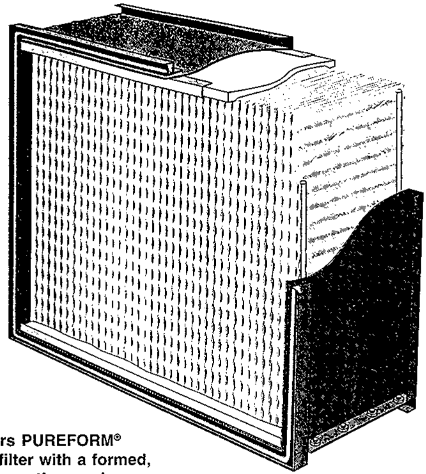
Filter Design and Construction

Filter Media

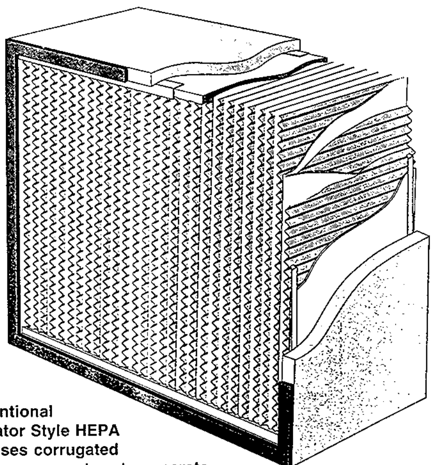
The filter media in Flanders' Nuclear Grade filter elements is glass (boron silicate microfiber) and contains a waterproofing binder which adds strength under both wet and dry conditions. Flanders manufactures its own filter media to meet or exceed the requirements of MIL-F-51079 (latest issue). Flanders '007' media is currently listed on the U.S. Army Qualified Products List QPL 51079. QPL-approved media which have been formulated for resistance to airborne acids are also available; consult the factor

Two types of Filter Packs

Flanders manufactures its own filter media and has developed a unique manufacturing process for the production of PUREFORM® Seperatorless HEPA filters. In one manufacturing operation, Flanders takes a glass fiber binder formulation and produces a self-supporting, self-separating PUREFORM® Media Pack. The PUREFORM® Filter offers many advantages over conventional Separator-Style Filters.



Flanders PUREFORM® HEPA filter with a formed, self-supporting pack.



Conventional Separator Style HEPA filter uses corrugated aluminum separators to separate the pleats in the filter pack.

- Longer service life due to higher dust holding capacity
- Maximum utilization of the media
- Can handle some harsh environments which may attack aluminum separators
- The media pack can be incinerated
- 12" deep PUREFORM® Pack has 295 sq. feet of media, as compared to 220 Sq. ft. for a conventional Separator Style filter. The PUREFORM® Media is significantly thicker (28 mils) than conventional media used in Separator Style HEPA Filters (15 mils)

Sealants

Fire-retardant solid urethane is used to bond the filter element to its integral frame. Maximum temperature rating for these sealants is 250°F.

Frame Material

Plywood — Fire-retardant plywood frames are ideal for many applications, and are easier to incinerate or break-down for disposal than are metal frame filters. However, they are not recommended for use in systems having high-moisture content or high temperature, since they may warp or support biological growth. Stainless steel frame materials should be used in moisture-laden applications.

Stainless Steel — Type 409 and Type 304 stainless steel frames are also available. The 14-gauge Type 409 stainless steel is used in place of the cadmium-plated and chromized steel that was used in the past. However, since the Type 409 material has a low resistance to caustic atmospheres, the Type 304 stainless steel is recommended for those applications.

Frame Style

The technique to be used to seal the filter in service determines the selection of the filter frame style. (See illustrations below.)

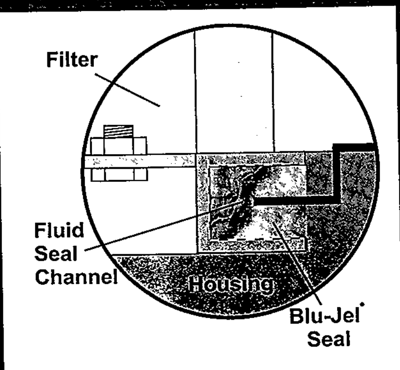
Fluid Seal — Metal frame fluid seal filters have a fabricated channel (3/4" wide x 3/4" deep) located on one face. Wood frame filters have a routed channel (3/8" wide x 3/4" deep) on one face.

BLU-JEL® Seal was developed by Flanders' and is the standard fluid seal material.
For complete information on BLU-JEL® Seal, *see Data Sheet 8601D.*

Gasket Seal — Metal frame gasketed filters are provided with one or two flanges for the placement of the gasket as specificed by the customer. On wooden frames, the gasket is applied to the face of the frame.

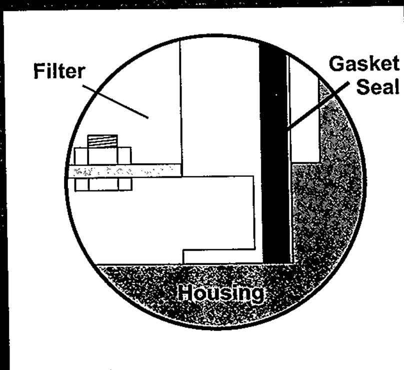
Gasketed filters for normal service are supplied with either closed cell sponge neoprene or silicone sponge gaskets (1/4" x 3/4"). High-temperature filters require the special sealants described on page 9. *Specify upstream, downstream, or both for the location of the gasket or fluid seal in the model number.*

The Fluid Seal



A knife edge in the filter housing mates into a fluid-filled channel provided on the filter. Flanders invented the fluid seal in response to requirements for an absolute seal in the most critial applications. In most cases, fluid seal filters are also easier and quicker to change out than gasketed filters.

The Gasket Seal



A filter clamping mechanism is typically used to maintain sealing pressure on gasketed filters. Gasket seals have a tendency to develop bypass leaks, primarily because of compression set.

Faceguards

The standard faceguard is 4 x 4 mesh, 23-gauge, welded and galvanized dipped steel. Type 304 stainless steel faceguards (4 x 4 mesh, 17-gauge woven wire per ASTM A276) are also available for highly-corrosive atmospheres. Faceguards protect the media, but are not a guarantee against damage due to mishandling.

Specify faceguard location as upstream, downstream or both.

Underwriters Laboratory, UL 586

To be listed under UL 586, filters must be submitted to Underwriters Laboratories for extensive testing including spot flame, and environmental exposure to heated air. A UL 586 listing is accepted by the DOE as meeting the Heated Air requirement in ASME AG-1 for Nuclear Grade filters.

UL labels are optional. Some high-temperature filters, and filters larger than 24" x 30" x 11½", are not eligible for UL 586.

Notes on Filter Selection

❶ Standard PUREFORM® maximum height is 24". When specifying non-standard filter size, the first dimension is always the height of the filter (the dimension parallel to the pleat of the medium); the second dimension is always the width of the filter; and the third dimension is the filter depth.

❷ The filter sizes included in the original military standards have not been expanded to include all of the sizes offered by manufacturers or requested by users today. A principal reason for this is the inherent physical weakness of the larger sizes. Filters larger than 24" x 24" x 11-1/2" should not normally be used in nuclear service (although some older installations do have larger filters which must be resupplied) or in any application where human health could be threatened.

❸ Of the five sizes appearing in the original specifications, the GG-F and GG-D are the largest. Capacities for other sizes are computed from one of these two, depending on the filter element depth of the unlisted filter and its effective face area relative to the listed size. (The face area is obtained by subtracting two inches from the height and width dimensions to allow for the thickness of the frame and the glue line.)

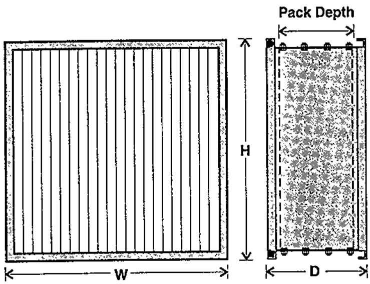
❹ 11-1/2" deep filters are generally selected for service where a minimum amount of space relative to a maximum amount of airflow is required. Most often this is required in built-up banks, walk-in plenums, or side-access housings. Flanders' GG-F size filter is most frequently selected.

❺ When operated at higher flows efficiency will decrease and resistance will increase. Care should be taken when planning to operate a filter at higher than the rated capacity to determine if hostile environmental factors, such as combined high operating flow rate, water vapor condensation, and/or acid vapors, will cause filter failure. For example, water condensate on the filter media could plug the element, causing failure.

Standard Sizes and Capacities

Flanders manufactures standard square and rectangular Nuclear Grade filters in a variety of sizes and capacities. (Sizes and capacities for Round and Nipple-Connected filters are listed in their respective sections in this bulletin.) The type (PUREFORM® or separator-type) and depth of the filter element is a primary factor in filter capacity.

NOTE: The maximum allowable resistance at the Nominal Rated Capacity is 1.0" w.g. (or 1.3" w.g. for the BB-D and CC-D sizes and rated flows greater than 1000 cfm).



11" PUREFORM Filter Element

FILTER SIZE DESIGNATOR	DIMENSIONS H	W	D	CAPACITY (CFM)	MAX INIT. RESISTANCE
CC-F	12"	12"	11-1/2"	200	1.0"w.g.
GC-F	24"	12"	11-1/2"	455	1.0"w.g.
GE-F	24"	18"	11-1/2"	725	1.0"w.g.
GG-F	24"	24"	11-1/2"	1000	1.0"w.g.
GG-F	24"	24"	11-1/2"	1250	1.3"w.g.
GG-F	24"	24"	11-1/2"	1500	1.3"w.g.
GN-F	24"	30"	11-1/2"	1275	1.0"w.g.

11" Separator-Type Filter Element

FILTER SIZE DESIGNATOR	DIMENSIONS H	W	D	CAPACITY (CFM)	MAX INIT. RESISTANCE
CC-F	12"	12"	11-1/2"	200	1.0"w.g.
GC-F	24"	12"	11-1/2"	455	1.0"w.g.
GE-F	24"	18"	11-1/2"	725	1.0"w.g.
GG-F	24"	24"	11-12"	1000	1.0"w.g.
GN-F	24"	30"	11-1/2"	1275	1.0"w.g.

4" PUREFORM Filter Element

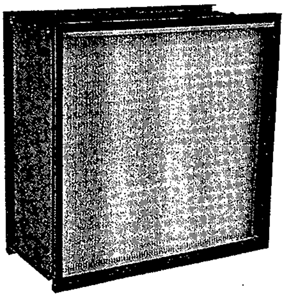
FILTER SIZE DESIGNATOR	DIMENSIONS H	W	D	CAPACITY (CFM)	MAX INIT. RESISTANCE
BB-D	8"	8"	5-7/8"	50	1.3"w.g.
CC-D	12"	12"	5-7/8"	125	1.3"w.g.
GC-D	24"	12"	5-7/8"	250	1.0"w.g.
GE-D	24"	18"	5-7/8"	375	1.0"w.g.
GG-D	24"	24"	5-7/8"	500	1.0"w.g.
GN-D	24"	30"	5-7/8"	625	1.0"w.g.

5-1/2" Separator-Type Filter Element

FILTER SIZE DESIGNATOR	DIMENSIONS H	W	D	CAPACITY (CFM)	RESISTANCE
BB-D	8"	8"	5-7/8"	50	1.3"w.g.
CC-D	12"	12"	5-7/8"	125	1.3"w.g.
GC-D	24"	12"	5-7/8"	250	1.0"w.g.
GE-D	24"	18"	5-7/8"	375	1.0"w.g.
GG-D	24"	24"	5-7/8"	500	1.0"w.g.
GN-D	24"	30"	5-7/8"	625	1.0"w.g.

Standard PUREFORM® Filters

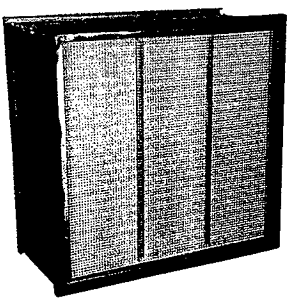
Insert the desired Filter Size Designator from the charts on page 6 at the end of the model number (for example, T-007-W-02-05-NU-51-13-GG-FU5). Typical model numbers specifying filters with galvanized or stainless steel faceguards on both faces and with either BLU-JEL® Seal or a neoprene gasket located on the upstream face are addressed below.



Fluid Seal Filters

DEPTH OF ELEMENT	FRAME MATERIAL	FILTER MODEL NUMBERS (Typical)
4"	Type 409 S/S	T-007-D-02-05-NU-51-13-____
	Type 304 S/S	T-007-D-03-05-NU-51-23-____
	3/4" F.R. Plywood	T-007-D-04-05-NU-51-13-____
11"	Type 409 S/S	T-007-W-02-05-NU-51-13-____
	Type 304 S/S	T-007-W-03-05-NU-51-23-____
	3/4" F.R. Plywood	T-007-W-04-05-NU-51-13-____

The 'T' prefix in the model number indicates a T-clip requirement for fluid seal-type filters used in side-access housings. (See fluid seal diagram on page 4).

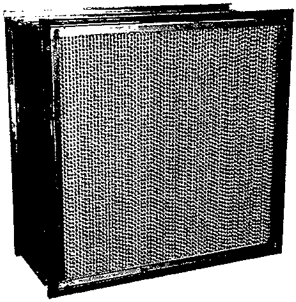


Gasket Seal Filters

DEPTH OF ELEMENT	FRAME MATERIAL	FILTER MODEL NUMBERS (Typical)
4"	Type 409 S/S	0-007-D-02-03-NU-11-13-____
	Type 304 S/S	0-007-D-03-03-NU-11-23-____
	3/4" F.R. Plywood	0-007-D-04-00-NU-11-13-____
11"	Type 409 S/S	0-007-W-02-03-NU-11-13-____
	Type 304 S/S	0-007-W-03-03-NU-11-23-____
	3/4" F.R. Plywood	0-007-W-04-00-NU-11-13-____

Standard Separator Style Filters

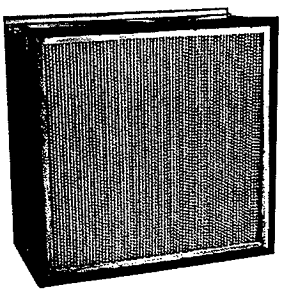
Insert the desired Filter Size Designator from the charts on page 4 at the end of the model number. (The Size Designator indicates whether a 5-1/2" or 11" filter element is being ordered.) Typical model numbers specifying filters with galvanized or stainless steel faceguards on both faces and BLU-JEL® Seal or a neoprene gasket located on the upstream face are addresses below.



Fluid Seal Filters

DEPTH OF ELEMENT	FRAME MATERIAL	FILTER MODEL NUMBERS* (Typical)
5-1/2"	Type 409 S/S	T-007-C-02-05-NU-51-13-___
	Type 304 S/S	T-007-C-03-05-NU-51-23-___
	3/4" F.R. Plywood	T-007-C-04-05-NU-51-13-___
11"	Type 409 S/S	T-007-C-02-05-NU-51-13-___
	Type 304 S/S	T-007-C-03-05-NU-51-23-___
	3/4" F.R. Plywood	T-007-C-04-05-NU-51-13-___

The 'T' prefix in the model number indicates the required T-clip for fluid seal - type filters used in side-access housings. (See fluid seal diagram on page 4).

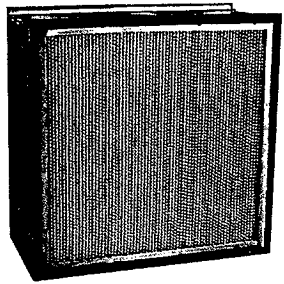


Gasket Seal Filters

DEPTH OF ELEMENT	FRAME MATERIAL	FILTER MODEL NUMBERS* (Typical)
5-1/2"	Type 409 S/S	0-007-C-02-03-NU-11-13-___
	Type 304 S/S	0-007-C-03-03-NU-11-23-___
	3/4" F.R. Plywood	0-007-C-04-00-NU-11-13-___
11"	Type 409 S/S	0-007-C-02-03-NU-11-13-___
	Type 304 S/S	0-007-C-03-03-NU-11-23-___
	3/4" F.R. Plywood	0-007-C-04-00-NU-11-13-___

Standard High-Temperature Filters

Flanders manufactures steel-frame Separator Style HEPA filters for applications with high-temperature requirements up to 1,000°F (540°C) for exhaust air only and 500°F (260°C) for supply air. They do not meet all of the qualification requirements of ASME-AG1 Section FC, and are not eligible for UL 586 labels. High-temperature filters are available with gasket or fluid seal, the latter for supply air applications only. (Filters with BLU-JEL® Seal have a maximum service temperature of 392°F.)



High Temperature Nuclear Grade Filters meet the requirements of IES-RP-CC-001.3 for Type B Filters and are tested in accordance with MIL-Std-282. Two types of high-temperature HEPA filters are offered, and the choice should be carefully made in accordance with the proposed filter service requirements for the specific application.

Silicone Sealant *(Designator NE)*

This is a high-temperature room-temperature-vulcanizing (RTV) silastic-sealant silicone compound rated for continuous service up to 500°F/260°C (supply air). **NOTE:** This high-temperature sealant is not UL 586 approved and does not meet all the qualification requirements of ASME-AG1 Section FC.

Glass Pack Sealant *(Designator NG)*

The glass pack seal is rated for continuous service up to 1,000°F/540°C in exhaust air applications only and with *separator-type filters only.* It is a mat of submicron glass fibers that creates a seal when compressed between the filter pack and filter frame. The glass packing is not an adhesive seal but a mechanical seal that functions much as the glass fiber medium of the filter itself. Additional flanges are added to prevent the filter pack from slipping at high pressure drops.

NOTE: Due to the possibility that the glass pack may shed glass fibers, *the glass pack sealant should be used for exhaust systems only.*

NOTE: Labels are not attached to high-temperature filters

Available Filter Sizes and Capacities*

FILTER SIZE	DIMNENSIONS H	W	D	CAPACITIES (CFM) 11" SEPARATOR	5-1/2" SEPARATOR	MAX. INIT. RESISTANCE
CC-F	12"	12"	11-1/2"	200	—	1.0" w.g.
GC-F	24"	12"	11-1/2"	455	—	1.0" w.g.
GG-F	24"	24"	11-12"	1000	—	1.0" w.g.
GN-F	24"	30"	11-1/2"	1275	—	1.0" w.g.
CC-D	12"	12"	5-7/8"	—	125	1.3" w.g.
GC-D	24"	12"	5-7/8"	—	250	1.0" w.g.
GG-D	24"	24"	5-7/8"	—	500	1.0" w.g.
GN-D	24"	30"	5-7/8"	—	625	1.0" w.g.

Supply or Exhaust Air

500° F Maximum (Gasket Seal) or 390° F Maximum (Fluid Seal)

Insert the desired Filter Size Designator from the chart on page 9 at the end of the model number. Typical model numbers specifying filters with galvanized or stainless steel faceguards on both faces and with BLU-JEL® Seal (for fluid seal filters) or silicone sponge (for gasket seal filters) located on the upstream face are addressed below.

Separator-Type Filters

DEPTH OF ELEMENT	FRAME MATERIAL	FLUID SEAL (Max. 390° F / 200° C)	GASKET SEAL (Max. 500° F / 260° C)
5½"	Type 409 S/S	T-007-C-02-05-NE-51-13-___	0-007-C-02-03-NE-31-13-___
	Type 304 S/S	T-007-C-03-05-NE-51-23-___	0-007-C-03-03-NE-31-23-___
11"	Type 409 S/S	T-007-C-02-05-NE-51-13-___	0-007-C-02-03-NE-31-13-___
	Type 304 S/S	T-007-C-03-05-NE-51-23-___	0-007-C-03-03-NE-31-23-___

Exhaust Air Only - 1000° F Maximum

Insert the desired Filter Size Designator, from the charts on page 9, at the end of the model number. Model numbers specifying filters with steel faceguards on both faces are addressed below.

Separator-Type Filters Only

DEPTH OF ELEMENT	FRAME MATERIAL	GLASS PACKING (1000° F / 540° C)
5½"	Type 409 S/S	0-007-C-02-03-NG-00-23-___
	Type 304 S/S	0-007-C-03-03-NG-00-23-___
11"	Type 409 S/S	0-007-C-02-03-NG-00-23-___
	Type 304 S/S	0-007-C-03-03-NG-00-23-___

NOTE: These filters are shipped without gaskets, since none of the standard gasket materials are rated for 1000°F service. However, two woven glass gaskets may be provided with the filter if requested. The gaskets are shipped unattached and must be installed with the filter.

EXAMPLE:

Category	Option	Code	Example
Special Hardware Options	None	O	T –
	Lifting Bail (for Round Filters)	B	
	Drilled Flanges	D	
	2" Extended Frame with Roughing Prefilter	P	
	Extractor T-Clips on Fluid Seal Filters	T	
	U-Handles on Wood Filters (For Flanders' G-1 Housings)	U	
Filter Media	Non-woven glass paper (boron silicate microfiber), 99.97% minimum efficiency,	007	0 0 7 –
	Same as 007, with additional treatment for resistance to HF	003	
	Same as 007, with additional treatment for resistance to HNO_3	010	
Pack Type	4" deep PUREFORM® filter pack (separatorless)	D	W –
	11" deep PUREFORM® filter pack (separatorless)	W	
	Pleated flat sheet with corrugated aluminum separators	C	
Frame Material	14-gauge Type 409 stainless steel	02	0 2 –
	14-gauge Type 304 stainless steel	03	
	3/4" fire-retardant plywood	04	
	14-gauge Type 304L stainless steel	12	
Frame Style	'Box-Type" Construction (For Wood Filters)	00	0 5 –
	Double-turn flanges, both faces (For Metal Filters)	03	
	Channel for fluid seal on one face (For Wood or Metal Filters)	05	
	Round Filter with No Flange	R0	
	Round Filter with Single Flange	R1	
	Round Filter with Double Flanges	R2	
	Round Filter with Channel for Fluid Seal	R5	
	N1 Filter - One Nipple Connection	N1	
	N2 Filter - Two Nipple Connections	N2	
Sealant	Fire-retardant solid urethane (PUREFORM® filters)	NU	N U –
	RTV silastic silicone for high temperature filters	NE	
	Glass Packing for 1000°F Exhaust Filter	NG	
Gasket Type/Location	TYPE (1st Box): 0. None; 1. Neoprene; 3. Silicone sponge; 4. Glass packing; 5. BLU-JEL® Seal; X. (Special Material)	LOCATION (2nd Box): 0. None; 1. Upstream face; 2. Downtream face; 3. Both faces	5 1 –
Faceguard Type/Location	TYPE (1st Box): 0. None; 1. Galvanized steel; 2. Stainless steel; X. (Special material)	LOCATION (2nd Box): 0. None; 1. Upstream face; 2. Downstream face; 3. Both faces	1 3
Filter Size	Seven spaces are alloted for filter size codes, although all spaces may not be required. Standard size designators (GG-F, etc.) are entered flush left, including dashes. Special sizes (Alpha Numeric Designators and Z-drawings) are entered flush left with the prefixes (no dashes)		G G - F U 5
UL Code	NOTE: UL Code is entered flush left in the remaining boxes. Use this code as applicable: U5 for UL586 label;		

(T-007-W-02-05-NU-51-13-GG-FU5)

Suggested Specification

The filters shall be model __(1)__ Nuclear Grade as manufactured by Flanders Filters, Inc., Washington, NC. The filter medium shall be all glass with a wet strength, water-repellent binder in accordance with MIL-F-51079 (latest issue).

To Specify PUREFORM® Filter Element:
Each filter element shall be constructed without the use of spacers of any kind, including separators, tape, string or strips of medium, by pleating a continuous sheet of a formed, corrugated medium back and forth upon itself so that it is self-supporting.

To Specify SEPARATOR STYLE Filter Element:
Each filter element shall be constructed by pleating a continuous flat sheet of medium over corrugated .0015" minimum thick aluminum spacers whose edges have been hemmed to resist tearing the medium at the fold.

The element shall be permanently bonded to a __(2)__ integral frame with a fire-retardant urethane sealant. The perimeter of the filter face shall have __(3)__ to seal it to its mounting device in service. Construction of the filter shall be in a accordance with the essential construction requirements of ASME AG-1 (latest issue).

Each filter shall be tested, while encapsulated, for resistance to airflow and penetration in accordance with Mil-Std-282 at the nominal rated capacity listed in ASME AG-1 (or, if not listed, as proportional to those listed values after factors for physical constraints are considered) and at 20% of that capacity for penetration only (filters with rated capacity of 75CFM or higher). The penetration at both flows shall not exceed 0.03%.

The HEPA filters shall comply with the performance requirements as listed in ASME AG-1. Each filter and filter carton shall bear identical labels indicating the filter model number, the serial number and the resistance and penetration readings at both test flows taken for the filter on the manufacturer's Q107 penetrometer or HFATS System. In addition, the manufacturer shall provide a filter test report and a Certification of Compliance report.

The manufacturer shall upon request submit evidence that its filters have been qualified in accordance with ASME AG-1 or that the manufacturer maintains its own qualified testing program, including wet overpressure, rough handling and heated air tests.

Filters that are 24" x 12" x 6" and larger shall be packaged one filter per carton. Each filter shall be encased in a flanged, tight-fitting linerboard sleeve that fits within the carton, leaving a minimum 1½" dead-air space on four sides of the filter. The top and the bottom of the filter shall be protected with a folded linerboard cushion. Linerboard cartons shall be strapped to a Flanders Type II pallet with 3/8" plywood facing on both faces.

Model Numbers and Specification

Fill in the numbered locations on the Suggested Specification Text by selecting from the corresponding category below:

(1) Filter model number
(See Page 16)

(2) Frame material
14-gauge, Type 409 stainless steel ...
14-gauge, Type 304 stainless steel ...
3/4" thick fire-retardant plywood ...

(3) Frame style
No flanges.
Two double turn flanges...
A 3/4" channel with fluid sealant...
A single pipe-nipple connection...
Two pipe-nipple connections...

Environmental Conditions

Heat Resistance

In high-temperature applications, the filter media will exhibit a significant loss of strength after the binder burns off. (This normally occurs in the 300°-325°F range.) The filter media becomes significantly weaker when the binder burns off and Flanders recommends only separator style filters be used in high temperature applications.

Filters not specifically designed for high-temperature applications are nevertheless constructed from self-extinguishing or incombustible components and will withstand periodic temperatures up to 250°F with no noticeable change in pressure drop or penetration. However, extended service under such conditions can cause accelerated aging of organic materials and may subsequently contribute to filter failure.

Humidity and Water Resistance

HEPA filter media will tolerate high humidity and some direct wetting, but excessive amounts of moisture, either from airborne droplets or condensation, can plug the filter and result in failure by over-pressure.

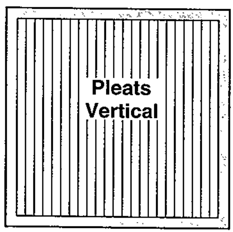
Wood frames are unsuitable for high-moisture conditions, since wood expands or warps when wet, and supports biological growth under humid conditions. Metal frame filters are more suitable for moisture laden atmospheres. Because aluminum separators can corrode in some environments and slough particles downstream of the filter, separatorless PUREFORM™ filters are also recommended for moist conditions, except in high-temperature or caustic applications.

Chemical Resistance

All materials utilized have good resistance to most organic solvents and are resistant to many weak organic and inorganic alkalies and acids. Exposure to acids such as HF, and those with NO_x radicals occurs in nuclear systems fairly often and with varying degrees of impact (HF attacks glass). Information about the potential effects of humidity, various chemical agents, and heated air, and the interrelationship of the construction materials, must be determined by the user through testing.

Packaging and Palletizing

The successful delivery of undamaged HEPA filters depends largely upon good packaging. Shipping damage is minimized by encasing each filter in a tight-fitting linerboard sleeve that is flanged outward at its top and bottom and then inserting the sleeved filter into a linerboard carton having a folded linerboard cushion in the top and bottom. This results in a 1½" dead-air space around the filter to absorb impact. Flanders packages all filters 24" x 12" x 5 ⁷/₈" and larger in this manner. All filter carton material (including the exterior carton, linerboard sleeve, and linerboard cushion) is tested for strength and certified to meet all construction requirements of the applicable freight classification. Additionally, all Nuclear Grade filters are palletized for shipment in groups of cartoned filters stacked side-by-side, with 3/8" plywood facing at the two most vulnerable ends and the aggregate strapped to the pallet.



Installation Note

HEPA filters should be installed with the pleats aligned with the vertical axis when the airflow is horizontal. This prevents sagging and potential tearing of the medium as the filter becomes loaded with dust in-service.

Receipt and Storage Requirements

HEPA filters should be stored in their original cartons, in an environmentally controlled room. HEPA filters should be oriented vertically with their pleats vertical, and be stacked no more than three cartons (slightly over 6 ft.) high unless intermediate bracing or flooring is provided to prevent the weight of the upper tier from bearing on the lower tier. Unless there is obvious damage to the cartons, HEPA filters should not be opened prior to use, or removed from shipping pallets or skids until immediately ready for installation.

While in storage, items should be checked periodically to ensure that they are not exposed to detrimental conditions. Storage areas should be uncluttered and permit easy access to items without the necessity of moving other items to get to them. A item-control procedure is suggested for the storage area to ensure that items are not removed from the area without proper authority, and to prevent improper or rejected items from being installed in the system. Materials and components should be moved a minimum number of times (receipt inspection, storage and release for installation only) and handled in a manner that does not damage the item or its packaging. If wrappings or cartons are removed for receiving inspection, they should be replaced and positively sealed immediately upon completion of the inspection. Receiving and storage personnel shall be informed of the necessity of proper handling of all components, especially the HEPA filters.

Shelf Life Information

Flanders recommends the filter be stored in its original shipping carton to prevent it from being exposed to ultra violet rays and possible damage to the filter media. The filter should be stored in a controlled area, 0°-120°F, and should not be exposed to ozone depleting sources. If these parameters are satisfied and storage requirements as detailed are maintained, the filter shelf life should be three (3) years from gasket cure date or three (3) years from manufacturing date for fluid seal filters.

Flanders®

FLANDERS FILTERS, INC.
THE FOREMOST DESIGNERS AND MANUFACTURERS
OF HIGH EFFICIENCY AIR FILTRATION SYSTEMS FOR SCIENCE AND INDUSTRY

CORPORATE OFFICE
531 Flanders Road, Washington, NC 27889
919/ 946-8081 FAX 919/946-3425
Email: marketing@ffi.flanderscorp.com
www.flanderscorp.com

Represented by:

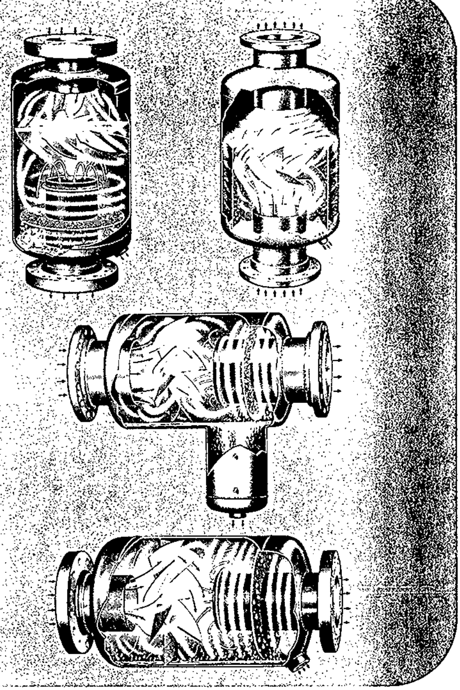
A Subsidiary of Flanders Corporation

APPENDIX - G

Moisture Separator Drawings and Qulification Report

WRIGHT-AUSTIN
1894

CENTRIFUGAL TYPE, IN-LINE GAS / LIQUID SEPARATORS with "VCP"



WRIGHT-AUSTIN'S EXCLUSIVE
"VCP" (Vortex Containment Plate)

In the past, separators have often operated at less than peak efficiency due to the re-entrainment of separated liquid at normal or high flow rates.

Wright-Austin has solved this problem through the development of a vortex containment plate system, now standard on all "30-L" series separators.

This "VCP" system is accomplished through the use of carefully placed rings that shield the separated liquid from the vortex action within the separator and direct it toward the drain.

Sheltered in this manner from the turbulence of the swirling gas or air flow, the liquid cannot be re-entrained after separation.

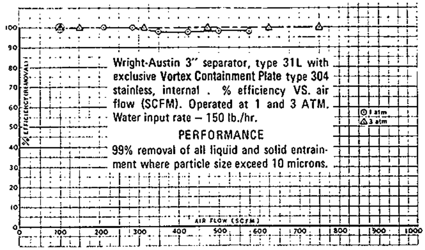
30L SERIES FOR HIGH, MEDIUM AND LOW PRESSURE AIR, GAS OR STEAM

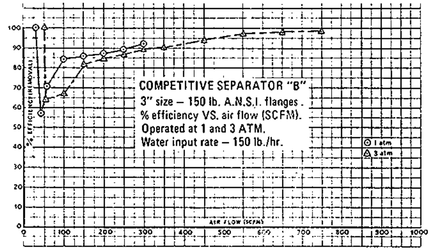
Wright-Austin's 30L series gas/liquid separators are suitable for the wide range of applications found in industry today. They embody a number of highly efficient, proved separator principles.

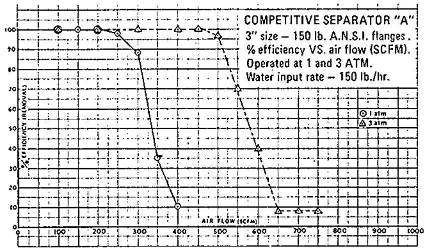
On entering these units, the steam, air or gas encounters curved stationary blading, creating controlled centrifugal action. As the whirling takes place, entrained liquids and solids are forced to the outer wall. The steam, air or gas then escapes through the outlet tube completely free of impurities.

The separators are compact and require scarcely more space than the line itself. The design holds pressure drop to a minimum. There are no moving parts, they are self-cleaning and require no maintenance. When combined with proper type trap, optimum performance is assured.

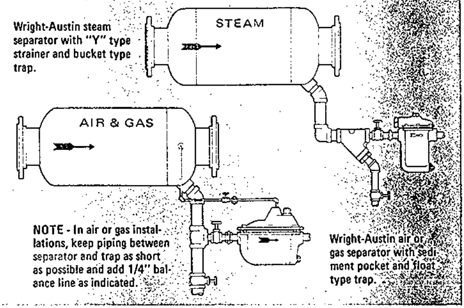
VORTEX CONTAINMENT PLATE COMPARATIVE TESTS







* TYPICAL INSTALLATIONS



* For positive drainage of separator, install trap a minimum of 6" below separator drain. For every inch of horizontal piping to trap, add 1" to the vertical piping. Never allow the top of the trap to extend above separator drain connection.

TRAP SELECTION - AIR AND GAS SERVICE (Ask for Bulletin 814)

SIZE	0-5 PSI	5-40 PSI	40-80 PSI	80-125 PSI	125-150 PSI	150-200 PSI	200-300 PSI	300-400 PSI	400-700 PSI
1-1/2" to 2-1/2"	3/4"500AC	3/4"500AC 1"230AC	3/4"500AC 1"230AC	3/4"500AC 1"230AC	3/4"500AC 1"310AC	1"510AC 1"310AC	1"510AC	3/4"71AC	3/4"101AC
3"	3/4"500AC	3/4"500AC 1"230AC	1"510AC 1"230AC	1"510AC 1"230AC	1"510AC 1"310AC	1"510AC 1"310AC	1"510AC	3/4"71AC	3/4"101AC
4"	1"510AC	1"510AC 1"230AC	1"510AC 1"230AC	1"510AC 1"230AC	1"510AC 1"310AC	1"510AC 1"310AC	1"510AC	3/4"71AC	3/4"101AC
5"	1"510AC	1"510AC 1"230AC	1"510AC 1"230AC	1"510AC 1"230AC	1"510AC 1"310AC	1"510AC 1"310AC	1"510AC	3/4"71AC	3/4"101AC
6"	1"510AC	1"510AC 1"230AC	1"510AC 1"230AC	1"510AC 1"230AC	1"510AC 1"310AC	1-1/4"520AC 1"310AC	1-1/4"520AC	3/4"71AC	3/4"101AC
8"	1-1/4"520AC	1-1/4"520AC 1"230AC	1-1/4"520AC 1"230AC	1-1/4"520AC 1"230AC	1-1/4"520AC 1"310AC	1-1/4"520AC 1"310AC	1-1/4"520AC	3/4"71AC	3/4"101AC
10"	1-1/4"520AC	1-1/4"520AC 1"310AC	1-1/4"520AC 1"310AC	1-1/4"520AC 1"310AC	1-1/4"520AC 1"310AC	1-1/4"520AC 1"310AC	1-1/4"520AC	3/4"71AC	3/4"101AC
12"	1-1/4"520AC	1-1/4"520AC 1"310AC	1-1/4"520AC 1"310AC	1-1/4"520AC 1"310AC	1-1/4"520AC 1"310AC	1-1/4"520AC 1"310AC	1-1/4"520AC	1"72AC	3/4"101AC
14"	1-1/4"520AC	1-1/4"520AC 1-1/4"320AC	1-1/4"520AC 1-1/4"320AC	1-1/4"520AC 1-1/4"320AC	1-1/4"520AC 1-1/4"320AC	1-1/4"520AC 1-1/4"320AC	1-1/4"520AC	1"72AC	3/4"101AC
16"	1-1/4"520AC	1-1/4"520AC 1-1/4"320AC	1-1/4"520AC 1-1/4"320AC	1-1/4"520AC 1-1/4"320AC	1-1/4"520AC 1-1/4"320AC	1-1/4"520AC 1-1/4"320AC	1-1/4"520AC	1"72AC	3/4"101AC
18"	1-1/2"530AC	1-1/2"530AC 1-1/4"320AC	1-1/2"530AC 1-1/4"320AC	1-1/2"530AC 1-1/2"330AC	1-1/2"530AC 1-1/2"330AC	1-1/2"530AC 1-1/2"330AC	1-1/2"530AC	1"72AC	1-1/4"103AC
20"	1-1/2"530AC	1-1/2"530AC 1-1/2"330AC	1-1/2"530AC 1-1/2"330AC	1-1/2"530AC 1-1/2"330AC	1-1/2"530AC 1-1/2"330AC	1-1/2"530AC 1-1/2"330AC	1-1/2"530AC	1"72AC	1-1/4"103AC
24"	1-1/2"530AC	1-1/2"530AC 1-1/2"330AC	1-1/2"530AC 1-1/2"330AC	1-1/2"530AC 1-1/2"330AC	1-1/2"530AC 2"340AC	1-1/2"530AC 2"340AC	1-1/2"530AC	1"72AC	1-1/4"103AC

TRAP SELECTION - STEAM

When selecting trap for STEAM service use condensate capacity equal to 10% of value shown on STEAM Flow Chart (Back Page). Ask for Bulletin 808 on Cast Iron Traps for pressures up to 250 PSI and Bulletin TB-565 for Carbon or Stainless Traps up to 700 PSI.

PERFORMANCE

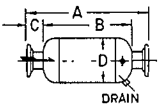
The Wright-Austin 30-L Series Gas/Liquid Separators, when properly sized, installed and drained, are guaranteed to remove 99% of all liquid and solid entrainment, where particle size is 10 microns or larger.

TO SPECIFY — Shall be line type carbon steel construction in accordance with the ASME Code, Section VIII, Division 1, with stamp.

Unit to have Type 304L stainless steel separating element with vortex containment plate capable of removing 99% of all liquid and solid entrainment where particle size is 10 microns or larger. Separator to be Wright-Austin Type 30L Series with vortex containment plate. Separator to be selected in accordance with Wright-Austin Steam, Air or Gas Flow Charts, TB-546 or TB-547, latest revision.

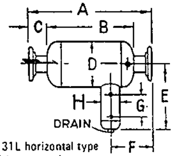
30L SERIES GAS / LIQUID SEPARATORS with "VCP"
for Steam, Air and Gas Purification

TYPE 31-L



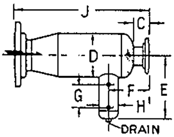
Can be installed horizontally, or vertically for down-flow operation.

TYPE 31-LS

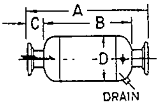


A 31L horizontal type with sump and water gauge mountings added.

TYPE 31-LSW

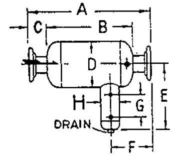


TYPE 31-LR

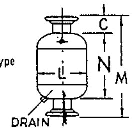


Inlet and outlet flanges are reduced one pipe size. Recommended where flow-through pipe exceeds chart values or where pressure drop must be less than rated drop. (31LSR-with sump)

TYPE 31-LSR

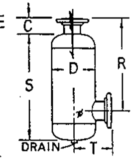


TYPE 32-L

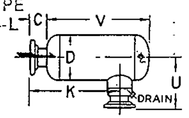


A vertical up-flow type separator

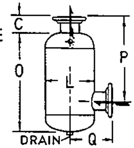
TYPE 33-L



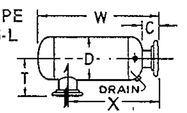
TYPE 34-L



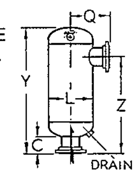
TYPE 35-L



TYPE 36-L



TYPE 37-L



DIMENSIONS

SIZE	1-1/2"	2"	2-1/2"	3"	4"	5"	6"	8"	10"	12"	14"	16"	18"	20"	22"	24"	26"	28"	30"	36"	42"
A	20	22	22	24	30	34	36	45	52	60	66	74	80	86	96	106	120	132	142	166	190
B	15	16	16	18	22	26	28	36	42	50	56	64	68	74	84	94	104	114	122	144	166
C	2-1/2	3	3	3	4	4	4	5	5	5	5	5	6	6	6	6	8	9	10	11	12
D	5-9/16	6-5/8	6-5/8	8-5/8	10-3/4	12-3/4	14	16	20	24	28	30	36	36	42	42	48	54	54	66	78
E	14	14-1/2	14-1/2	16-1/2	17-1/2	19-1/2	21	24	27	30	33	35	39	42	46	47	50	54	55	63	70
F	8-1/2	9	9	10	12	13	14	16	19	20	23	24	27	28	31	31	35	38	40	48	56
G	6-3/4	6-3/4	6-3/4	6-3/4	6-3/4	6-3/4	6-3/4	7-7/8	7-7/8	7-7/8	7-7/8	7-7/8	9-1/8	9-1/8	10-1/4	10-1/4	10-1/4	10-1/4	10-1/4	11-7/8	11-7/8
H	2-3/8	2-7/8	2-7/8	3-1/2	4-1/2	5-9/16	6-5/8	8-5/8	10-3/4	10-3/4	12-3/4	14	16	18	20	20	22	22	24	30	36
J	21	23	23	25	32	36	40	48	58	65	71	80	86	92	103	114	129	140	152	178	202
K	15-1/2	17	17	19	24	28	31	40	47	54	60	68	77	83	90	101	112	122	136	158	184
L	6-5/8	8-5/8	8-5/8	10-3/4	14	16	18	20	24	30	36	40	42	48	48	54	60	66	72	78	96
M	17	19	19	22	28	30	33	39	48	54	60	66	72	78	83	88	98	106	114	134	142
N	12	13	13	16	20	22	25	29	38	44	50	56	60	65	71	76	82	88	94	112	118
O	19	20	20	26	28	33	37	45	54	66	73	85	90	97	105	113	122	130	140	166	180
P	15	16	16	21	23	27	30	37	44	52	58	68	72	78	84	90	98	105	114	135	144
Q	6	8	8	9	11	12	13	15	17	20	23	25	27	30	30	33	38	42	46	50	60
R	12-1/2	14	14	16	20	24	27	33	40	46	52	59	68	74	81	87	96	104	112	134	160
S	16	18	18	21	25	30	34	41	50	58	65	74	85	92	101	108	118	127	136	163	194
T	5-1/2	7	7	8	10	11	12	13	15	17	19	20	24	24	27	27	32	35	37	44	51
U	8-1/2	10	10	11	14	15	17	19	22	25	28	29	33	34	38	38	44	48	51	59	68
V	20	22	22	25	30	36	40	50	59	68	76	86	96	104	114	126	137	149	165	192	223
W	24	26	26	29	36	41	45	58	68	79	89	99	109	118	131	144	163	177	189	222	255
X	18	20	20	22	28	32	35	46	54	63	71	80	87	95	108	117	131	143	153	180	207
Y	25	27	27	31	38	43	46	59	67	78	87	96	105	113	126	138	155	167	180	210	244
Z	18	20	20	22	28	32	34	45	51	60	67	75	81	88	99	109	122	133	144	168	194
DRAIN NPT	1	1	1	1-1/2	1-1/2	1-1/2	1-1/2	2	2	2-1/2	2-1/2	3	3	4*	4*	4*	4*	4*	4*	4*	4*

*Flanged drain.

NOTE—Dimensions shown for 1-1/2" through 6" valid for 150 lb., 300 lb. and 600 lb. ANSI flanges. Dimensions for 8" size and larger are valid for 150 lb. and 300 lb. flanges. Four inch drains and larger have flanged fittings.

Designed and constructed to the latest ASME code for unfired pressure vessels. Section VIII, division 1, with stamp.

FLANGES AND VESSEL RATINGS

150 Lb. ANSI Flanges – 75 PSIG at 450°F
150 Lb. ANSI Flanges – 150 PSIG at 450°F
150 Lb. ANSI Flanges – 200 PSIG at 300°F

300 Lb. ANSI Flanges – 250 PSIG at 650°F
300 Lb. ANSI Flanges – 350 PSIG at 650°F
300 Lb. ANSI Flanges – 500 PSIG at 650°F

TO ORDER: State pipe size, flow, maximum pressure, temperature, molecular weights of gases and vapors, pressure drop allowable and flange rating desired. See proper chart on back page for sizing and capacities.

APPLICATIONS

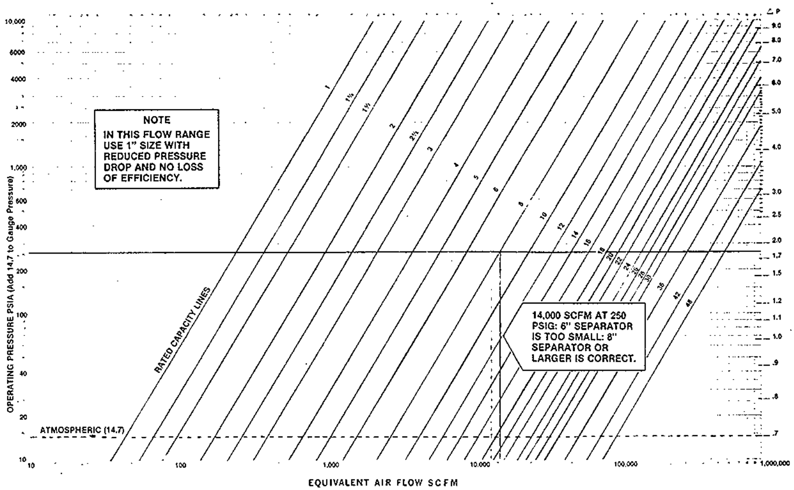
STEAM 1. Installation ahead of Steam Turbines to protect blading against erosive action of wet steam, pipe scale and other entrained solids. **2.** Used in steam distribution lines to assure clean, dry steam entering Heat Exchangers, Pressure Reducing Valves, Temperature Regulators, Meters and other Process Equipment.

COMPRESSED AIR 1. Installation following Intercoolers and Aftercoolers to remove entrained moisture which may otherwise cause damage in successive stages of compression or to subsequent processes. **2.** For entrainment removal in primary Air Lines leading to air using equipment, such as: Air Chucks, Air Nozzles and Paint Spray equipment. Particularly suitable for long runs of pipe and where wide temperature differentials are to be found. **3.** Highly efficient for moisture separation of Refrigerated Air Dryer packages.

COMPRESSED GAS 1. For use in conjunction with Intercooler and Aftercooler equipment installed on Gas Compressors. The units are highly effective and eliminate OIL, TAR, WATER and other objectional entrainment.

& CAPACITY CHART

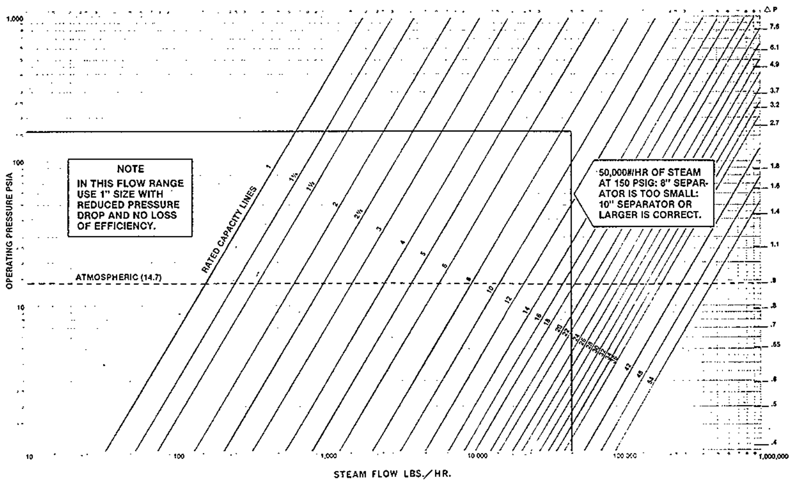
AIR FLOW IN STANDARD CUBIC FEET PER MINUTE through standard Wright-Austin Separators.



The Wright-Austin air flow chart is based on SCFM (cubic feet per minute of air measured at standard conditions of 14.7 psia and 60° F). If any of the operating conditions are varied from the above, request TB546 showing correction factors, conversions and pressure drop.

STEAM SELECTION & CAPACITY CHART

The values below represent maximum recommended STEAM FLOW (SATURATED) IN LBS. PER HOUR through standard Wright-Austin Separators.



For complete and larger chart showing pressure drop, request TB-547.

WRIGHT-AUSTIN COMPANY

GENERAL OFFICE
3250 Franklin St., Detroit, Mich. 48207
Tel. (313) 259-1925 FAX (313) 259-1962

WRIGHT-AUSTIN LIMITED
P.O. Box 7267
Windsor, Ontario N9C 3Z1
Phone: (519) 255-9740

GREAT BRITAIN
Vee Bee Limited
Old Wharf Rd., Stourbridge
W. Midlands, England DY8 4LS
Phone: 44 384 378884
Telex: 337757
FAX: 44 384 374179

EXPORT DEPARTMENT
360 N. Michigan Ave., Suite 911
Chicago, Illinois 60601
Phone: (312) 263-3747
FAX: (312) 263-0448

WRIGHT-AUSTIN COMPANY

3250 FRANKLIN STREET, DETROIT, MICHIGAN 48207
PHONE (313) 259-1925 • FAX (313) 259-1962

WRIGHT-AUSTIN 1894

Established in 1894

January 18, 1996

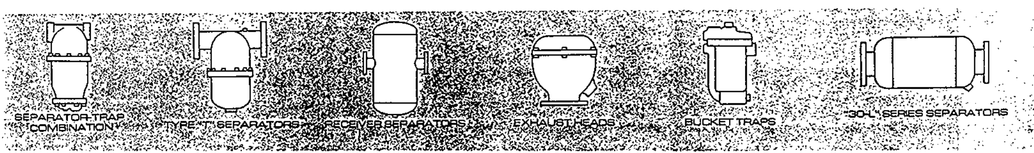
Subject: Drain Pipe on Serial # 15792 on PO # 95-455

To Whom It May Concern,

All are records show that Sch. 40 pipe was used in the manufacturing of the pipe in question with the mill test report for that pipe being sent. If you feel the pipe is Sch. 80 the following mill test report is for the only Sch. 80 pipe that was in house at the time or manufacturing.

Daniel Chanon
QC Insp.

VI. 22668 SUP. 089
SHT. 2034-2061
Bldg. MO24



COURTNEY & NYE INC.

ENGINEERED PRODUCT SALES
232 2nd AVENUE SO., SUITE 104
KENT, WASHINGTON 98032
P.O. BOX 219
KENT, WASHINGTON 98035-0219
PHONE (206) 813-2144
FAX (206) 813-2182

January 31, 1996

Westinghouse Hanford
M/S G1-64
P.O. Box 1970
Richland, WA 99352

Attention: Mr. Bob Kitchen

Subject: DRAWINGS FOR WRIGHT-AUSTIN SEPARATORS

Reference: Your Order #WX1-XVR-78255
W-A Order #02848
C&N #95-455

Dear Bob,

Enclosed you will find six (6) copies of the following revised certified drawings for the WRIGHT-AUSTIN SEPARATOR that was supplied on the purchase order referenced above.

-- Material Certification for Sch 40
-- Material Certification for Sch 80
-- Letter explaining the materials used for this unit
-- As built drawing

Thank you very much for your order. Please advise if there is anything further that you require from us.

Sincerely,

Leslie M. Grimm
Enclosure:
cc: C&N, OR - this page only

COURTNEY & NYE INC.
ENGINEERED PRODUCT SALES
232 2nd AVENUE SO., SUITE 104
KENT, WASHINGTON 98032
P.O. BOX 219
KENT, WASHINGTON 98035-0219
PHONE (206) 813-2144
FAX (206) 813-2182

September 21, 1995

Westinghouse Hanford Company
M/S G7-22
P.O. Box 888
Richland, WA 98352

Attention: Mr. Marv McCollom

Subject: DRAWINGS FOR WRIGHT-AUSTIN SEPARATORS

Reference: Your Order #WX1-XVR-78255
W-A Order #02848
C&N #95-455

Dear Marv,

Enclosed you will find six (6) copies of the following certified information for the WRIGHT-AUSTIN SEPARATOR being furnished on the purchase order referenced above.

1. Seismic Analysis Report
2. Material Test Report
3. ASME Form U-1A
4. Certificate of Conformance - Penetrant Inspection
5. Hyrostatic Test Certificate

Please note that Wright-Austin separators are self cleaning, have no moving parts and therefore, parts lists are not available. The separators are bolted, threaded or welded into the lines and are self-cleaning. The do not need lubrication or maintenance and therefore lubrication list, operating and maintenance manuals are also not available.

This order shipped Sept. 14, 1995.

Thank you very much for your order. Please let us know if we can be of any further assistance.

Sincerely,

Leslie M. Grimm
Enclosure:
cc: Courtney & Nye - OR

Wright-Austin Company
6 Inch Type "33-L" Gas/Liquid Separator
Seismic Analysis Report

Document No. 28042.100.01

Revision 0

August 30, 1995

JOHN WILLIAM KIMPEL
LICENSED
7981
KANSAS
PROFESSIONAL ENGINEER

Black & Veatch

Kansas City, Missouri

SEISMIC ANALYSIS OF
WRIGHT-AUSTIN 6 INCH TYPE "33-L" GAS/LIQUID SEPARATOR

INTRODUCTION

This report describes the seismic analysis of a Wright-Austin 6 Inch Type "33-L" Gas/Liquid Separator (nuclear non-safety related). Details of the separator are found on Wright-Austin drawing A-30486-1, revision A, Date 7-24-95.

DISCUSSION

Seismic analysis of the separator was performed in accordance with the "Uniform Building Code", 1991 Edition (UBC-91), Sections 2336 and 2337, Seismic Zone 2B.

An equivalent static lateral force of $F_p = 0.375W_p$ was applied at the center of mass of the separator. In the perpendicular horizontal direction a force of 30% of this value was applied. Forces due to the weight of the separator and the weight of water were also applied and combined with seismic forces as appropriate. Assembly weight of 264 pounds was furnished by Wright-Austin and the water weight was conservatively calculated assuming the vessel filled with water. Effects such as water sloshing and impingement on the separator are beyond the scope of the analysis and have not been considered.

The design code was taken to be the "Specification for Structural Steel Buildings, Allowable Stress Design and Plastic Design", June 1989, contained in the "Manual of Steel Construction" AISC ASD, Ninth Edition.

Seismic stresses in the four support legs (L 2 1/2 x 2 1/2 x 5/16) were computed and compared to the allowable values prescribed in the above code. Maximum shear stress in the support legs was computed and found to be very low (51 psi compared to an allowable value of 14,4000 psi). The combined stress ratio (CSR) due to combined axial and bending stresses in the support legs was computed to be 0.266, significantly less than the allowable value of 1.0.

Seismic shear and uplift forces were computed for the anchor bolts at each baseplate and found to be very low. For practical considerations, it is recommended to use one 5/8" diameter A325 bolt for each baseplate.

Seismic stresses of the vessel, inlet and outlet piping, welds, etc., were not explicitly computed. By inspection seismic stresses of these components will be very low.

CONCLUSION

The resultant stresses created by a UBC-91 Zone 2B seismic loading are minimal. The performance of the Wright-Austin 6 Inch Type "33-L" Gas/Liquid Separator to such a loading is satisfactory.

REFERENCES

1. Specification W320P8.SP.1503, Revision 0, Date 12-16-94.

2. Wright-Austin Drawing A-30486-1, Revision A, Date 7-24-95 "6" TYPE "33-L" GAS/LIQUID SEPARATOR".

3. "Uniform Building Code", 1991 Edition (UBC-91)

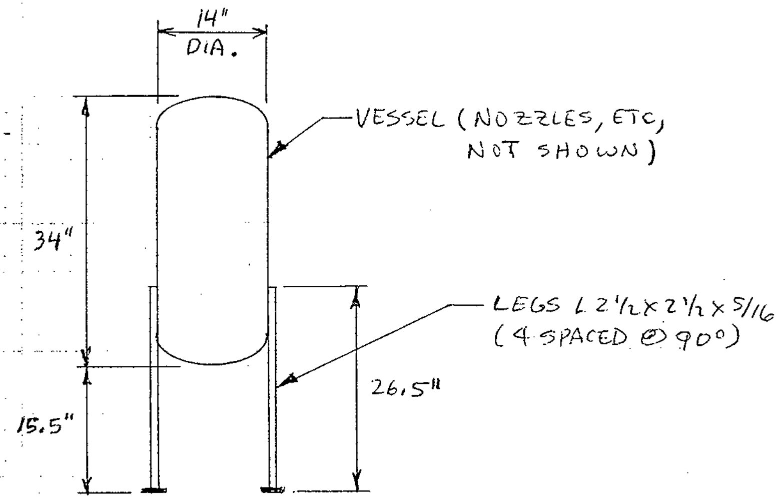
4. "Manual of Steel Construction", AISC ASD, Ninth Edition.

APPENDIX

BLACK & VEATCH ENGINEERS-ARCHITECTS	Owner WRIGHT AUSTIN COMPANY	Computed By JW Kimpel	
	Plant	Unit	Date 8-23 1995
	Project No. 28042.100	File No.	Checked By MATTHEW C. LEE
	Title SEISMIC ANALYSIS OF MOISTURE SEPARATOR 6" TYPE "33-L"		Date 8-25 1995
			Page 1 of 9

DO NOT WRITE IN THIS SPACE

GEOMETRY



FON-175A

WEIGHT

Approximate Assembly Weight = 264 #
(per Wright Austin Company)

Assume vessel full of water (conservative)

Approx Volume = $\frac{\pi}{4}(13.5'')^2(30'') = 4294 in^3$ (13.5" = ID)

Water Weight = $(4294 in^4)\left(\frac{62.4 pcf}{12^3}\right) = 155\#$

Total Weight Vessel + Contents

= 264 # + 155 # = 419 #

DO NOT WRITE IN THIS SPACE

PGN-175A

DO NOT WRITE IN THIS SPACE

SEISMIC FORCES

UBC-91, Section 2336

$F_p = Z I C_p W_p$

$Z = 0.20$	Table 23-I, Zone 2B
$I = 1.25$	Table 23-L
$C_p = 2 \times 0.75$	Table 23-P

$F_p = (0.20)(1.25)(2 \times 0.75) W_p = 0.375 W_p$

$W_p =$ 419# (see previous page)

$F_p = (0.375)(419\#) = 157\#$ say 160#

$30\% F_p = 0.3(157\#) = 47\#$ say 50#

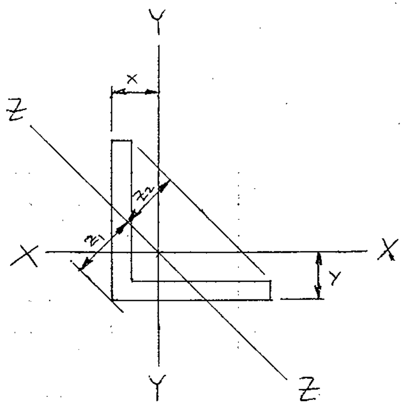
Note: 100% of Fp shall be applied in one horizontal direction and 30% of Fp shall be applied in the other horizontal direction

P-GN-173A

DO NOT WRITE IN THIS SPACE

P-GN-173A

PROPERTIES L 2½ x 2½ x 5/16



PROPERTIES ABOUT GEOMETRIC AXES

Area = 1.460 in^2
$I_x = I_y = 0.849 \, in^4$
$S_x = S_y = 0.482 \, in^3$
$r_x = r_y = 0.761$ in
$x = y = 0.740$ in

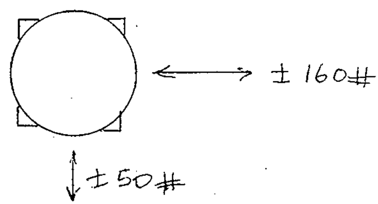
PROPERTIES ABOUT PRINCIPLE AXES

$I_z = A r_z^2 = (1.46)(0.489)^2 = 0.349 \, in^4$
$\bar{I}_z = I_x + I_y - I_z = 2(0.849) - 0.349 = 1.349 \, in^4$
$z_1 = \sqrt{2}(.740) = 1.047$ in
$z_2 = (2\tfrac{1}{2}" + \tfrac{5}{16}")\left(\tfrac{1}{\sqrt{2}}\right) - \sqrt{2}(.740) = 0.942$ in
$S_z = I_z / z_1 = 0.349 / 1.047 = 0.333 \, in^3$
$r_z = 0.489$ in

DO NOT WRITE IN THIS SPACE

CHECK SHEAR IN ANGLES L 2½ × 2½ × 5/16

By inspection the following will be the critical case for shear.



Shear Force Per Leg

$V = 160\# / 4 = 40\# / leg$

Shear Area L 2½ × 2½ × 5/16

$A_v = (2\tfrac{1}{2}'')(5/16'') = 0.78\ in^2$

Shear Stress

$f_v = V / A_v = 40\# / 0.78 in^2 = 51 psi = \underline{0.05 ksi}$

Allowable Shear Stress

$F_v = 0.4 F_y = 0.4 (36^{ksi}) = \underline{14.40\ ksi}$

$f_v << F_v$ SO OK

P-GN-175A

BLACK & VEATCH ENGINEERS-ARCHITECTS

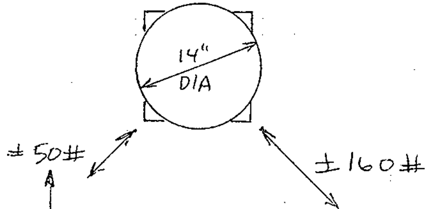
Owner WRIGHT AUSTIN COMPANY
Plant ______ Unit ______
Project No. 28042.100 File No. ______
Title SEISMIC ANALYSIS OF MOISTURE SEPARATOR 6" TYPE "33-L"

Computed By JW Kimpel
Date 8-23 1995
Checked By MCL
Date 8-25 1995
Page 6 of 9

DO NOT WRITE IN THIS SPACE

CHECK COMBINED AXIAL & BENDING IN ANGLES L 2½ x 2½ x 5/16

By inspection the following will be the critical case for combined axial and bending.



(By inspection ±50# force will produce zero stress in legs under consideration)

Overturning Moment

Height to c.g. $\cong 15.5" + \frac{34"}{2} = 32.5"$

O.T. Moment $= (160\#)(32.5") = 5{,}200"\#$

P-GN-1/31

DO NOT WRITE IN THIS SPACE

Axial Stress

$$P = \frac{5{,}200\#}{14''}\ (\text{Seismic}) + \frac{264\#}{4}\ (\text{Ass'y Weight}) + \frac{155\#}{4}\ (\text{Water Weight})$$

$$= 372\# + 66\# + 39\# = 477\#\text{ per leg}$$

$$f_a = \frac{P}{A} = \frac{477\#}{1.46\,in^2} = 327\text{ psi} = 0.33^{KSI}$$

Assume Effective Length of Leg

$$= (15.5'' + 26.5'')/2 = 21''$$

$$\frac{Kl}{r_z} \simeq \frac{(1.0)(21'')}{(0.489'')} = 43$$

$F_a = 18.95^{KSI}$ (ASD 9th Ed, page 3-16)

$$\frac{f_a}{F_a} = \frac{0.33}{18.95} = 0.017 \ll 1 \quad OK$$

Bending Stress

$$M_z \simeq (160\#/2)(21'') = 1680\ ''\#$$

$$f_{bz} = \frac{M_z}{S_z} = \frac{1680''\#}{0.333\,in^3} = 5040\text{ psi} = 5.04\text{ KSI}$$

Assume $F_{bz} = F_a = 18.95^{KSI}$ (very conservative)

$$\frac{f_{bz}}{F_{bz}} = \frac{5.04^{KSI}}{18.95^{KSI}} = 0.266 < 1 \quad OK$$

P-GN-1 /3A

DO NOT WRITE IN THIS SPACE

Bending Stress Due To Eccentric Axial Load

$M_{zz} = (P)(z_1) = (477\#\text{ per leg})(1.047") = 500"\#$

$f_{bzz} = \frac{M_{zz}}{S_z} = \frac{500"\#}{0.333\text{ in}^3} = 1500\text{ psi} = 1.50\text{ KSI}$

Assume $F_{bz} = F_a = 18.95$ KSI (very conservative)

$\frac{f_{bzz}}{F_{bz}} = \frac{1.50}{18.95} = 0.079 < 1$ OK

Combined Stresses

Check combined axial and bending stresses due to seismic, dead weight, and water weight

$$CSR = \frac{f_a}{F_a} + \frac{f_{bz}}{F_{bz}} + \frac{f_{bzz}}{F_{bz}}$$

$$= \frac{0.33}{18.95} + \frac{5.04}{18.95} + \frac{1.50}{18.95}$$

$$= 0.017 + 0.266 + 0.079 = \underline{0.363 < 1 \quad OK}$$

DO NOT WRITE IN THIS SPACE

BASEPLATE BOLTS

Use one bolt per baseplate

Maximum Shear = 160#/2 = 80#/bolt
(ie, assume shear resisted by two opposite legs)

Maximum Tension

(up) Seismic, Ass'y Weight, Water Weight

= -372# + 0.85 (66# + 39#) = -283#/bolt (uplift)

(0.85 ↑ UBC-91 2337(a))

Above bolt forces are very low

Recommend 1- 5/8"φ A325 Bolt each Baseplate

Allowable loads for 5/8"φ A325 bolt

Tension 13.5 Kips/bolt >> 283# OK

Shear 3.68 Kip/bolt >> 80# OK

↑ assume SC Class A, LSL (conservative)

[X] HEADQUARTERS:
795 REYNOLDS INDUSTRIAL PARK ROAD
GREENVILLE, PA 16125
PHONE (412) 646-1500
FAX (412) 646-1505 (LAB)

DAMASCUS-BISHOP TUBE COMPANY, INC.

MARCEGAGLIA GROUP

[ ] PO BOX 1189, RT. 30 & MALIN ROAD
FRAZER, PA 19355
PHONE (610) 647-3450
FAX (610) 647-2540

CERTIFICATE OF TEST

MILL ORDER NO.	5-3054-01
PURCHASE ORDER NO.	614954
DATE SHIPPED	02/21/95

SPECIFICATIONS
WELDED ASTM A312-92x AND/OR
ASME SA312-92 SMAIN

OTHER SPECIFICATIONS

SOLD TO [redacted]

SHIP TO SAME

FLAR	HYDRO	FLAT	FLAN	EDDY	MAND	RFLT
OK	OK	OK	OK	OK		

ADDITIONAL INFO.
MATERIAL SOLUTION ANNEALED AT 2,000 F FOR 1 HOUR PER INCH OF THICKNESS AND WATER QUENCHED BELOW 800 F IN LESS THAN 3 MINUTES.

ITEM	TYPE	O.D./I.P.S.	GA./SCH.	HEAT NO.	CARBON	MANG.	PHOS.	SULPHUR	SILICON	CHROMIUM	NICKEL	MOLY.	COPPER	COBALT	TI				
03	TP304/TP304L	3"	10	142921	.023	1.61	.029	.015	.57	18.18	9.01	.35	.32	.13					
09	TP304/TP304L	1-1/2"	40	6273	.023	1.66	.028	.017	.28	18.20	8.45	.29	.22						
	TP304/TP304L	1-1/2"	40	865314	.024	1.83	.025	.046	.47	18.29	8.34	.33	.40	.07					

ITEM	ROCKWELL HARDNESS	YIELD STRENGTH (PSI)	TENSILE STRENGTH (PSI)	ELONGATION	HYDRO PSI (IF APPLICABLE)	MELT SOURCE (IF APPLICABLE)	PIECES	FOOTAGE
03	B78	39,500	85,200	51%	1000		25	525'
09	B78	35,600	79,700	65%	2300	D	5	104'
	B82	75,400	91,700	55%	2300			

WE CERTIFY THAT THE CHEMICAL, PHYSICAL OR MECHANICAL TESTS REPORTED HEREIN ARE CORRECT AS SHOWN ON OUR RECORDS.

DAMASCUS

[signature]
Q.C. MANAGER

12/94

00422

AST AVESTA SHEFFIELD PIPE
AVESTA SANDVIK TUBE, INC.
Rt. 2, Box 1A, Hwy. 301 N.
Wildwood, FL 34785

Material Test Report

SOLD TO

BUYER ORDER NO. 554392

DATE SHIPPED 8-25-94

MILL ORDER NO. C056649 3095 1-13,11,12 10,1

ITEM	QUANTITY	DESCRIPTION	SPECIFICATIONS & PROCEDURES
5050DD	104' 9"	6" SCH 40S NPS TP316/TP316L	ASTM A312-93, ASME SA312-93,Welded
1320BD	524' 7"	4" SCH 40S NPS TP304/TP304L	ASTM A312-93, ASME SA312-93,Welded
5050BD	94' 2"	6" SCH 40S NPS TP304/TP304L	ASTM A312-93, ASME SA312-93,Welded
1310BD	627' 7"	4" SCH 10S NPS TP304/TP304L	ASTM A312-93, ASME SA312-93,Welded
1040DD	210' 0"	1/2" SCH 10S NPS TP316/TP316L	ASTM A312-93, ASME SA312-93,Welded

CHEMICAL ANALYSIS

ITEM	HEAT NO.	PLATE HEAT ANAL.	PLATE PROD. ANAL.	WELD ANAL.	C	Mn	P	S	Si	Cr	Ni	Mo	N_2	Ti	Cb/Ta
050DD	9712				.017	1.78	.027	.003	.56	17.02	11.92	2.20			
320BD	9699				.010	1.77	.027	.002	.52	18.14	9.87				
	9512				.014	1.86	.027	.001	.46	18.19	9.73				
050BD	716735				.021	1.76	.030	.014	.43	18.16	8.32				
310BD	716707				.024	1.80	.024	.012	.42	18.21	8.78				
	A2800				.014	1.37	.024	.009	.46	18.30	9.10				
	916694				.021	1.74	.029	.013	.38	18.49	8.22				
04[illegible]	714839				.019	1.81	.027	.016	.40	16.44	10.24	2.08			

MECHANICAL TESTS

ITEM	HEAT NO.	PLATE	PIPE	YIELD PSI	TENSILE PSI	EL IN 2"	HARD	HYDRO T.P	FLARE	FLNG	FLAT	REV FLAT	EDDY TEST	GUIDED BENDS FACE/ROOT/SIDE
050DD	9712			41,290	80,086	50		1300						ok
320BD	9699			40,110	82,600	48		1600			ok			
	9512			35,700	83,390	56		1600			ok			
050BD	716735			48,592	89,953	44		1300						ok
310BD	716707			41,180	87,000	56		800			ok			
	A2800			46,649	89,639	52		800			ok			
	916694			44,186	87,860	54	RB75	800			ok			
040DD	714839			46,500	85,600	61	RB80	2500			ok			

CERTIFICATION/REMARKS

CAUTION: "Processing that produces fumes and dust may cause respiratory disease: Especially alloys containing Chromium and Nickel."

HEAT TREATMENT

Solution annealed at a minimum of 1900°F and water quenched to below 800°F within 3 minutes.

WE CERTIFY THAT THE ANALYSIS FIGURES ARE CORRECT AS CONTAINED IN THE RECORDS OF THE COMPANY AND THAT THE MATERIAL IS FREE FROM MERCURY AND LOW MELTING ALLOY CONTAMINATION.

THE AVESTA GROUP

Sworn and subscribed to before me this _______ 19_______

QUALITY CONTROL DEPARTMENT

TRINITY INDUSTRIES, INC.
HEAD DIVISION
11861 MOSTELLER RD * CINCINNATI OH 45241 * (513)-771-2300
MTR COVER LETTER

WRIGHT-AUSTIN
3245 WIGHT ST
DETROIT MI 48207-4347

ATTN : Q. C. MANAGER

REFERENCE : CUSTOMER P/O 442 , TAG #
TRINITY S/O 2-23974

GENTLEMEN :

ATTACHED ARE COPIES OF MILL TEST REPORTS FOR THE FOLLOWING MATERIAL PROVIDED ON YOUR REFERENCED PURCHASE ORDER.

HEADS FROM STOCK
2-SA240-304L ELLIPTICAL HEAD 14.0000 OD 0.1875 THICK
WITH 2.8125 SF.

HEAT NUMBER

2522262- A5103000

ALL HEADS WERE COLD FORMED AND ARE IN COMPLIANCE WITH REGULATION UG - 81 AND UG - 79 AS STATED IN SECTION VIII DIVISION I OF THE ASME BOILER AND PRESSURE VESSEL CODE. HEADS WERE FORMED WITHOUT COMING IN CONTACT WITH MERCURY OR ANY OF IT'S COMPOUNDS.

IF YOU HAVE ANY FURTHER QUESTIONS CONCERNING MILL TEST REPORTS ONLY, PLEASE CONTACT ME IN CINCINNATI, OHIO AT 1-800-543-1644.

VERY TRULY YOURS,
Charnie Bryant
TRINITY INDUSTRIES, INC
HEAD DIVISION 8/11

8/10/95

JUN 30'95 8:29 FR WASHINGTON STE 412 228 9893 TO 17084594657 P.02/5

166163

(413523

WASHINGTON STEEL

A [illegible] COMPANY

P.O. Box 494, Woodland & Griffith Aves.
Washington, PA 15301-0494
412-222-8000 or 800-705-4960

CERTIFICATE OF ANALYSIS

DATE 06/24/95

TO: WASHINGTON SPECIALTY METALS
1400 EAST LAKE COOK RD
SUITE 150
BUFFALO GROVE, ILLINOIS 60089

CUSTOMER'S P.O. NO. W3539 MILL ORDER NO. X2275

TYPE 304L FINISH HRAP ITEM 01

SIZE .1875 X 48 X CL PCS. 2

ASTM-A-240-93b ASME-SA-240-92 ASTM-A-167-93 QQS-766-D-COND. A
MATERIAL IS FREE FROM MERCURY CONTAMINATION.
THIS ANALYSIS MEETS THE REQUIREMENTS OF TYPE 304.
MIN. SOLUTION ANNEALED TEMP. 1925 NO WELD REPAIRS WERE PERFORMED.

CAUTION: PROCESSING THAT MAKES FUMES, DUST, OR SOLUTIONS MAY CAUSE LUNG DISEASE. SEE MATERIAL SAFETY DATA SHEET SUPPLIED TO YOUR PURCHASING DEPARTMENT FOR FURTHER INFORMATION.

HEAT #	C	MN	P	S	SI	CR	NI	CU	CO	N	MO
252262	.013	1.47	.028	.010	.49	18.29	9.03	.22	.16	.09	.30

COIL #	YIELD PSI	ULTIMATE PSI	% EL IN 2''	HARDNESS ROCKWELL	IC	BENDS
5102999(1)	43,220	88,930	53.8	B82.7	OK	OK
5103000(1)	44,280	89,190	56.5	B82.2	OK	OK

TOTAL WEIGHT OF SHIPMENT 44,930

IC = INTERGRANULAR CORROSION

...st values indicate capability of the tests to meet or exceed the listed ...ecifications.

...ingly and willfully falsifying or concealing a material fact on this ... making false or fictitious or fraudulent entries on this form ... constitute a felony punishable under federal law.

I hereby certify that the above figures are correct as contained in the records of Washington Steel Corporation.

[signature]

METALLURGICAL DEPARTMENT
Authorized signature per

[handwritten: 11/20/95]

AVESTA SHEFFIELD PIPE

Material Test Report

:STA SANDVIK TUBE, INC.
2. Box 1A, Hwy. 301 N.
:twood, FL 34785

[redacted]

BUYER ORDER NO.	DATE SHIPPED
80-S-34688	7-5-94

MILL ORDER NO.
C054472 2955 1-4

:EM	QUANTITY	DESCRIPTION	SPECIFICATIONS & PROCEDURES
BP	302' 9.25"	14" SCH 10(250)NPS Tp304/304L 14.000" x .250" WALL	ASTM A312-93, ASME SA312-92, Welded

CHEMICAL ANALYSIS

:EM	HEAT NO.	PLATE HEAT ANAL.	PLATE PROD. ANAL.	WELD ANAL.	C	Mn	P	S	Si	Cr	Ni	Mo	N_2	Ti	Cb/Ta
3P	241658				.017	1.53	.031	.016	.46	18.15	9.00				

MECHANICAL TESTS

:EM	HEAT NO.	PLATE	PIPE	YIELD PSI	TENSILE PSI	EL' IN 2"	HARD	HYDRO	[redacted]	GUIDED BENDS FACE/ROOT/SIDE
3P	241658			43,802	86,997	50		550		ok

This report, to which this stamp is affixed, is a copy of the original supplier's test report. There is indicated, not only the complete identification of this material but also a record of tests made in accordance with specification requirements. If several items are shown in this report, those items which are shipped to you are checked (✓) as being pertinent. We certify herewith that the material supplied to you is completely identifiable by this document.

Cust. P.O. 2744
Part No. 60-001021
I.T.C Order No. 96197
Date 8-7
Q.C. Signature MW

:ERTIFICATION/REMARKS

ION: "Processing that produces fumes and dust may cause respiratory disease: Especially alloys containing Chromium and Nickel."

HEAT TREATMENT

Solution annealed at a minimum of 1900°F and water quenched to below 800°F within 3 minutes.

VE CERTIFY THAT THE ANALYSIS FIGURES ARE CORRECT AS CONTAINED IN THE RECORDS OF THE COMPANY AND THAT THE MATERIAL IS FREE FROM MERCURY AND LOW MELTING ALLOY CONTAMINATION.

Q.C. REVIEWED 7/11/94 PJL

FORM U-1A MANUFACTURER'S DATA REPORT FOR PRESSURE VESSELS
(Alternate Form for Single Chamber, Completely Shop-Fabricated Vessels only)
As Required by the Provisions of the ASME Code Rules, Section VIII, Division 1

1. Manufactured and certified by WRIGHT- AUSTIN COMPANY 3250 Franklin Street, Detroit, Michigan 48207
(Name and address of manufacturer)
2. Manufactured for COURTNEY & NYE, PO BOX 9, HILLSBORO, OR. 97123
(Name and address of purchaser)
3. Location of installation UNKNOWN
(Name and address)
4. Type: Vertical (Horiz. or vert. tank) 15792 (Mfgr's serial no.) ------------ (CRN) A-21968 (Drawing no.) 10700 (Nat'l. Bd.No.) 1995 (Year built)
5. The chemical and physical properties of all parts meet the requirements of material specifications of the ASME BOILER AND PRESSURE VESSEL CODE. The design, construction and workmanship conform to ASME Rules, Section VIII, Division 1: 1992 (Year) to 12-31-94 (Addenda (Date)) ----- (Code Case Nos.) ----- (Special Service per UG-120(d))
6. Shell: SA-312Tp.304L (Matl. (Spec. No., Grade)) 1/4" (Nom. Thk (in.)) ------ (Corr. Allow. (in.)) 1' -1 1/2" (Diam. I.D. (ft. & in.)) 1' -10 5/8" (Length (overall) (ft. & in.))
7. Seams: UW12(1) (Long. (Welded, Dbl., Sngl., Lap, Butt)) None (R.T. (Spot or Full)) 70% (Eff. (%)) ----- (H.T. Temp. (F)) ---- (Time (hr)) UW12(1) (Girth (Welded, Dbl., Sngl., Lap, Butt)) None (R.T. (Spot, Partial, or Full)) One (No. of Courses)
8. Heads: (a) Matl. SA-240Tp.304L (Spec. No., Grade) (b) Matl. SA-240Tp.304L (Spec. No., Grade)

	Location (Top, Bottom, Ends)	Minimum Thickness	Corrosion Allowance	Crown Radius	Knuckle Radius	Elliptical Ratio	Conical Apex Angle	Hemispherical Radius	Flat Diameter	Side to Pressure (Convex or Concave)
a)	Top	.125"	—	---	---	2:1	---	---	—	Concave
b)	Bottom	.125"	—	---	---	2:1	---	---	---	Concave

If removable, bolts used (describe other fastenings) -------------------- (Matl., Spec. No., Gr., Size, No.)

9. MAWP: FV 15 psi at max. temp 200 °F
Min design metal temp. *-20 °F at FV 15 psi . Hydro., pneu. or comb. test pressure 29 psi.

10. Nozzles, inspection and safety valve openings:

Purpose Inlet Outlet, Drain)	No.	Diam. or Size	Type	Matl.	Nom. Thk.	Reinforcement Matl.	How Attached	Location
Inlet/Outlet	2	6"	CL150FLG.	SA312/304L	.280"	Inherent	UW16.1(C)	----
Drain	1	1 1/2"	CL150FLG.	SA312/304L	.145"	Inherent	UW16.1(C)	----
Insp. Opening	1	1 1/2"	THD'DCPLG	SA182F 304	3000#	Inherent	UW16.1(Y-2)	----
Other	1	1/2"	THD'DCPLG	SA182F 304	3000#	Inherent	UW16.1(Y-2)	----

11. Supports: Skirt No (Yes or no) Lugs 2 (No.) Legs 4 (No.) Other ----- (Describe) Attached SHELL WELDED (Where and How)
12. Remarks: Manufacturer's Partial Data Reports properly identified and signed by Commissioned Inspectors have been furnished for the following items of this report:
(Name of part, item number, Mfgr's. name and identifying stamp)
6" TYPE "33L" GAS/LIQUID SEPARATOR

*UHA-51a ** FACTORY MUTUAL ENGINGEERING ASSOCIATION

CERTIFICATE OF SHOP COMPLIANCE

We certify that the statements made in this report are correct and that all details of design, material, construction, and workmanship of this vessel conform to the ASME Code for Pressure Vessels, Section VIII, Division 1. "U" Certificate of Authorization No 1070 expires Feb. 28 ,1998
Date 8/30/95 Co. name WRIGHT- AUSTIN COMPANY (Manufacturer) Signed Daniel Chauor (Representative)

CERTIFICATE OF SHOP INSPECTION

Vessel constructed by WRIGHT- AUSTIN COMPANY at 3250 Franklin Street, Detroit, Michigan 48207
I, the undersigned, holding a valid commission issued by The National Board of Boiler and Pressure Vessel Inspectors and the State or Province of Michigan and employed by Arkwright Mutual Insurance Company of Norwood, Mass have inspected the component described in this Manufacturer's Data Report on 8/30 , 19 95 and state that, to the best of my knowledge and belief, the Manufacturer has constructed this pressure vessel in accordance with ASME Code, Section VIII, Division 1. By signing this certificate neither the Inspector nor his employer makes any warranty, expressed or implied, concerning the pressure vessel described in this Manufacturer's Data Report. Futhermore, neither the Inspector nor his employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.
Date 8/30 ,19 95 Signed Robert R. Thompson (Authorized Inspector) Commissions **NB7491 A, Ohio 2/1/96, Mich... (Nat'l Board (incl. endorsements) State, Prov. and No.)

WRIGHT-AUSTIN COMPANY

3250 FRANKLIN STREET, DETROIT, MICHIGAN 48207
PHONE (313) 259-1925 • FAX (313) 259-1962

Established in 1894

HYDROSTATIC TEST CERTIFICATE

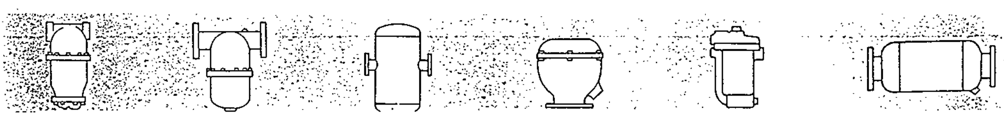
Wright-Austin 6" Type "33 L"Receiver/ Separator
Carbon Steel (FV TO 15 PSI @ 200°F)

Reference: COURTNEY & NYE
PO BOX 9
HILLSBORO, OR. 97123

YOUR PURCHASE ORDER #: 95-455
OUR ORDER #: 02848
SERIAL #: 15792
Date: 8/30/95

We, the Wright-Austin Company certify that the 6" Type '33 L' Separator supplied on the above referenced purchase order, was hydrostatically tested, per ASME Code Section VIII, Division 1, UG99, at 29 PSI for 20 minutes with no apparent leakage.

Daniel Charron
Q.C. Inspector



WRIGHT-AUSTIN COMPANY

WRIGHT-AUSTIN 1894

3250 FRANKLIN STREET, DETROIT, MICHIGAN 48207
PHONE (313) 259-1925 • FAX (313) 259-1962

Established in 1894

CERTIFICATE OF CONFORMANCE
PENETRANT INSPECTION

Serial Number: 15792 Date: 9/1/95

All penetrant inspection was accomplished per ASME CODE Section V, and found to be acceptable.

Penetrant	DP-40
Cleaner	DR-61
Developer	100-NF

Before Load Test

Penetrant Dwell Time: 10 Minutes

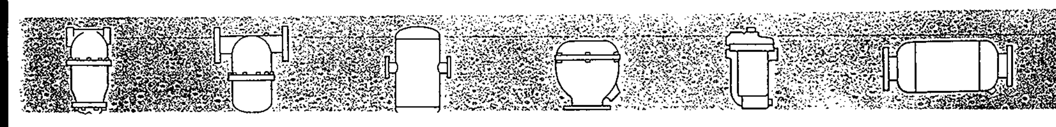
Developer Dwell Time: 2 Minutes Q. C. Inspection: Daniel Charron

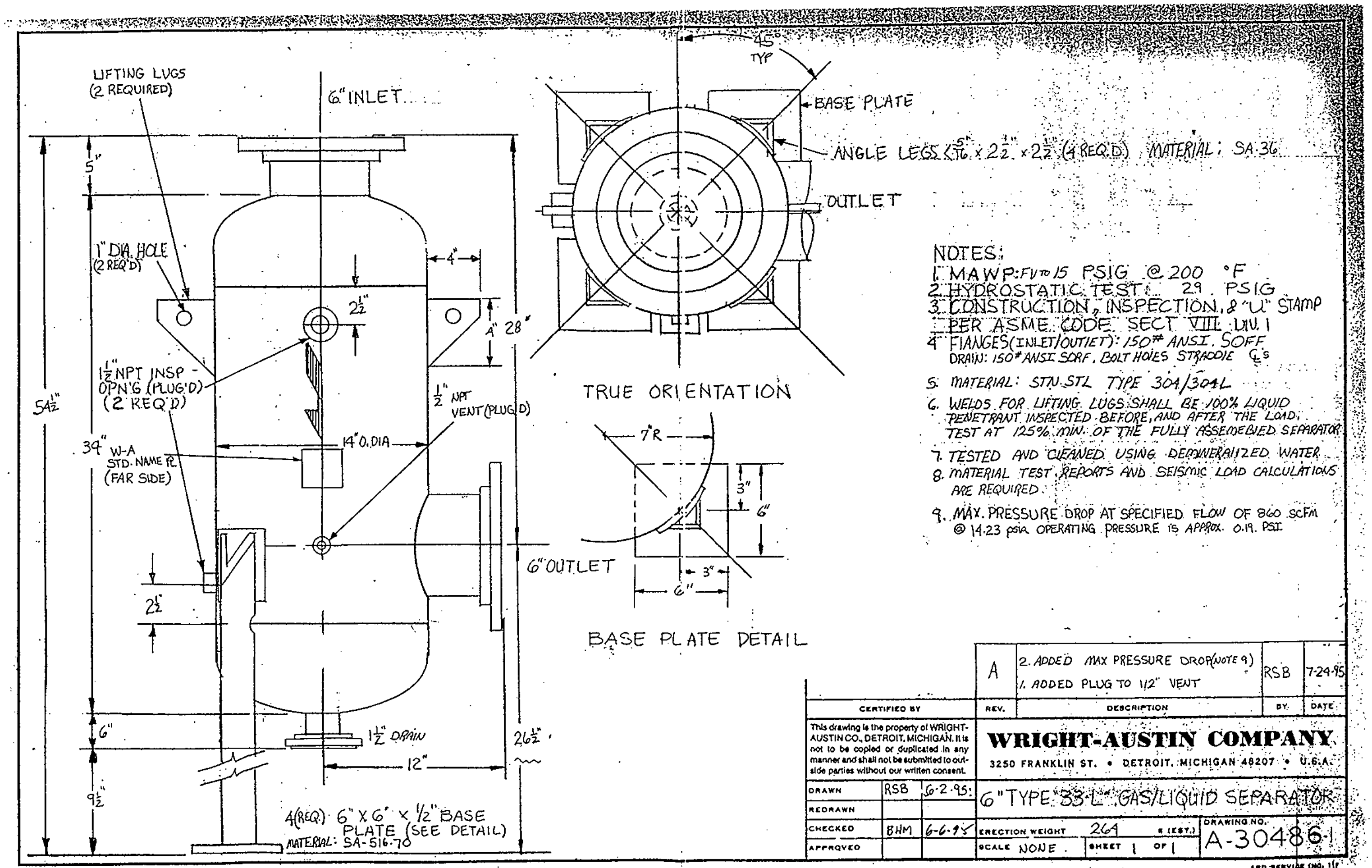
After Load Test

Penetrant Dwell Time: 10 Minutes

Developer Dwell Time: 2 Minutes Q. C. Inspection: Daniel Charron

Unit Weight: 245 lbs.
Load Test Weight: 307 lbs.




LIFTING LUGS (2 REQUIRED)
6" INLET
1" DIA. HOLE (2 REQ'D)
1½" NPT INSP - OPN'G (PLUG'D) (2 REQ'D)
W-A STD. NAME PL (FAR SIDE)
½" NPT VENT (PLUG'D)
14" O.DIA
6" OUTLET
1½" DRAIN
4(REQ) 6" X 6" X ½" BASE PLATE (SEE DETAIL)
MATERIAL: SA-516-70
45° TYP
BASE PLATE
ANGLE LEGS 5/16 x 2½" x 2½" (4 REQ'D) MATERIAL: SA-36
OUTLET
TRUE ORIENTATION
BASE PLATE DETAIL
NOTES:
1. MAWP: FV to 15 PSIG @ 200 °F
2. HYDROSTATIC TEST: 29 PSIG
3. CONSTRUCTION, INSPECTION, & "U" STAMP PER ASME CODE SECT VIII DIV. 1
4. FLANGES (INLET/OUTLET): 150# ANSI. SOFF DRAIN: 150# ANSI SORF, BOLT HOLES STRADDLE ℄'s
5. MATERIAL: STN. STL TYPE 304/304L
6. WELDS FOR LIFTING LUGS SHALL BE 100% LIQUID PENETRANT INSPECTED BEFORE, AND AFTER THE LOAD TEST AT 125% MIN. OF THE FULLY ASSEMBLED SEPARATOR
7. TESTED AND CLEANED USING DEMINERALIZED WATER
8. MATERIAL TEST REPORTS AND SEISMIC LOAD CALCULATIONS ARE REQUIRED
9. MAX. PRESSURE DROP AT SPECIFIED FLOW OF 860 SCFM @ 14.23 psia OPERATING PRESSURE IS APPROX. 0.19 PSI
A 2. ADDED MAX PRESSURE DROP (NOTE 9) 1. ADDED PLUG TO 1/2" VENT RSB 7-24-95
CERTIFIED BY
REV. DESCRIPTION BY DATE
This drawing is the property of WRIGHT-AUSTIN CO., DETROIT, MICHIGAN. It is not to be copied or duplicated in any manner and shall not be submitted to outside parties without our written consent.
WRIGHT-AUSTIN COMPANY
3250 FRANKLIN ST. • DETROIT, MICHIGAN 48207 • U.S.A.
DRAWN RSB 6-2-95
REDRAWN
CHECKED BHM 6-6-95
APPROVED
6" TYPE 33-L GAS/LIQUID SEPARATOR
ERECTION WEIGHT 264 # (EST.)
SCALE NONE
SHEET 1 OF 1
DRAWING NO. A-30486-1

APPENDIX - H

Heater Drawings and Qualification Report

ENG-329
Rev. 1

ELECTRICAL DEVICE & WIRING CHECK REPORT

Unit Tag No.: K07C1

Date: 4-16-96

S/N 151660

DEVICE CHECK	ACCEPTABLE	UNACCEPTABLE
CONTACT CONFIGURATION OF RELAYS	✓	
CONTACT CONFIGURATION OF CONTROL & INSTRUMENT SWITCHES	✓	
CONTACT OPERATION	✓	
SPRING RETURN OPERATION	✓	

WIRING CHECK	ACCEPTABLE	UNACCEPTABLE
POINT TO POINT CHECK	✓	
CONTINUITY CHECK	✓	

Signed: (Technician) [signature]

(Q.C.) [signature]

Approved: (Eng.) [signature] 4/96

ELLIS & WATTS BATAVIA, OHIO 45103	SIZE A	CAGE CODE 98437	
ELECTRICAL DEVICE & WIRING CHECK REPORT ENG 253	TEST REPORT	PAGE	REV.

K0701 [illegible]

ELECTRIC HEATING COIL FUNCTIONAL TEST REPORT

ENG-325
Rev. 2

E&W Heating Coil P/N K0701-2248

Mfg. Model No. 376-246-11-1 (AC121395-00JH)

Mfg Serial No. N/A

1. Visual Inspection: ✓ Accept (Check)

2. Circuit Continuity Test: Control Circuit ✓ Accept (Check)
   Heater Circuit ✓ Accept (Check)

3. Step controller or SCR (if applicable):
   Accpetance Criteria - proportional control of heater stages

   ✓ Accept ______ Not Applicable (Check one)

4. Power Lead Voltage and Amperage:

Record:

	Voltage	Amperage
L1	482	2.2
L2	486	2.3
L3	480	2.2

Acceptance Criteria -

Voltage High Limit = Nameplate Voltage x 1.07 = 513.6 VAC
Voltage Low Limit = Nameplate Voltage x 0.93 = 446.4 VAC

Amperage High Limit = (Nameplate Wattage x 1.05)/ (1.73 x Voltage Low Limit) = 2.719 Amps
Amperage Low Limit = (Nameplate Wattage x 0.95)/ (1.73 x Voltage High Limit) = 2.138 Amps

✓ Accept (Check)

List Test Equipment used including ID Numbers and Calibration date:

4339 Due 10-16-96
7623 Due 5-15-96

	SIGNATURE	COMPANY	DATE
Inspection Performed By:	[signature]	Ellis + Watts	4-16-96
E&W QA Witnessed By:	[signature]	ELLIS & WATTS	4-16-96
QA Witnessed By:	N/A	N/A	N/A

ELLIS & WATTS BATAVIA, OHIO 45103	SIZE A	CAGE CODE 98437		
	REPORT NO.		PAGE —	REV.
ELECTRIC HEATING COIL FUNCTIONAL TEST REPORT (SEE ENG-277)				

APPENDIX - I

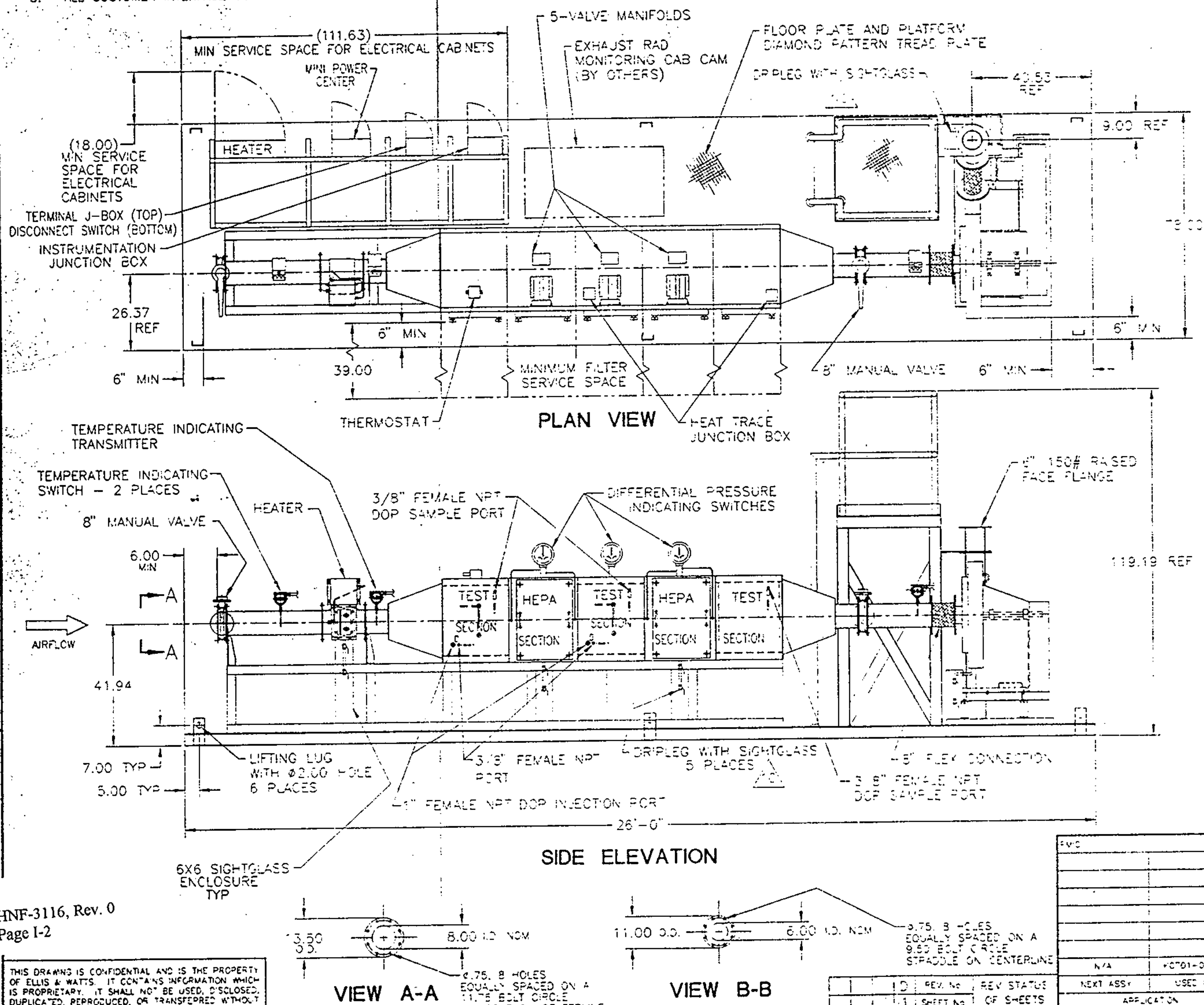
Housing Drawings

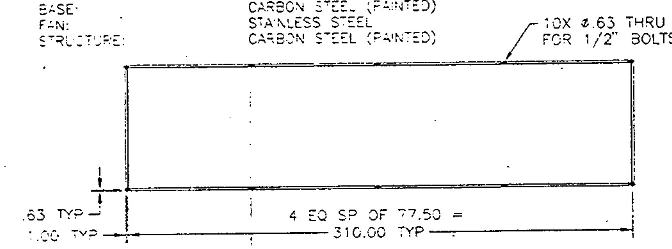
ZONE	LTR	DESCRIPTION	DATE (YR-MO-DA)	BY	APPROVED	ENGINEERING APPROVED	Q.A. APPROVED
	A	REVISED PER ECN-K0701-09	96-01-17	JPC	DPP 96-01-17	MAD 96-01-17	CEH 96-01-
	B	REVISED PER ECN-K0701-10	96-03-05	TEL	DPP 96-03-06	MAD 96-03-06	CEH 96-03-
	C	REVISED PER ECN-K0701-19	96-04-29	TEL	DPP 96-04-29	MAD 96-04-29	CEH 96-04-
	D	REVISED PER ECN-K0701-21	98-07-08	AJG	7/8/98	7/9/98	7/8/98

NOTES:

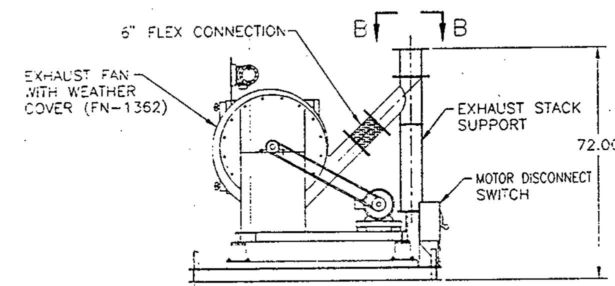
1. EXHAUST RAD MONITORING CAB CAM TO BE INSTALLED BY OTHERS.
2. SKID MOUNTING BY OTHERS.
3. WELDERS & WELDING PROCEDURES WILL BE IN ACCORDANCE WITH ASME SECTION IX.
4. PAINTING OF BASE, PLATFORM AND STRUCTURE WILL BE PER SECTION 3.5.4 EXCLUDING 3.5.4.4 OF SPEC. W-320-P1 REV. 0.
5. UNIT WILL BE SHIPPED LESS FILTERS INSTALLED.
6. HOUSING LEAK RATE TEST WILL BE PERFORMED PER E&W PROCEDURE ENG-204 REV. 3.
7. WELD INSPECTION WILL BE PER E&W PROCEDURE QA-111A REV. 0.
8. ALL CUSTOMER INTERFACE CONNECTIONS ARE NON-LOAD BEARING CONNECTIONS.
9. 1" THICK INSULATION WILL BE APPLIED TO UNIT FROM INLET MANUAL VALVE TO EXHAUST FLANGE ON FAN UNIT.
10. DRIPLEGS TO BE ENCLOSED WITH INSULATION AND HEAT TAPE.
11. STACK LOADS ON 6" OUTLET FLANGE WILL BE PER SKETCH ES-1 OF SPEC. W-320-P1 REV.0.
12. PIPE/TUBE WALL THICKNESS WILL BE 14 GA. MINIMUM. OF SPEC. W-320-P1 REV.0.
13. LIFTING OF SKID IS TO BE PERFORMED UTILIZING EQUAL WEIGHT DISTRIBUTION OF ALL SIX (6) LIFTING LUGS.

CUSTOMER:	WESTINGHOUSE HANFORD CO.
SPECIFICATION NO:	W-320-P1 REV 0
ELLIS & WATTS JOB NO:	K0701
PERFORMANCE:	
FILTER CAPACITY:	1000 CFM @ 1" W.G. CLEAN
FAN CAPACITY:	RANGE: 180 SCFM @ 19" S.P. TO 360 SCFM @ 42" S.P. NOMINAL FLOW: 230 SCFM
DESIGN TEMPERATURE:	150°F
DESIGN PRESSURE:	±50" W.G.
HEPA FILTER EFFICIENCY:	99.97% ON 0.3 MICRON PARTICLES
EST. WEIGHT:	3885 LBS EMPTY 3985 LBS OPERATING
MATERIALS:	
VALVES:	316 STAINLESS STEEL
PIPE:	304 STAINLESS STEEL
HOUSINGS:	304 STAINLESS STEEL
BASE:	CARBON STEEL (PAINTED)
FAN:	STAINLESS STEEL
STRUCTURE:	CARBON STEEL (PAINTED)





SKID MOUNTING PATTERN
SCALE: 1/2



END VIEW
PLATFORM AND BELT GUARD REMOVED FOR CLARITY

SYM	NOMENCLATURE	CAGE CODE	IDENTIFYING NO.	MATERIAL / SPECIFICATION	UNIT WT.	ZONE

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE: FRACTIONS ±N/A; DECIMALS .XX = 50, .XXX = N/A; ANGLES ±N/A. DO NOT SCALE DRAWING.

NEXT ASSY: N/A — USED ON: K0701-0101 — APPLICATION

DRAWN BY TEL 95-11-01; CHECKER CCL 95-12-01; ENGINEER DPP 95-12-01; QUALITY ASSURANCE APPROVAL JPL 95-12-01; ENGINEERING APPROVAL MAD 95-12-01

ELLIS & WATTS
DIVISION OF DYNAMICS CORPORATION OF AMERICA
CINCINNATI, OHIO

TITLE: FILTER TRAIN, VENTILATION EXHAUST A

SIZE D — CAGE CODE 98437 — DWG. NO. K0701-0101
SCALE 1/20 — UNIT WT. — SHEET 1 OF

APPENDIX - J

HEPA and Adsorber Clamping Device Drawings

ELLIS & WATTS (513) 752-9000
DIVISION OF DYNAMICS CORPORATION OF AMERICA (513) 752-4545

FACSIMILE COMMUNICATION

TO: Numatec Hanford Co. **DATE:** July 21, 1998

ATTENTION: Beth Vickstrom **MESSAGE NO.:**

FAX NO.: 509-372-0504

NUMBER OF PAGES(INCLUDING COVER SHEET 2 16

FROM: Michael A. Doersam

RE: Revised drawing

Dear Beth,

Attached is a copy of our factory visual inspection report for our project K0701. The stamp in the "Performed By" column is the stamp of our quality assurance inspector. A Hard copy of this report will be mailed to you today.

Regarding the clamping devices for the HEPA filters and Type II adsorber, the clamping device is considered proprietary information of Ellis & Watts. The drawings are on file as our facility for your review.

If you have any questions please do not hesitate to give me a call.

Regards,

Ellis & Watts
Michael A. Doersam

OPERATOR: Mike Doersam FAX: (513) 752-4545

4400 Glen Willow Lake Lane, Batavia, Ohio 45103

C:\OFFICE\WPWIN\WPDOCS\FAX\BETHV.WPD

APPENDIX - K

Manifold Drawings

ELLIS & WATTS
DIVISION OF DYNAMICS CORPORATION OF AMERICA
(513) 752-9000
FAX (513) 752-4983

July 14, 1998

Hanford Numetech
12 Jawin, Room 504S
Richland, WA 99352

Attn: Ms. Beth Vickstrom, MS B4-51

Reference: HEPA Test Section Qualification

Dear Ms. Vickstrom:

Attached you will find both a copy of our In-Place Test Section Qualification Procedure and a copy of the completed Test Report. The E&W In-Place Test Section is available in filter arrangements from 1 x 1 up to 1 x 4. The test section that was qualified was a 1 x 4 arrangement. The four filter wide test section has individual injection and sampling ports for each one of the four filters. Each section of the four wide test section was tested and the results verified the E&W test section met the requirements of ASME N509. Each section of our four wide test section meets the requirements of $\pm$ 20% of the calculated average reading (ASME N510, para 9.6). A test section for only one filter wide would demonstrate similar results.

Finally, the E&W in-place test section design is considered proprietary information. The complete shop drawings are available at our facility for your review. If you have any additional questions or need any additional information please do not hesitate to contact us.

Sincerely,

Michael A. Doersam

ELLIS & WATTS
Michael A. Doersam
Engineering Manager, Power Plant

4400 Glen Willow Lake Lane Batavia, Ohio 45103

APPENDIX - L

Factory Visual Inspection Report

MANUFACTURING AND QUALITY PLAN

JOB NO: K0701 MODEL NO: ACT

CUSTOMER: Westinghouse Hanford SERIAL NO: 15166

PRODUCT NAME: Air Clean Up Train

BASE WELDMENT AND DETAILS	PERFORMED BY	DATE
1. Fabricate per released E&W drawing K0701-0402, Rev. ∅ and K0701-0402-1, Rev. ∅.	EW 017K	2.27.96
2. Check dimensions at fix-up in accordance with drawing (see step 1 for dwg. no.).	EW 017K	3-1-96
3. Welding to be performed per approved procedure SM-12, Rev. 4.	EW 017K	3-5-96
4. Welds to be inspected for correct location and proper size per drawing (see step 1 for drawings no.).	EW 017K	3-5-96
5. Visually inspect welds per QA-111A, Rev. 8.	EW 017K	3-5-96
6. Verify and record welding operator initials. P.T. #1214	EW 017K	2.27.96
7. Record weld filler metal heat number. #V38585 P.O. 67446	EW 017K	2.27.96
8. Remove all excess splatter and slag from welded area. Clean all exterior welds and/or as noted on the drawings.	EW 017K	3-5-96
9. Remove all burrs and sharp edges.	EW 017K	3-5-96

MANUFACTURING AND QUALITY PLAN

JOB NO: K0701 MODEL NO: ACT

CUSTOMER: Westinghouse Hanford SERIAL NO: 15166

PRODUCT NAME: Air Clean Up Train

FILTER SUPPORT WELDMENT AND DETAILS	PERFORMED BY	DATE
1. Fabricate per released E&W drawing K0701-0403, Rev. A and K0701-0403-1, Rev. A.	EW 017K	3-6-96
2. Check dimensions at fix-up in accordance with drawing (see step 1 for dwg. no.).	EW 017K	3-15-96
3. Welding to be performed per approved procedure SM-12, Rev. 4.	EW 017K	3-15-96
4. Welds to be inspected for correct location and proper size per drawing (see step 1 for drawings no.).	EW 017K	3-15-96
→ 5. Visually inspect welds per QA-111A, Rev. 8.	EW 017K	3-15-96
6. Verify and record welding operator initials. P.T. # 1214	EW 017K	3-6-96
7. Record weld filler metal heat number. # 038585 P.O. 607446	EW 017K	3-6-96
8. Remove all excess splatter and slag from welded area. Clean all exterior welds and/or as noted on the drawings.	EW 017K	3-15-96
9. Remove all burrs and sharp edges.	EW 017K	3-15-96
Q.A. NOTE: FILTER SUPPORT WELDMENT COMPLETE EXCEPT ITEMS #607 GUSSET AND FORMED ANGLE TO BE LOCATED AT ASSY. SEE NOTE ON DWG. K0701-0403 ZONE C6	EW 017K	4-15-96

2

MANUFACTURING AND QUALITY PLAN

JOB NO: K0701 MODEL NO: ACT

CUSTOMER: Westinghouse Hanford SERIAL NO: 15166

PRODUCT NAME: Air Clean Up Train

PLATFORM WELDMENT AND DETAILS	PERFORMED BY	DATE
1. Fabricate per released E&W drawing K0701-0404, Rev. Ø and K0701-0404-1, Rev. Ø.	EW 017	3.12.96
2. Check dimensions at fix-up in accordance with drawing (see step 1 for dwg. no.).	EW 017	3.25.96
3. Welding to be performed per approved procedure SM-12, Rev. 4.	EW 017	3.25.96
4. Welds to be inspected for correct location and proper size per drawing (see step 1 for drawings no.).	EW 017	3.25.96
→ 5. Visually inspect welds per QA-111A, Rev. 8.	EW 017	3.25.96
6. Verify and record welding operator initials. P.T. #1214	EW 017	3.12.96
7. Record weld filler metal heat number. #J38585 P.O. 67446	EW 017	3.12.96
8. Remove all excess splatter and slag from welded area. Clean all exterior welds and/or as noted on the drawings.	EW 017	3.25.96
9. Remove all burrs and sharp edges.	EW 017	3.25.96
Q.A. NOTE: ~~PLATFORM~~ PLATFORM WELDMENT COMPLETE EXCEPT ITEM 6 ANGLE & ITEM 7 BRACKET TO BE LOCATED AT ASSY. REF DWG. K0701-0404 ZONE B6	EW 017	4.15.96

3

MANUFACTURING AND QUALITY PLAN

JOB NO: K0701 MODEL NO: ACT

CUSTOMER: Westinghouse Hanford SERIAL NO: 15166

PRODUCT NAME: Air Clean Up Train

FAN BASE WELDMENT	PERFORMED BY	DATE
1. Fabricate per released E&W drawing K0701-0405, Rev. A.	EW 017	3.25.96
2. Check dimensions at fix-up in accordance with drawing (see step 1 for dwg. no.).	EW 017	3.26.96
3. Welding to be performed per approved procedure SM-12, Rev. 4.	EW 017	3.27.96
4. Welds to be inspected for correct location and proper size per drawing (see step 1 for drawings no.).	EW 017	3.27.96
→ 5. Visually inspect welds per QA-111A, Rev. 8.	EW 017	3.27.96
6. Verify and record welding operator initials. P.T. #1214	EW 017	3.25.96
7. Record weld filler metal heat number. #J38585 P.O.67446	EW 017	3.25.96
8. Remove all excess splatter and slag from welded area. Clean all exterior welds and/or as noted on the drawings.	EW 017	3.27.96
9. Remove all burrs and sharp edges.	EW 017	3.27.96

4

MANUFACTURING AND QUALITY PLAN

JOB NO: K0701 MODEL NO: ACT

CUSTOMER: Westinghouse Hanford SERIAL NO: 15166

PRODUCT NAME: Air Clean Up Train

HEATER BOX ASSEMBLY AND DETAILS		PERFORMED BY	DATE
1.	Fabricate per released E&W drawing K0701-0407, Rev. Ø and K0701-0407-1, Rev. Ø.	EW 017K	4.10.96
2.	Check dimensions at fix-up in accordance with drawing (see step 1 for dwg. no.).	EW 017K	4.10.96
3.	Welding to be performed per approved procedure SM-10, Rev. 4.	EW 017K	4.10.96
4.	Welds to be inspected for correct location and proper size per drawing (see step 1 for drawings no.).	EW 017K	4.10.96
→ 5.	Visually inspect welds per QA-111A, Rev. 8.	EW 017K	4.10.96
6.	Verify and record welding operator initials. S.C. #1007	EW 017K	4.9.96
7.	Record weld filler metal heat number. #79607 P.O. 300851	EW 017K	4.9.96
8.	Remove all excess splatter and slag from welded area. Clean all exterior welds and/or as noted on the drawings.	EW 017K	4.10.96
9.	Remove all burrs and sharp edges.	EW 017K	4.10.96

5

MANUFACTURING AND QUALITY PLAN

JOB NO: K0701 MODEL NO: ACT

CUSTOMER: Westinghouse Hanford SERIAL NO: 15166

PRODUCT NAME: Air Clean Up Train

DUCT AND TRANSITION WELDMENT	PERFORMED BY	DATE
1. Fabricate per released E&W drawing K0701-0408, Rev. B.	EW 017	4.12.96
2. Check dimensions at fix-up in accordance with drawing (see step 1 for dwg. no.).	EW 017	4.12.96
3. Welding to be performed per approved procedure SM-10, Rev. 4.	EW 017	4.12.96
4. Welds to be inspected for correct location and proper size per drawing (see step 1 for drawings no.).	EW 017	4.12.96
→ 5. Visually inspect welds per QA-111A, Rev. 8.	EW 017	4.12.96
6. Verify and record welding operator initials. S.C. #1007	EW 017	4.9.96
7. Record weld filler metal heat number. #7967 P.O.302851	EW 017	4.9.96
8. Remove all excess splatter and slag from welded area. Clean all exterior welds and/or as noted on the drawings.	EW 017	4.12.96
9. Remove all burrs and sharp edges.	EW 017	4.12.96

6

MANUFACTURING AND QUALITY PLAN

JOB NO: K0701 MODEL NO: ACT

CUSTOMER: Westinghouse Hanford SERIAL NO: 15166

PRODUCT NAME: Air Clean Up Train

LAMP MOUNTING WELDMENT AND DETAILS	PERFORMED BY	DATE
1. Fabricate per released E&W drawing K0701-0410, Rev. A and K0701-0410-1, Rev. Ø.	EW 017	4.2.96
2. Check dimensions at fix-up in accordance with drawing (see step 1 for dwg. no.).	EW 017	4.3.96
3. Welding to be performed per approved procedure SM-12, Rev. 4.	EW 017	4.3.96
4. Welds to be inspected for correct location and proper size per drawing (see step 1 for drawings no.).	EW 017	4.3.96
→ 5. Visually inspect welds per QA-111A, Rev. 8.	EW 017	4.3.96
6. Verify and record welding operator initials. S.C. #1007	EW 017	4.2.96
7. Record weld filler metal heat number. #J38585 P.O.67446	EW 017	4.2.96
8. Remove all excess splatter and slag from welded area. Clean all exterior welds and/or as noted on the drawings.	EW 017	4.3.96
9. Remove all burrs and sharp edges.	EW 017	4.3.96

7

MANUFACTURING AND QUALITY PLAN

JOB NO: K0701 MODEL NO: ACT

CUSTOMER: Westinghouse Hanford SERIAL NO: 15166

PRODUCT NAME: Air Clean Up Train

ELECTRICAL CABINET SUPPORT ASSEMBLY	PERFORMED BY	DATE
1. Fabricate per released E&W drawing K0701-0406, Rev. A.	EW 017	4.1.96
2. Check dimensions at fix-up in accordance with drawing (see step 1 for dwg. no.).	EW 017	4.1.96
3. Welding to be performed per approved procedure SM-12, Rev. 4.	EW 017	4-2-96
4. Welds to be inspected for correct location and proper size per drawing (see step 1 for drawings no.).	EW 017	4.2.96
→ 5. Visually inspect welds per QA-111A, Rev. 8.	EW 017	4.2.96
6. Verify and record welding operator initials. P.T. #1214	EW 017	4.1.96
7. Record weld filler metal heat number. #J38585 P.O.67446	EW 017	4.1.96
8. Remove all excess splatter and slag from welded area. Clean all exterior welds and/or as noted on the drawings.	EW 017	4.2.96
9. Remove all burrs and sharp edges.	EW 017	4.2.96

8

MANUFACTURING AND QUALITY PLAN

JOB NO: K0701 MODEL NO: ACT

CUSTOMER: Westinghouse Hanford SERIAL NO: 15166

PRODUCT NAME: Air Clean Up Train

UNIT ASSEMBLY	PERFORMED BY	DATE
1. Fabricate per released E&W drawing K0701-0201, Rev. B.	E&W 017 (stamp)	4.13.96
2. Check dimensions at fix-up in accordance with drawing (see step 1 for dwg. no.).	E&W 017 (stamp)	4.13.96
3. Welding to be performed per approved procedures SM-10, Rev. 4, SM-12, Rev. 4 and GM-05-IX, Rev. 2.	E&W 017 (stamp)	4.10.96
4. Welds to be inspected for correct location and proper size per drawing (see step 1 for drawings no.).	E&W 017 (stamp)	4.13.96
→ 5. Visually inspect welds per QA-111A, Rev. 8.	E&W 017 (stamp)	4.13.96
6. Verify and record welding operator initials. P.T. #1214	E&W 017 (stamp)	4.8.96
7. Record weld filler metal heat number. #J38585 P.O.67446	E&W 017 (stamp)	4.8.96
8. Remove all excess splatter and slag from welded area. Clean all exterior welds and/or as noted on the drawings.	E&W 017 (stamp)	4.13.96
9. Remove all burrs and sharp edges.	E&W 017 (stamp)	4.13.96

9

MANUFACTURING AND QUALITY PLAN

JOB NO: K0701 MODEL NO: ACT

CUSTOMER: Westinghouse Hanford SERIAL NO: 15166

PRODUCT NAME: Air Clean Up Train

TESTING	PERFORMED BY	DATE
1. Verify VSD/Fan/Motor Assembly Performance Testing and Run In Test per K0701-VSD, Rev. 1 (customer hold point).	EW 017K	3-22-96
2. Verify performance of electrical device and wiring check per procedure ENG-253, Rev. 0.	EW 017K	4-16-96
→ 3. Verify performance of Housing Leak Test per procedure ENG-204, Rev. 3 (customer witness point).	EW 017K	4-15-96
4. Verify performance of Electric Heating Coil Functional Test per procedure ENG-277, Rev. 1.	EW 017K	4-16-96
5. Visual inspect unit for damage or manufacturing rework after test.	EW 017K	4-16-96
6. Verify completion of all test data sheets and forms.	EW 017K	4-16-96

MANUFACTURING AND QUALITY PLAN

JOB NO: K0701 MODEL NO: ACT

CUSTOMER: Westinghouse Hanford SERIAL NO: 15166

PRODUCT NAME: Air Clean Up Train

FINAL ASSEMBLY/INSPECTION	PERFORMED BY	DATE
11. Verify installation of all gasket and sealant materials.	EW 017K	4.29.96
12. Verify configuration and dimensional conformance to approved drawing K0701-0101, Rev. B.	EW 017K	4.29.96
13. Verify that all fasteners have been tightened and provided with lockwashers and other miscellaneous hardware necessary.	EW 017K	4.29.96
14. Verify proper tagging of electrical wiring and components.	EW 017K	4-26.96
15. Verify the removal of chips, dirt, and other foreign materials.	EW 017K	4-29.96
16. Verify proper location of all piping and electrical connections.	EW 017K	4-29.96
→ 17. Welds for lifting attachments shall be 100% visually inspected per QA-111A, Rev. 8 and 100% Liquid Penetrant inspected per QA-140, Rev. 9 (Document results on QC-72). (SEE NEXT PAGE)	EW 02K Performed at Assy. (Prior to painting)	3/14/96
18. Verify that there are no suspect fasteners used as identified on the attached Figure QI 15.6-2, Suspect Headmark List.	EW 017K	4.29.96

10

Form QC-72
Rev. 2

Liquid Penetrant Inspection Data Sheet

E&W Job No.: K0701 Per L.P. Procedure: QA-140 Method: Solvent Removable
Customer: WESTINGHOUSE HANFORD P.O. or Contract No. WX4-XDV-80203
E&W S/N: 15166 E&W Model No.: ACT
E&W Part No.: 89Y Quantity: 6 LIFT LUGS (see Below)

PRECLEANER: Batch No.: 93J 04P Material: SKC-S (Magnaflux)
Method Cleaned By: Clean lint free cloth ~~or paper towel~~ with cleaner
Drying Time: As needed to allow cleaner to evaporate

PENETRANT: Batch No.: 93K 02P Material: SKL-HF/S or SKL-SP (Magnaflux)
Method Applied By: ~~Spraying, dipping or~~ brushing
Dwell Time: 5 minutes min./30 minutes max.

PENETRANT REMOVAL: Batch No.: 93J 04P Material: SKC-S (Magnaflux)
Method Removed By: Dry cloth or paper towel/moist cloth ~~or paper towel~~/dry cloth ~~or paper towel.~~
Drying Time (Prior to applying developer): 5 minutes min./ 15 minutes max.

DEVELOPER: Batch No.: 93K06K 11351 Material: SKD-S2 (Magnaflux)
Method Applied By: Spray
Developing Time: 7 minutes min./30 minutes max.

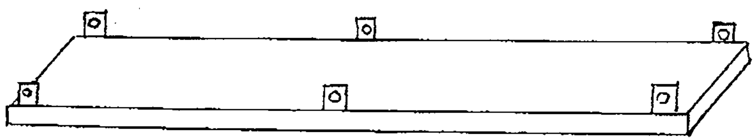
ACC/REJ CRITERIA: ☒ QA-111A (AWS D1.1 & ASME IX) ☐ QA-111C (ANSI B31.1, B31.5) ☐ QA-111B (Mil-Std-2219) ☐ QA-111D (AWS D1.2, ASME IX)

INSPECTION RESULTS: Accept [stamp] Reject ______

POST CLEANING: Batch No.: 93J 04P Material: SKC-S (Magnaflux)
Method Removed By: Dry cloth or paper towel/moist cloth or paper towel/dry cloth or paper towel

ITEM AND/OR DEFECT DETAIL:

100% VISUAL INSPECTION & 100 LIQUID PENETRANT INSPECTION OF ALL LIFT LUG WELDS (6 LIFT LUGS, WELDED TOP & BOTTOM).



TECHNICIAN: [signature] LEVEL: III DATE: 3/14/96

ELLIS & WATTS ROGER R. SCHERTLER BATAVIA, OH

11

APPENDIX - M

Factory Housing Leak Test Results

FIGURE I
HOUSING LEAK RATE TEST REPORT

E&W Job No. K0701 Customer Spec. or P.O. No. ______

Unit Serial No. 15166 Customer Name WESTINGHOUSE HANFORD

Part No. 89Y

Test Engineer (Sign/Date and Print Name) Emery S Saxton 4-15-96 EMERY S SAXTON

Inspector (Sign/Date and Print Name) M Bogard 4-15-96 MEL BOGARD

Distribution:

☐ QA File ☐ Customer (if required) ☐ Other (specify) ______

Test Equip. C.I.D. No. 76026, 76038, ______

Test Method Used

☐ Pressure Decay, Sec. 5.1, ENG-204

☐ Direct Pressure, Sec. 5.2, ENG-204

This unit was tested in accordance with Housing Leak Rate Test Procedure ENG-204 and found to have a leak rate of 0.793 which is

☑ Less than or equal to maximum allowable leak rate of 10 CFM.

☐ Greater than the maximum allowable leak rate of ______.

If leak rate found is greater than the specified acceptance value, complete the following sections:

Leaks were located by the following method: (check one)

☐ ENG-205, Section 6.2, Bubble Method

☐ Spray D.O.P. Method

☐ Liquid Penetrant Method

☐ Other (specify) ______

The number, location and type of leaks were:

______

______

______

The defects were repaired by the removal of the defective area by:

☐ Removal of the weld and rewelding with approved Procedure ______.

☐ Other ______.

☐ Retested in accordance with E&W ENG-205, Section ______, and determined to have a leak rate of ______ which is less than or equal to maximum allowable leak rate of ______.

2

FIGURE 2

HOUSING LEAK RATE TEST REPORT

DATA AND CALCULATION – PRESSURE DECAY METHOD (ENG-204, Section 5.1)

E&W Job No. K0701 Customer Spec. or P.O. No. ______

Unit Serial No. 15166 Customer Name WESTINGHOUSE HANFORD CO

Part No. 89Y

Test Engineer (Sign/Date and Print Name) [signature] 4-15-96 EMERY S SAXTON

Inspector (Sign/Date and Print Name) [signature] 4-15-96 MEL BOGARD

Distribution:

△ QA File △ Customer (if required) △ Other (specify) ______

Initial Test YES Retest No. ______

I. Test Equipment Used (List description and CID No.)

1. 7626
2. 7638
3. ______

II. Conversion Factors

1" w.g.= 5.204 lb/ft²

°R = °F + 460

P_{abs} = Gage Pressure and Barometric Pressure

1" Hg= 70.73 lb/ft²

III. Test Data

V = 81.1 ft³

Barometric Pressure (BP) = 28.84 " Hg

Design Pressure (P_o) = –50 " w.g.

Time, Temperature and Pressure Readings

ti 5 min.

Ti 72 °F

Pi –50 " w.g.

Individual Pressure Readings @ 1 minute intervals

P_1 50 " w.g.	P_6 ____ " w.g.	P_{11} ____ " w.g.
P_2 46 " w.g.	P_7 ____ " w.g.	P_{12} ____ " w.g.
P_3 38 " w.g.	P_8 ____ " w.g.	P_{13} ____ " w.g.
P_4 36 " w.g.	P_9 ____ " w.g.	P_{14} ____ " w.g.
P_5 30 " w.g.	P_{10} ____ " w.g.	P_{15} ____ " w.g.

tf = 15 min. or t @ 75% P_o = 5 min.

Tf = 72° °F

Pf = 30 P_{15} or 75% P_o = ______ " w.g.

3

FIGURE 2
HOUSING LEAK RATE TEST REPORT
DATA AND CALCULATION - PRESSURE DECAY METHOD (ENG-204, Section 5.1)

E&W Job No. K0701 Customer Spec. or P.O. No. ____
Unit Serial No. 151660 Customer Name WESTINGHOUSE HANFORD C.O.
Part No. 89Y
Test Engineer (Sign/Date and Print Name) [signature] 4-15-96 EMERY S SAXTON
Inspector (Sign/Date and Print Name) [signature] 4-15-96 MEL BOGARD
Distribution:
△ QA File △ Customer (if required) △ Other (specify) ____

IV. Calculation of Leak Rate

A. Conversion of Readings

1. Convert °F to °R

Ti = 72 °F + 460 = 532 °R

Tf = 72 °F + 460 = 532 °R

2. Convert P (" w.g.) to P (lb/ft²)

Pi = -50 " w.g. x 5.204 = -260.20 lb/ft²

Pf = -30 " w.g. x 5.204 = -156.12 lb/ft²

3. Convert BP ("Hg) to BP (lb/ft²)

BP = 28.84 " Hg x 70.73 = 2039.85 lb/ft²

4. Convert P_{gage} to P_{abs}

$$Pi_{(abs)}\ (lb/ft^2) = Pi\ (lb/ft^2) + BP\ (lb/ft^2)$$

$$Pf_{(abs)}\ (lb/ft^2) = Pf\ (lb/ft^2) + BP\ (lb/ft^2)$$

B. Leak Rate

$$\overline{Q} = \left(\frac{Pi}{Ti} - \frac{Pf}{Tf}\right)\left(\frac{81.1\ V}{R_A \Delta t\ (0.075\ lb/ft^2)}\right)$$

$$\overline{Q} = \left(\frac{lb/ft^2}{°R} - \frac{lb/ft^2}{°R}\right)\left(\frac{81.1\ ft^3}{(53.35\ \frac{ft\text{-}lb}{lb\ °R})\ (min.)\ (0.075\ lb/ft^2)}\right)$$

$$\overline{Q} = 0.793\ SCFM$$

4

APPENDIX - N

Fan Drawings and Qualification Test Report

nyb | The New York Blower Company

7660 Quincy Street, Willowbrook, IL 60521

PERFORMANCE CURVE

To determine Performance at another RPM multiply
CFM x K
SP x K^2
BHP x K^3
where K is new RPM divided by RPM shown at right.

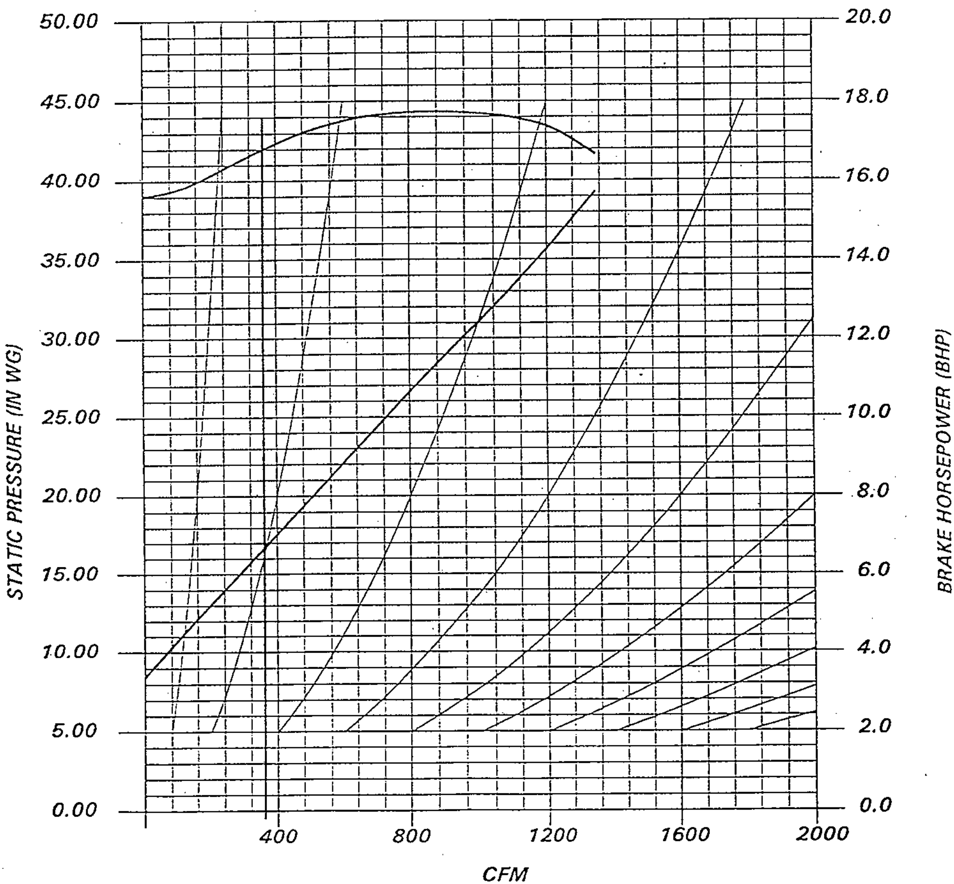
CUST. NO : *302839*
CUSTOMER : *ELLIS & WATTS*
TAGGING :
FAN TYPE : *Pressure Blower - ST*
FAN SIZE : *2306S*
CFM : *360*
SP : *42.0*
RPM : *3518*
BHP : *6.66*

CAPACITY TYPE: STD
TEMP : *70* deg F
DENS : *0.075* LB/FT^3

DATE : *Feb 5 1996*

FILE : *N01467 - 100* *JKM*

PERFORMANCE OPTIONS :



ELLIS & WATTS

PURCHASE ORDER : 302839

TAG :

FAN INFORMATION

QUANTITY : 1
FAN TYPE : Pressure Blower - ST
FAN SIZE : 2306S
FAN CLASS : NONE
ROTATION : CCW
DISCHARGE : BAU
ARRANGEMENT : 1
INLET TYPE : FLANGED

MOTOR INFORMATION

ENCLOSURE : TEHI
HORSEPOWER : 7.5
RPM : 3500
ELECT. DATA : 3-60-230/460
FRAME SIZE : 213T
MOTOR POS : Z
MOTOR BY : NYB
MOUNT BY : NYB

FAN PERFORMANCE DATA

MAX SAFE SPEED : 3800 RPM at 70 Deg.

CAP	TYPE	CFM	SP	RPM	BHP	TEMP	ALT	DENSITY
1	STD.	360.0	42.00	3518	6.66	70	0.0	0.0750

DRIVE INFORMATION

DRIVE S.F. : 1.4
FAN SHV QTY : 1
FAN BSH QTY : 1
MTR SHV QTY : 1
MTR BSH QTY : 1
BELT QTY : 2

FAN SHV PART NUMBER : 2TA40
FAN BSH PART NUMBER : P1 X1-11/16
MTR SHV PART NUMBER : 2AK44H
MTR BSH PART NUMBER : H X1-3/8
BELT PART NUMBER : AX85

CERTIFIED DRAWING PACKET*

FAN CERTIFIED DRAWING.................................. Dwg# N01467-100-2
BELT GUARD.................................. Dwg# N01467-101-3
UNITARY BASE.................................. Dwg# N01467-102-4 Rev A
ISOLATION.................................. Dwg# N01467-102-5

ADDITIONAL ACCESSORIES

SHAFT & BEARING GUARD
DRAIN
FLUSH BOLTED CLEAN-OUT DOOR LOCATED AT 9:00 O'CLOCK
NOMINALLY AIRTIGHT CONSTRUCTION

VI. 22668 SUP. 148
SHT. 4607-4863
Bldg. Exhaust Skid

ADDITIONAL INFORMATION

NUMBER OF DRAWING SETS : 5
ESTIMATED SHIPPING WT. : 539 lbs.
(includes fan, motor, & pertinent accessory weights)

* DRAWINGS ARE FOR CONSTRUCTION PURPOSES
SEE SECOND PAGE (Dwg 1a) FOR ADDITIONAL NOTES

nyb The New York Blower Company
7660 Quincy Street, Willowbrook, IL 60521

Pressure Blower - ST
SIZE 2306S

Date 02/20/96 Certified JKM
Drawing No. N01467-100-1 Rev. A

IDCOVER

ELLIS & WATTS

PURCHASE ORDER : 302839

TAG :

ADDITIONAL NOTES

- MOTOR MFG: SIEMENS
- ADD TO FURNISH (304 SST) TO THE AIRSTREAM AND C.O. DOOR.
- ADD TO FURNISH (316 SST) TO THE DRAIN, DRAIN PLUG, AND BUNA SHAFT SEAL.
- ADD TO FURNSIH A UNITARY BASE WITH AN OVERALL LENGTH OF 53-3/16".

REV A: CHANGED UNITARY BASE DIMENSIONS TO MEET CUSTOMER'S SPECIFICATIONS.

nyb | The New York Blower Company

7660 Quincy Street, Willowbrook, IL 60521

Pressure Blower - ST

SIZE 2306S

Date 02/20/96 Certified JKM

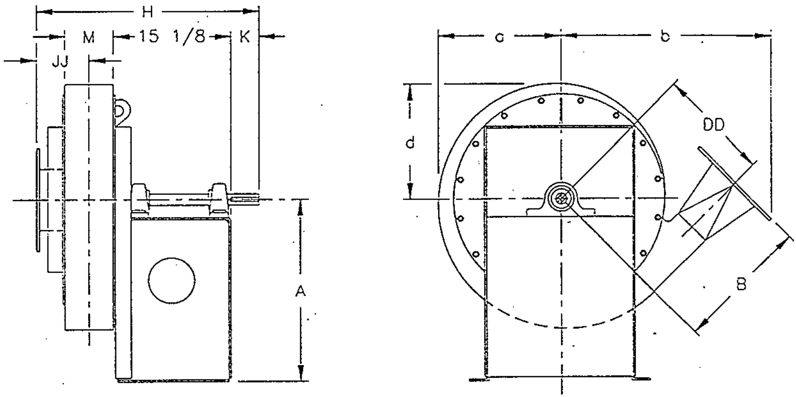
Drawing No. N01467-100-1a Rev. A

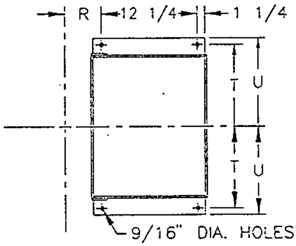
HDCOVER

ELLIS & WATTS

PURCHASE ORDER: 302839

TAG:





PRESSURE BLOWERS ARE ROTATABLE IN THE FIELD BY 22 1/2° INCREMENTS.

FURNISHED WITH FLANGED INLET AND OUTLET WHICH FITS ANSI 150 PIPE FLANGES.

MAXIMUM TEMPERATURE : 200°F (93°C)

ITEM	DIMENSIONS in	DIMENSIONS mm
A	26 5/8	676
B	19	483
H	29 5/8	752
L	8 5/8	219
M	5	127
R	3 7/8	98
T	10 7/8	276
U	11 3/4	298
DD	17 5/8	448
JJ	7	178
c	18 7/8	479
b	29 13/16	757
d	17 11/16	449
SHAFT DIAM.	1 11/16	–
KEYWAY	3/8	–

FLANGED OUTLET	DIMENSIONS in	DIMENSIONS mm
I.D.	6	152
B.C.	9 1/2	241
O.D.	11	279
NO. HOLES	8	–
DIA. HOLES	7/8	22

FLANGED INLET	DIMENSIONS in	DIMENSIONS mm
I.D.	8	203
B.C.	11 3/4	298
O.D.	13 1/2	343
NO. HOLES	8	–
DIA. HOLES	7/8	22

TOLERANCE: ± 1/8" (± 3mm)

nyb The New York Blower Company

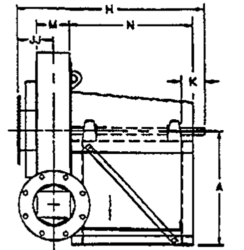
7660 Quincy Street, Willowbrook, IL 60521

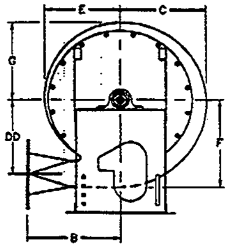
PRESSURE BLOWER
SIZE 2306 CCW BAU

Date 02-05-96 Certified JKM

Drawing No. N01467-100-2 Rev. ____

B1R

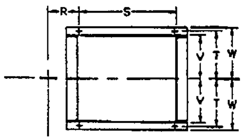




Accessories

Items checked are to be furnished.

- _____ FLANGED INLET. Fits ANSI 150 pipe flanges.
- _____ VENTURI INLET, with guard.
- _____ PLAIN PIPE INLET.
- _____ STEEL WHEEL.
- _____ DRAIN, 1" tank flanges (less plug).
- _____ WAFER OUTLET DAMPER, TYPE BW, per drawing _____.
- _____ WAFER OUTLET DAMPER, TYPE BL, per drawing _____.
- _____ FLEXIBLE CONNECTOR, per drawing _____.
- _____ INLET FILTER, per drawing _____.
- _____ ISOLATION, per drawing _____.
- _____ SILENCER, per drawing _____.
- _____ FLUSH BOLTED CLEANOUT DOOR, located at _____ O'clock.
- _____ TYPE SPARK RESISTANT CONSTRUCTION.
- _____ SHAFT SEAL, CERAMIC FELT.
- _____ POSITIVE SCREW ADJUSTMENT.
- _____ WEATHER COVER BELT GUARD.
- _____ TEFLON SHAFT HOLE CLOSURE.
- _____ 201°F thru 500°F HEAT FAN.
- _____ 501°F thru 600°F HEAT FAN.



PRESSURE BLOWERS ARE ROTATABLE IN THE FIELD.

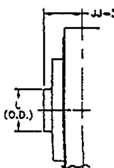
FURNISHED WITH FLANGED OUTLET WHICH FITS ANSI 150 PIPE FLANGES.

MAXIMUM TEMPERATURE:
STANDARD FAN ---------200°F
HEAT FAN ---------600°F

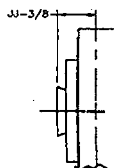
ALL HEAT FANS INCLUDE A SHAFT COOLER, GUARD, AND MOTOR HEAT SHIELD. A STEEL WHEEL IS REQUIRED ABOVE 200°F. HIGH-TEMP. PAINT IS USED ABOVE 500°F.

FOR SALES PURPOSES ONLY

This drawing has NOT been certified!

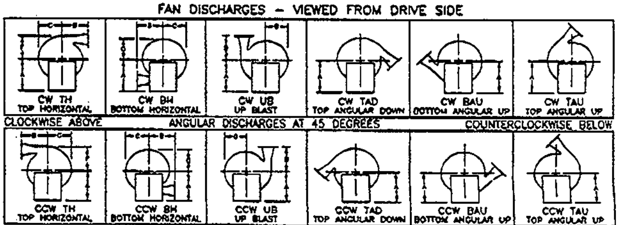


PLAIN PIPE INLET



VENTURI INLET

FAN DISCHARGES – VIEWED FROM DRIVE SIDE



DOWN BLAST AND BOTTOM ANGULAR DOWN DISCHARGES REQUIRE SPECIAL DRAWINGS.

TOLERANCE: ±1/8"

DIMENSIONS (IN INCHES)

WHEEL DIAMETER	A	C	DD	E	F	G	K	N	S	T	V	W	SHAFT DIAMETER	KEYWAY	BASE HOLES
14 THRU 18	21	13 5/8	11 3/4	12	14 3/8	12 3/4	3 1/2	22	17 5/16	9 3/8	8 1/4	10 1/4	1 7/16	3/8	9/16
~~19 THRU 22~~	~~27 6/8~~	~~16 1/2~~	~~14 7/8~~	~~14 1/2~~	~~17 1/2~~	~~16 1/2~~	~~4 1/2~~	~~26~~	~~19 7/8~~	~~12 1/4~~	~~11~~	~~13~~	~~1 7/16~~	~~5/8~~	~~3/4~~
23 THRU 26	27 7/8	19 1/2	17 5/8	17 1/8	20 5/8	18 1/4	4 1/2	26	19 7/8	12 1/4	11	13	1 11/16	3/8	3/4

WHEEL DIAMETER	OUTLET DIA.	B	H	JJ	L	M	R	FLANGES (I.D.) OUTLET	FLANGES (I.D.) INLET
14 THRU 18	4	18 1/4	31 1/8	5 5/8	6 5/8	3 7/8	4 5/16	4	6
	6	18 1/4	33 1/2	6 3/4	8 5/8	6 1/4	5 1/2	6	8
15 THRU 18	8	18 1/4	33 1/2	6 3/4	8 5/8	6 1/4	5 1/2	8	8
19 THRU 22	4	17 3/4	36 1/8	6 1/8	6 5/8	3 7/8	5 1/16	4	6
	6	17 3/4	36 1/8	6 1/8	6 5/8	3 7/8	5 1/16	6	6
	8	17 3/4	38	6 3/4	8 5/8	6 1/4	6 1/4	8	8
	10	21 3/4	38	6 3/4	8 5/8	6 1/4	6 1/4	10	10
23 THRU 26	6	19	37 5/8	7	8 5/8	5	5 5/8	6	8
	~~8~~	~~19~~	~~37 5/8~~	~~7~~	~~8 5/8~~	~~5~~	~~5 5/8~~	~~8~~	~~8~~
	10	23	39	7 1/4	10 3/4	7 1/4	6 3/4	10	10
	12	23	39	7 1/4	10 3/4	7 1/4	6 3/4	12	12

FLANGE DIMENSIONS (OUTLET-INLET)

I.O.	B.C.	O.D.	HOLES* NO.	HOLES* DIA.
~~4~~	~~7 1/2~~	~~9~~	~~8~~	~~3/4~~
6	9 1/2	11	8	7/8
~~8~~	~~11 3/4~~	~~13 1/2~~	~~8~~	~~7/8~~
10	14 1/4	16	12	1
12	17	19	12	1

*HOLES STRADDLE THE CENTERLINES

WHEEL DIAMETER	MAX. MOTOR LIMITATIONS MOTOR FRAME OPEN	MOTOR FRAME TE	LENGTH C-NW
14 THRU 18	215T	215T	16 5/8
~~19 THRU 22~~	~~256T~~	~~254T~~	~~18 5/8~~
23 THRU 26	256T	254T	18 5/8

* SIZE NOMENCLATURE (5 DIGITS)
  - FIRST & SECOND – Wheel Dia.
  - THIRD & FOURTH – Outlet Dia. (I.D.)
  - FIFTH (LETTER) – Wheel Type:
    - A = Aluminum
    - S = Steel Or Stainless Steel

DIMENSIONS SHOULD NOT BE USED FOR CONSTRUCTION PURPOSES UNLESS CERTIFIED.

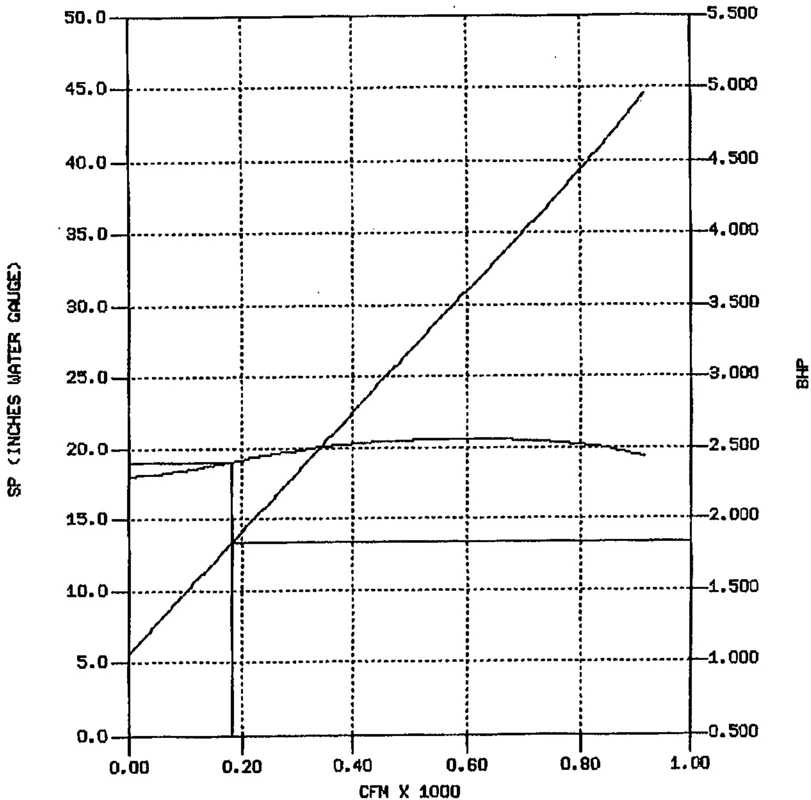
DATE _____ CERTIFIED _____ CONTROL NO. _____

CUSTOMER'S NO. _____
CUSTOMER'S NAME _____

CERTIFIED DRAWING | FORM NO. B-38 A

THE NEW YORK BLOWER COMPANY

=FAN=TO=SIZE=



FAN INFORMATION	
Pressure Blower - ST	
Belt Drive	MATL: Mild Steel
Size: 2306S	
Tag :	
Date: 5/22/1995	
CFM : 180	SP : 19.00
OV : 900	
RPM : 2396	BHP: 1.83
DEN : 0.0750	
TEMP: 70 DEG F	
SE : 29.3%	ME : 29.4%

CUSTOMER

YOUR REPRESENTATIVE

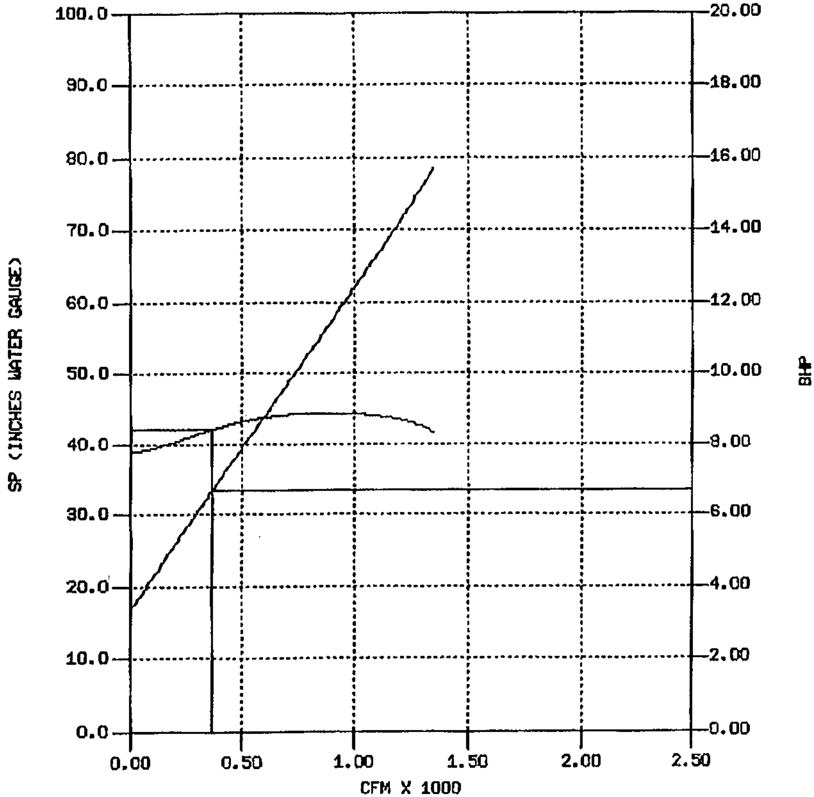
CINN-QUIP, INC

P.O. BOX 6629
CINCINNATI, OH
45206
Phone: (513) 684-0044
FAX : (513) 684-0066

v1.20

THE NEW YORK BLOWER COMPANY

=FAN=TO=SIZE=



FAN INFORMATION

Pressure Blower - ST
Belt Drive MATL: Mild Steel
Size: 2306S
Tag :
Date: 5/22/1995
CFM : 360 SP : 42.00
OV : 1800
RPM : 3519 BHP: 6.66
DEN : 0.0750
TEMP: 70 DEG F
SE : 35.6% ME : 35.8%

CUSTOMER

YOUR REPRESENTATIVE

CINN-QUIP, INC

P.O. BOX 6629
CINCINNATI, OH
45206
Phone: (513) 684-0044
FAX : (513) 684-0066

v1.20

nyb | The New York Blower Company®
7660 QUINCY STREET – WILLOWBROOK, ILLINOIS 60521-5998

FAN BALANCING

SALES BULLETIN
SB-504
April 15, 1994

The intent of this sales bulletin is to clarify nyb's balance standard and nyb's policy concerning customer specifications, special balancing requirements, and field balancing.

NEW YORK BLOWER BALANCE STANDARD

New York Blower's standard dictates that wheels are dynamically balanced prior to installation in the fan assembly. Wheels are balanced to ISO 1940/ANSI S2.19 Quality Grade G-6.3. (See Fan Components Catalog Sheet for further details.) The entire fan assembly is then trim balanced after wheel installation. This final balancing procedure decreases vibration which was caused by the accumulation of various manufacturing tolerances.
New York Blower's vibration standard dictates acceptable vibration levels for shipment of equipment from nyb's factory. Equipment is tested in the factory under ideal conditions. As such, vibration levels may be higher when the fan is installed in the field, in less than ideal conditions, which are beyond the control of nyb and beyond the scope of nyb's responsibility.

APPLICABLE PRODUCTS

The following products are test run and balanced after final assembly at the factory by New York Blower:

AcF/PLR (All Classes)	FRP General Purpose FE	General Purpose, GPA	Series 60
AF-Forty	FRP Pressure Blower	Plug Fan	Tubeaxial
Duct Fan	FRP Radial Fume Exhauster	Pressure Blower	Tubular AcF/PLR
FRP Fume Exhauster	GI (Series 20, 30, 45)	RTS	Vaneaxial

NOTE: While vibration levels on Junior, Compact GI, Propeller fans and Unit Heaters are not governed by this standard, they are test run after final assembly. These products are checked for speed, rotation, and general operating condition when motors and drives are installed by nyb. Any products displaying noticeable vibration will be repaired and/or balanced prior to shipment.

LIMITATIONS

Available Voltage: 110, 208, 240, 480, 575
Available Frequency: 60 cycle (50 cycle motors can not be test run)
Test Running Speeds: Fans are tested at operating speed if known. If unknown, with package nyb drive, fan is tested at midrange of drive. If unknown without packaged drive, fan is generally tested at 90% of maximum RPM. Axial bare fans are not test run.
Horsepower: Motors over 300 HP cannot be test run in nyb's shop.

PICK-UP LOCATIONS

PICK-UP TO BE PLACED IN HORIZONTAL DIRECTION

NOTE: New York Blower measures vibration of a fan assembly in the horizontal direction with "filter in". This method gives the most accurate measure of wheel imbalance. Vibration levels in the vertical and axial directions are affected by other variables and may not provide an accurate measure of wheel imbalance.

Fan	Location
Arrangement 1, 8, 9	Inboard bearing foot
Arrangement 10	Vertical side sheet in line with top of bearing platform
Arrangement 3 & 7	Drive side bearing foot

Fan	Location
Arrangement 4 (except tube fans)	Motor mounting foot (shaft end)
Axial Fans	Outer tube wall at center
Plug Fans	Base of motor platform even with inboard bearing

BALANCE WEIGHTS

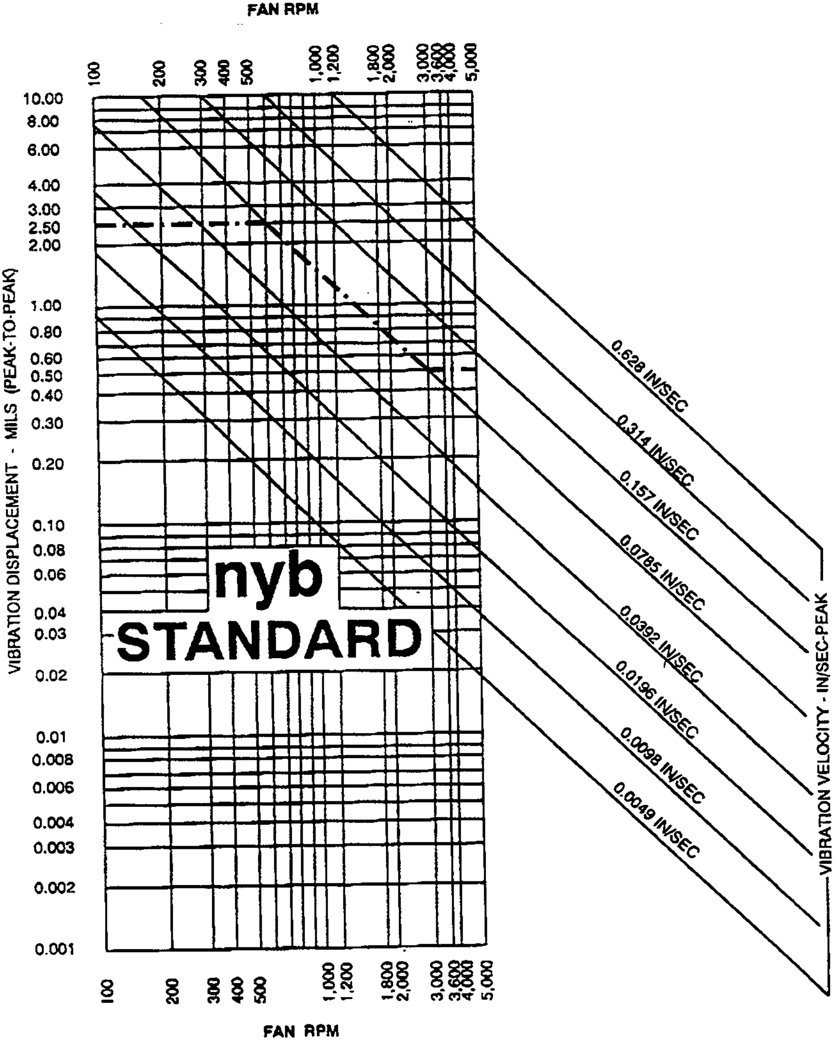
Clip-on weights are used on all clean-air, low temperature fans: Junior, AcF/PLR, General Purpose, GPA, Pressure Blower.
Weld-on weights are used on all: Material handling fans: General Industrial, RTS
High-capacity fans: Class IV, AF-Forty, Series 60
High-heat and axial flow clean air fans: Junior, Air Kit, AcF/PLR, Vaneaxial

NOTE: All stainless steel wheels receive weld-on 316L SST weights. All aluminum wheels (except Pressure Blowers) use welded aluminum weights.
Compact GI wheels have weights welded on the backplate or back of blade. Touch-up is achieved by grinding the blades or backplate.
Coated wheels are drilled through the frontplate or backplate. SST bolts, nuts, and washers are added for weight. Weights are touched-up with coating material.
Fiberglass wheels have patch of parent material added to backplate or material is ground from backplate as required. All ground surfaces are then resin coated.
Touch-up balancing is performed on purchased axial wheels. Material is ground off the hub of Tubeaxial wheels. Welded or bolted weights are added to Duct Fan wheels.

VIBRATION SEVERITY CHART

Vibration levels must fall below the broken line on the chart below prior to shipment from nyb's factory.

NOTE: These levels do not reflect field conditions such as installation and foundation. It is required that the mounting surface upon which the fan is set, is adequate to provide the support and stability necessary to maintain acceptable vibration levels. It is the user's responsibility to provide the proper foundation design and installation. Other factors such as turbulent aerodynamic conditions, background vibration, and maintenance of the equipment may affect vibration levels and are beyond the control of New York Blower.



NEMA STANDARD DIMENSIONS [Inches]

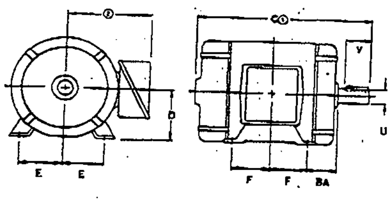
(See motor sketch, page 2)

Figure 2B

Frame	BA	D*	E	F	U★	V†	① C - TE Min	① C - TE Max	① C - ODP Min	① C - ODP Max
143T	2.25	3.50	2.75	2.00	.875	2.00	11.49	12.13	10.69	11.36
145T	2.25	3.50	2.75	2.50	.875	2.00	12.94	13.13	11.69	12.36
182T	2.75	4.50	3.75	2.25	1.125	2.50	14.50	14.56	12.69	13.58
~~184T~~	~~2.75~~	~~4.50~~	~~3.75~~	~~2.75~~	~~1.125~~	~~2.50~~	~~15.50~~	~~15.56~~	~~13.69~~	~~14.58~~
213T	3.50	5.25	4.25	2.75	1.375	3.13	17.63	19.82	15.75	17.26
~~215T~~	~~3.50~~	~~5.25~~	~~4.25~~	~~3.50~~	~~1.375~~	~~3.13~~	~~19.13~~	~~19.82~~	~~17.25~~	~~17.26~~
254T	4.25	6.25	5.00	4.12	1.625	3.75	22.38	25.31	20.50	22.31
256T	4.25	6.25	5.00	5.00	1.625	3.75	24.13	25.31	22.25	22.31
284T	4.75	7.00	5.50	4.75	1.875	4.38	25.32	28.31	23.38	24.94
284TS	4.75	7.00	5.50	4.75	1.625	3.00	23.94	26.92	22.00	23.56
286T	4.75	7.00	5.50	5.50	1.875	4.38	26.82	28.31	24.88	24.94
286TS	4.75	7.00	5.50	5.50	1.625	3.00	25.44	26.92	23.50	23.56
324T	5.25	8.00	6.25	5.25	2.125	5.00	28.12	31.70	26.00	27.56
324TS	5.25	8.00	6.25	5.25	1.875	3.50	26.63	30.20	24.50	26.06
326T	5.25	8.00	6.25	6.00	2.125	5.00	29.62	31.70	27.50	27.56
326TS	5.25	8.00	6.25	6.00	1.875	3.50	28.13	30.20	26.00	26.06
364T	5.88	9.00	7.00	5.62	2.375	5.63	32.38	33.94	28.63	29.69
364TS	5.88	9.00	7.00	5.62	1.875	3.50	30.26	31.81	26.50	27.56
365T	5.88	9.00	7.00	6.12	2.375	5.63	33.38	33.94	29.63	29.69
365TS	5.88	9.00	7.00	6.12	1.875	3.50	31.26	31.81	27.50	27.56
404T	6.63	10.00	8.00	6.12	2.875	7.00	37.25	38.81	32.50	34.06
404TS	6.63	10.00	8.00	6.12	2.125	4.00	34.25	35.81	29.50	31.06
405T	6.63	10.00	8.00	6.87	2.875	7.00	38.75	38.81	34.00	34.06
405TS	6.63	10.00	8.00	6.87	2.125	4.00	35.75	35.81	31.00	31.06
444T	7.50	11.00	9.00	7.25	3.375	8.25	41.88	44.94	37.63	39.81
444TS	7.50	11.00	9.00	7.25	2.375	4.50	38.13	41.18	33.88	36.06
445T	7.50	11.0	9.00	8.25	3.375	8.25	43.88	44.94	39.63	39.81
445TS	7.50	11.00	9.00	8.25	2.375	4.50	40.13	41.18	35.88	36.06

Figure 2A

Rating (HP)	Synchronous Speed (RPM) ⑤ 3600 Dripproof	3600 TEFC	1800 Dripproof	1800 TEFC	1200 Dripproof & TEFC
¾	–	–	–	–	143T
1	–	–	143T	143T	145T
1½	143T	143T	145T	145T	182T
2	145T	145T	145T	145T	184T
3	145T	182T	182T	182T	213T
5	182T	184T	184T	184T	215T
7½	184T	213T	213T	213T	254T
10	213T	215T	215T	215T	256T
15	215T	254T	254T	254T	284T
20	254T	256T	256T	256T	286T
25	256T	284TS	284T	284T	324T
30	284TS	286TS	286T	286T	326T
40	286TS	324TS	324T	324T	364T
50	324TS	326TS	326T	326T	365T
60	326TS	364TS	364T	364T	404T
70	364TS	365TS	365T	365T	405T
100	365TS	405TS	404T	405T	444T
125	404TS	444TS	405T	444T	445T



MOTOR DATA SHEET

DATA SHEET M-01

Application	Fan Driver
Location	"C" Tank Farm, 200 E
No. Required	1

EQUIPMENT NUMBER	DESCRIPTION
FN-1362	DRIVER FOR EXHAUST SKID EXHAUST FAN

SPECIFICATIONS

Electrical Type	Squirrel Cage Induction
Enclosure, Type	TEFC
Motor Rating:hp	7.5
Duty Rating	Continuous
Service Factor	1.15
v 480 Phase 3	Poles 4
Frequency	60 hz
Rated RPM	3600
Rated Temp. Rise °C	40 @ 1.0 S.F.
Ambient Temp. °C	50
Insulation Class	F
Ambient Atmosphere	115 °F
Bearings	Anti-Friction, Regreasable
Lubrication	Grease
Starter Here Furnished (If any)	By Seller
Altitude	700 ft
Drive System Furnished By	Ellis & Watts
Base Furnished By	Fan Supplier
Non Standard Mount or Extensions	NONE
Approx. Load hp (under representative load)	6.7 BHP

GENERAL INFORMATION

(To be furnished by vendor)

Manufacturer	Ellis & Watts
Outline Drawing No.	N/A
Frame No.	213T
Serial No.	N/A
Net Weight lb.	152 max.

NEMA Motor Code Letter	B
Starting Current: Amps	30
Full Load Current	10.5
Recommended Motor Feeder Size/Type	N/A

(1) Equipment number is for the complete assembly of fan, driver and support base. (2) Motor is compatible with variable frequency drive in accordance with Spec. section 3.1.6.

APPENDIX - O

Fan Motor Drawings and Data Sheets

NEMA STANDARD DIMENSIONS (Inches)

(See motor sketch, page 2)

Figure 2B

Frame	BA	D*	E	F	U★	V†	① C - TE Min	① C - TE Max	① C - ODP Min	① C - ODP Max
143T	2.25	3.50	2.75	2.00	.875	2.00	11.49	12.13	10.69	11.36
145T	2.25	3.50	2.75	2.50	.875	2.00	12.94	13.13	11.69	12.36
182T	2.75	4.50	3.75	2.25	1.125	2.50	14.50	14.56	12.69	13.58
~~184T~~	~~2.75~~	~~4.50~~	~~3.75~~	~~2.75~~	~~1.125~~	~~2.50~~	~~15.50~~	~~15.56~~	~~13.69~~	~~14.58~~
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254T	4.25	6.25	5.00	4.12	1.625	3.75	22.38	25.31	20.50	22.31
256T	4.25	6.25	5.00	5.00	1.625	3.75	24.13	25.31	22.25	22.31
284T	4.75	7.00	5.50	4.75	1.875	4.38	25.32	28.31	23.38	24.94
284TS	4.75	7.00	5.50	4.75	1.625	3.00	23.94	26.92	22.00	23.56
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324TS	5.25	8.00	6.25	5.25	1.875	3.50	26.63	30.20	24.50	26.06
326T	5.25	8.00	6.25	6.00	2.125	5.00	29.62	31.70	27.50	27.56
326TS	5.25	8.00	6.25	6.00	1.875	3.50	28.13	30.20	26.00	26.06
364T	5.88	9.00	7.00	5.62	2.375	5.63	32.38	33.94	28.63	29.69
364TS	5.88	9.00	7.00	5.62	1.875	3.50	30.26	31.81	26.50	27.56
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404T	6.63	10.00	8.00	6.12	2.875	7.00	37.25	38.81	32.50	34.06
404TS	6.63	10.00	8.00	6.12	2.125	4.00	34.25	35.81	29.50	31.06
405T	6.63	10.00	8.00	6.87	2.875	7.00	38.75	38.81	34.00	34.06
405TS	6.63	10.00	8.00	6.87	2.125	4.00	35.75	35.81	31.00	31.06
444T	7.50	11.00	9.00	7.25	3.375	8.25	41.88	44.94	37.63	39.81
444TS	7.50	11.00	9.00	7.25	2.375	4.50	38.13	41.18	33.88	36.06
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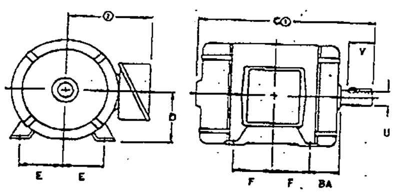
Figure 2A

Rating (HP)	Synchronous Speed (RPM) ⑤ 3600 Dripproof	3600 TEFC	1800 Dripproof	1800 TEFC	1200 Dripproof & TEFC
¾	--	--	--	--	143T
1	--	--	143T	143T	145T
1½	143T	143T	145T	145T	182T
2	145T	145T	145T	145T	184T
3	145T	182T	182T	182T	213T
5	182T	184T	184T	184T	215T
7½	184T	213T	213T	213T	254T
10	213T	215T	215T	215T	256T
15	215T	254T	254T	254T	284T
20	254T	256T	256T	256T	286T
25	256T	284TS	284T	284T	324T
30	284TS	286TS	286T	286T	326T
40	286TS	324TS	324T	324T	364T
50	324TS	326TS	326T	326T	365T
60	326TS	364TS	364T	364T	404T
70	364TS	365TS	365T	365T	405T
100	365TS	405TS	404T	405T	444T
125	404TS	444TS	405T	444T	445T



MOTOR DATA SHEET

DATA SHEET M-01

Application	Fan Driver
Location	"C" Tank Farm, 200 E
No. Required	1

EQUIPMENT NUMBER	DESCRIPTION
FN-1362	DRIVER FOR EXHAUST SKID EXHAUST FAN

SPECIFICATIONS

Electrical Type	Squirrel Cage Induction
Enclosure, Type	TEFC
Motor Rating:hp	7.5
Duty Rating	Continuous
Service Factor	1.15
v 480 Phase 3	Poles 4
Frequency	60 hz
Rated RPM	3600
Rated Temp. Rise °C	40 @ 1.0 S.F.
Ambient Temp. °C	50
Insulation Class	F
Ambient Atmosphere	115 °F
Bearings	Anti-Friction, Regreasable
Lubrication	Grease
Starter Here Furnished (If any)	By Seller
Altitude	700 ft
Drive System Furnished By	Ellis & Watts
Base Furnished By	Fan Supplier
Non Standard Mount or Extensions	NONE
Approx. Load hp (under representative load)	6.7 BHP

GENERAL INFORMATION
(To be furnished by vendor)

Manufacturer	Ellis & Watts	NEMA Motor Code Letter	B
Outline Drawing No.	N/A	Starting Current: Amps	30
Frame No.	213T	Full Load Current	10.5
Serial No.	N/A	Recommended Motor Feeder Size/Type	N/A
Net Weight lb.	152 max.		

(1) Equipment number is for the complete assembly of fan, driver and support base. (2) Motor is compatible with variable frequency drive in accordance with Spec. section 3.1.6.

APPENDIX - P

Damper Drawings and Reports

We Improved The World's Best Butterfly Valve!

Users have acclaimed the Demco resilient-seated butterfly valve as the best valve in the industry. In response, we have added even more features to make it more **"user friendly"**—while maintaining our proven design.

WHAT'S THE SAME

BRONZE BEARINGS
- Eliminates stem seizures
- Supports the load
- Consistent actuation torque

DRY STEM JOURNAL
- Line fluid does not corrode the stems

HIGH FLOW DISC
- No stem boss in the path of line fluid (5"-12")

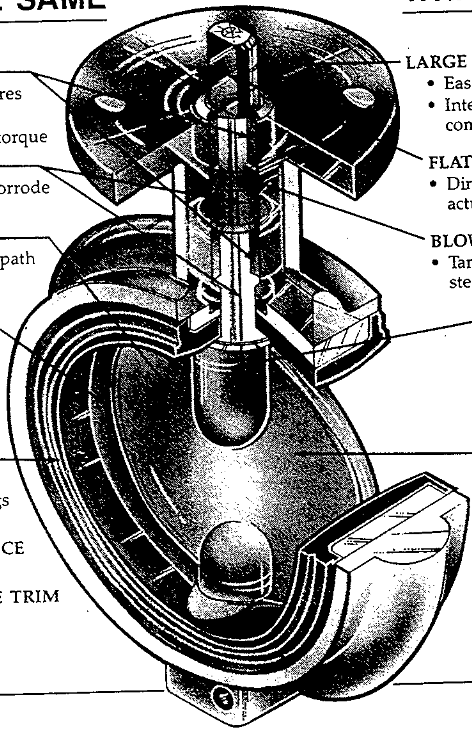
HARD-BACKED CARTRIDGE SEAT
- No movement of the elastomer
- Line media cannot get behind seat
- Repeatable torques

INTEGRAL FLANGE SEALS
- No gaskets or o-rings required

END-OF-LINE SERVICE TO 200 PSI

INTERCHANGEABLE TRIM COMPONENTS—
- Discs, Stems, Seats

EASY TO REPAIR



WHAT'S BETTER

LARGE TOP FLANGE
- Easier to actuate
- Interchanges with competitive actuation

FLATTED STEM DRIVE
- Direct-mount actuation

BLOWOUT PROOF STEM
- Tangential pin stem retention

POSITIVE STEM/DISC ORIENTATION
- Handle/stem flats indicate disc position

HIGH FLOW DISC
- No stem boss in the path of line fluid on all sizes.

INCREASED PRESSURE RANGE
- Standard Pressure increased to 200 psi.
- High Pressure increased to 285 psi.

All Features (New & Old) Are Available in the Current Design:

PREVIOUS DESIGN	CURRENT DESIGN
Series NE	Series NE–C
Series NE–S	Series NE–I
Series NE–S Sanitary	Series NE–I Sanitary
Series NE–N	Series NE–D

You Can Still Depend On Demco

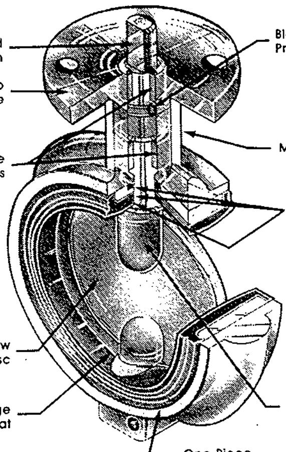
DEMCO BUTTERFLY VALVE DESIGN FEATURES—2"–12"

BODY

One piece bodies are ribbed to assure **high strength** and **minimum weight**. Bodies are cast in both wafer and tapped-lug patterns, in a wide variety of material choices, to meet virtually every installation requirement.

Body rating is ANSI Class 150 (285 psi non-shock). Wafer body diameters are designed to self-center in ANSI 150 flange patterns.

The **large top flange** provides a secure mounting area for automatic or manual actuators.



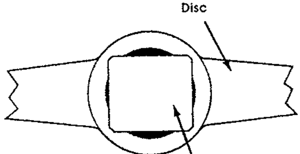
SEAT

The Demco Butterfly Valve seat is constructed by bonding a resilient elastomer to a rigid back-up ring, which forms the outside periphery of the seat. Slip fitted in the valve body, the seat is **field replaceable** without special tools. In the closed position, the disc rim and stem seal lands form an uninterrupted line of sealing contact with the resilient seat, to assure **drop tight sealing** at rated shutoff pressure.

Offered in a wide range of materials, seats interchange in all recent series of Demco Butterfly Valves.

DISC

Demco Butterfly Valve discs are configured for **low pressure drop** and high flow coefficients. Full radius polished edges slide into drop tight seat engagement with little turning effort.



DISC DRIVE

Proper orientation of the stem/disc connection is assured by the rectangular drive. The disc is permitted to float on the stem to perfectly center in the valve seat.

STEMS

Upper stems are flatted for positive drive and for easy installation of handles and actuators.

Retained by tangential pins, upper and lower stems are **blowout proof** for safety when handles or actuators are removed from the valve top.

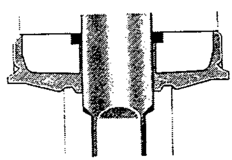
STEM JOURNAL

Two self-lubricating bronze **bearings** reduce torsional friction, eliminate galling and seizing of the stem, while supporting the stem against side loading from pressure on the closed disc. Demco places one bearing at the base of the stem where the maximum sideload on the upper stem occurs. The other bearing is at the valve top.

STEM SEALS

The stem holes in the disc are surrounded by an annular raised land which presses onto the seat flat at every angular position of the disc. The resilient seat presses back with a higher specific force than the line pressure, **preventing leakage** to the stem.

In competitive stem seal designs with boot seats, a seal is accomplished by an interference "squeezing" on the stem, or an o-ring in the stem journal. The potential for leakage behind the seat is high. As the disc wipes the seat, elongation of the stem seal area allows leakage to collect behind the seat. This condition is eliminated by **Demco's dry stem journal** and hard-backed seat.



FLANGE SEALS

The inner surface of the seat is widened to project outside the face-to-face width of the valve body. When mounted between weld neck or socket flanges, the extra rubber is compressed to form a positive seal against both flanges. The seal surface, near the outer periphery of each seat face, is designed to seal against slip-on or threaded flanges. Only valves with throttling discs require gaskets.

DEMCO BUTTERFLY VALVE DESIGN FEATURES—2"–12"

PRESSURE RATING

Three drop tight pressure ratings are offered for Demco Butterfly Valves. Normally, 200 psi shutoff is used in butterfly applications. However, 285 psi shutoff is optionally available for higher pressure applications. For smaller actuator sizing, 50 psi valves offer reduced torque.

For **minimum torque**, throttling valves, which do not provide drop tight closure, are available.

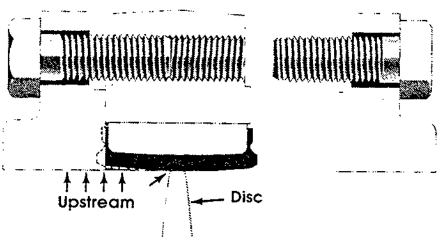
VACUUM RATING

Demco Butterfly Valves will seal against **10 microns of vacuum** (29.9 inches of mercury). For reduced torque and extended seat life, 50 psi discs are recommended for the dry service conditions found in many vacuum applications.

END-OF-LINE SERVICE

Lug body valves may be used in end-of-line service, with downstream piping removed. **(Weld neck or socket flanges, only, can be used for this service.)** Since upstream pressure is excluded between the flange and the seat face by the exclusive Demco flange seal, there is no effective force to slide the seat downstream. Demco Lug Butterfly Valves are recommended for **liquid** service up to 200 psi with downstream piping removed.

Lug body valves are recommended for isolation of pumps, control devices or other system components which may need to be removed for repair or replacement. Lug valves are also suitable for installation at points from which piping expansions may proceed. Such valves are normally blanked with blind flanges, to protect the exposed seats, until new piping is attached.



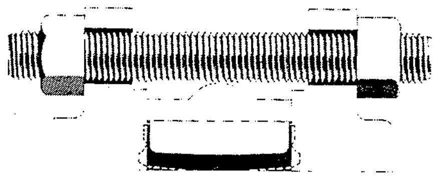
MARKING

Each valve is positively identified by marking and tagging per MSS SP 25.

ACTUATION

Positive latch handles, worm gear operators and automatic actuators are available and totally interchangeable on the Demco valve.

The Demco top flange is dimensionally compatible with other competitive butterfly valves. With optional "utility top" stem, the Demco valve interchanges directly with competitive valves, allowing valve replacement without the need for new actuation.



INSTALLATION AND MAINTENANCE

Demco Butterfly Valves are bi-directional, with identical flow-way from either face. To install, simply close the valve, insert between flanges and make up with studs or cap screws. No regular maintenance or lubrication is ever required. Disassembly is simple, for inspection or replacement of parts. Open the valve, remove handle or actuator, remove tangential pins, pull out the stems and push the disc and seat out of the body. Reassemble in reverse order, with a small amount of general purpose non-hydrocarbon based lubricant on the outside of stems, seat and disc flats.

Steel or cast iron flanges of either raised or flat-faced type are suitable for use with Demco Butterfly Valves. Plastic flanges are subject to damage at installation by over-tightening the bolting and may deflect or "cup," resulting in flange leaks. Refer proposed plastic flange installations to Demco Quotations for review and recommendation.

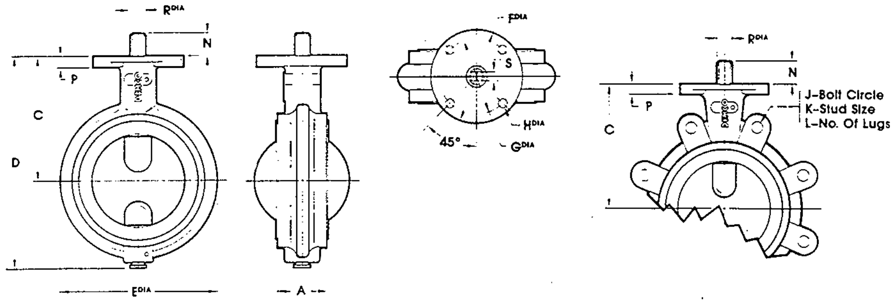
Throttling discs, with no seat interference, do not provide a stem seal. Stem o-rings are provided for this application. Flange gaskets assist the o-rings in 2"–12" valves, and must be used with throttling discs, only.

ORDERING INFORMATION

State valve size, application, body material, stem, disc and seat materials. Give choice of lever (2"–12") or gear operator. Order by appropriate Assembly Part Number.

Butterfly Valves are available in different shutoff pressures; 200 psi is normal and 285 psi is optionally offered for on-off service. Fifty psi and throttling valves require less torque and smaller actuators. When ordering actuated valves, give the required shutoff pressure and supply air pressure or electric voltage. Indicate all required accessories. Also state whether weatherproof or explosion-proof electrical enclosures are required.

DEMCO SERIES NE-I BUTTERFLY VALVES 2"–12"
(Replaces Series NE-S)



The Series NE-I is suited for a wide range of applications in many industries due to a multitude of body materials, body configurations, seat elastomers, and trim combinations. The valves are designed for installation between ANSI 125/150 flanges.

DIMENSIONS

VALVE SIZE	A	C	D	E	F	G	H	J	K	L	N	P	R	S
2"	1.74	3.94	6.75	4.12	4.00	3.25	.408	4.75	5/8–11	4	1.00	.44	.625	.375
2-1/2"	1.86	4.44	7.50	4.88	4.00	3.25	.408	5.50	5/8–11	4	1.00	.44	.625	.375
3"	1.86	4.69	8.00	5.38	4.00	3.25	.408	6.00	5/8–11	4	1.00	.44	.625	.375
4"	2.11	5.44	9.31	6.88	4.00	3.25	.408	7.50	5/8–11	8	1.00	.44	.625	.375
5"	2.24	6.38	10.75	7.75	4.00	3.25	.408	8.50	3/4–10	8	1.25	.44	.838	.500
6"	2.24	6.88	11.88	8.75	4.00	3.25	.408	9.50	3/4–10	8	1.25	.44	.838	.500
8"	2.54	8.06	14.19	11.00	6.00	5.0	.533	11.75	3/4–10	8	1.38	.56	.838	.500
10"	2.74	9.97	17.41	13.38	6.00	5.0	.533	14.25	7/8–9	12	1.38	.56	.963	.625
12"	3.24	10.91	20.41	16.12	6.00	5.0	.533	17.00	7/8–9	12	1.38	.56	1.338	.750

General dimensions—page 28.

BUTTERFLY VALVE ASSEMBLY BASE PART NUMBERS AND WEIGHTS

DESCRIPTION		2"	2-1/2"	3"	4"	5"	6"	8"	10"	12"
Series NE-I	200 psi	22128	22129	22130	22131	22132	22133	22134	22135	22136
	*285 psi	22252	22253	22254	22255	22256	22257	22258	22259	22260
	50 psi	22261	22262	22263	22264	22265	22266	22267	22268	22269
	Throttling	22270	22271	22272	22273	22274	22275	22276	22277	22278
Weight (lbs.—bare stem) —Water	Iron, Steel, SS	4.9	6.4	6.9	10.2	13.7	16.4	28.4	44.8	66.8
	Bronze	4.7	6.2	6.7	9.9	13.4	16.0	28.0	44.3	66.3
	Aluminum	2.8	3.4	4.1	5.9	8.7	10.8	18.2	30.4	47.2
—Lug	Bronze	6.8	8.7	9.5	15.7	23.1	27.0	42.0	64.4	96.8
	Steel, SS	7.0	8.9	9.7	16.0	23.5	27.5	42.5	64.9	97.5

*Lug valves in end-of-line service not recommended for 285 psi shutoff.

Gear operator recommended.

BUTTERFLY VALVE ASSEMBLY PART NUMBER

A base number defines series, size and shutoff pressure, and is followed by a 7-digit suffix which specifies all options, including handles.

- BODY CONFIGURATION — **1** Water **5** Lug
- BODY MATERIAL* — **1** Ductile Iron **3** Aluminum Bronze **4** Steel **5** Aluminum **6** ENC Coated Ductile Iron **8** Stainless Steel (CF8M)
- STEM MATERIAL — **1** 416 SS **2** 316 SS** **3** Monel **4** Steel
- DISC MATERIAL — **2** 316 SS **3** Monel **4** Aluminum Bronze **5** Nickel Pltd Iron **6** PVF Coated Ductile Iron† **7** Alloy 20†† **8** Hastelloy "C"
- SEAT ELAS — **31** Buna-N **32** Black Neoprene **33** Hypalon **34** Viton **35** EPT **36** Natural Rubber **37** White Neoprene **01** ETM-30230 **02** Fluorosteam **03** Food Grade EPT **04** Peroxide Cured Buna-N
- HANDLE — **1** 10 Position Lkg. **2** Throttling/Mem. Stop **5** Square Nut **6** 2 Position Lkg. **9** None

BASE NUMBER (from table above)

XXXXX — X X X X XX X

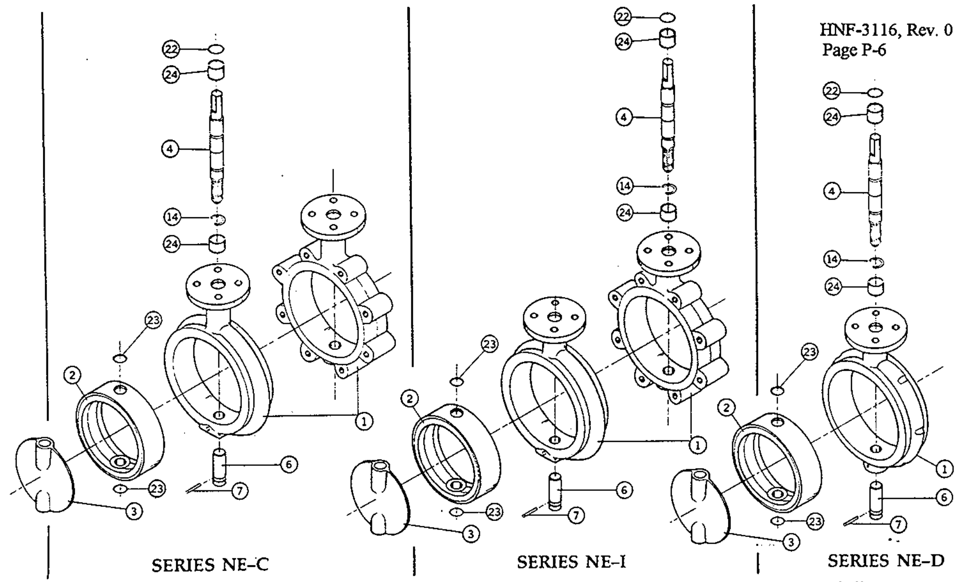
*Standard for ferrous bodies is green enamel; other coatings available on request.

**17-4 PH SS for 8"–12" Upper Stem Only

†200 psi only.

††Except 285 psi.

DEMCO BUTTERFLY VALVE COMPONENT PARTS LIST — SERIES NE–C, NE–I, NE–D



Replacement Parts for Series NE, NE–S, and NE–N — Consult Factory or Company Representative.

REF. NO.	COMPONENT DESCRIPTION		2"	2-1/2"	3"	4"	5"	6"	8"	10"	12"
1	BODY	NE–C Wafer	22137–012	22138–012	22139–012	22140–012	22141–012	22142–012	22143–012	22144–012	22145–012
			ASTM A48 Gray Iron **–012**								
		NE–C Lug	21986–05x	21987–05x	21988–05x	21989–05x	21990–05x	21991–05x	21992–05x	21993–051	21994–051
		Options	ASTM A395 Ductile Iron **–051**, ASTM A48 Gray Iron **–052**								
		NE–I Wafer	22681–01x	22682–01x	22683–01x	22684–01x	22685–01x	22686–01x	22687–01x	22688–01x	22689–01x
		Options	ASTM A395 Ductile Iron **–011**, ASTM B148 Al. Bronze **–013**, ASTM A216 WCB Steel **–014**, ASTM B179 Aluminum **–015**, DI/ENC **–016**, ASTM A351 SS **–018**								
		NE–I Lug	22695–05x	22696–05x	22697–05x	22698–05x	22699–05x	22700–05x	22701–05x	22702–05x	22703–05x
		Options	ASTM B148 Al. Bronze **–053**, ASTM A216 WCB Steel **–054**, ASTM A351 SS **–058**								
		NE–D Wafer	22187–021	22682–011	22188–021	22189–021	22190–021	22191–021	22687–011	22192–021	22689–011
		Options	ASTM A395 Ductile Iron **–0x1**								
2	SEAT		1786–xxx	1788–xxx	1790–xxx	1792–xxx	1794–xxx	1002–xxx	1798–xxx	1815–xxx	1817–xxx
		Options	**–031** Buna–N, **–032** Blk. Neoprene, **–033** Hypalon, **–034** Viton, **–035** EPT, **–036** Nat. Rubber **–037** White Neoprene, **–231** Peroxide Cured Buna–N, **–244** Fluorosteam, **–331** ETM–30230								
3	DISC	200 psi	22045–0xx	22046–0xx	22047–0xx	22048–0xx	22049–0xx	22050–0xx	22051–0xx	22052–0xx	22053–0xx
		285 psi	22196–0xx	22197–0xx	22198–0xx	22199–0xx	22200–0xx	22201–0xx	22202–0xx	22203–0xx	22204–0xx
		50 psi	22205–0xx	22206–0xx	22207–0xx	22208–0xx	22209–0xx	22210–0xx	22211–0xx	22212–0xx	22213–0xx
		Throttling	22214–0xx	22215–0xx	22216–0xx	22217–0xx	22218–0xx	22219–0xx	22220–0xx	22221–0xx	22222–0xx
		Options	**–002** 316 SS, **–003** Monel, **–005** Ni. Pltd. Duct. Iron, **–007** Alloy 20†, **–008** Hastelloy C, **–014** Alum. Bronze								
	PVF Coated	200 psi	22714–001	22715–001	22716–001	22717–001	22718–001	22719–001	22720–001	22721–001	22722–001
4	UPPER STEM	NE–C	22066–00x	22067–00x		22068–00x	22069–00x		22070–00x	22071–00x	22072–00x
		NE–I	22073–00x	22074–00x		22075–00x	22076–00x		22077–00x	22078–00x	22079–00x
		NE–D	22073–00x	22074–00x	22193–00x	22194–00x	22195–00x		22077–00x	22078–00x	22079–00x
	UPPER STEM —Utility Top	NE–C	22334–00x	22335–00x		22336–00x	22337–00x		22338–00x	22339–00x	22340–00x
		NE–I	22841–00x	22842–00x		22843–00x	22844–00x		22345–00x	22346–00x	22347–00x
6	LOWER STEM		22080–00x	22081–00x		22082–00x	22083–00x		22084–00x	22085–00x	22086–00x
		Options	**–001** 416 SS, **–002** 316 SS*, **–003** Monel, **–004** Phos. Coated Steel								
7	SPRING PIN (2)	302 SS	5448–18720				5448–18724		5448–25028		
14	RETAINER	Stainless Steel	22117			13704	13705			13706	13707
22	TOP O-RING	Buna–N	5526–114			5526–115	5526–117			5526–119	5526–125
23	STEM O-RING††	Buna–N	5526–113	5526–115		5526–116	5526–212			5526–214	5526–220
24	BEARING (2)	Bronze	22526–001	22118–001		13112–001	13115–001			13116–001	13117–001

*–012: 17–PH SS For 8"–12" Upper Stem Only (All Pressures). †Except 285 psi. ††4 Required for valves with throttling discs only.

NOTE: Where a suffix contains an "X" (example: -01x), the line just below that line outlines material options from which to pick in order to replace the "x" with a selection number.

DEMCO BUTTERFLY VALVE HANDLES
(NE-C, NE-I, and NE-D)

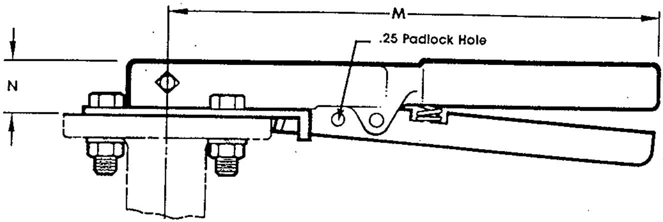
THREE BASIC HANDLE DESIGNS interchange on any 2"-12" Demco Butterfly Valve. The Locking Handle consists of a latch that engages in a notched throttle plate at 10 disc positions. Two-position throttle plates are available as an option. Upward pressure on the latch releases the handle for movement. Throttling with Memory Stop Handles are infinitely adjustable and set by a lock nut with a memory stop setting (adjustable open stop). Square Operating Nuts fit tee handles and are secured to the throttle plate with a screw. Standard coating on all handles is green enamel; special order options are white epoxy, coal tar epoxy, or inorganic zinc primer.

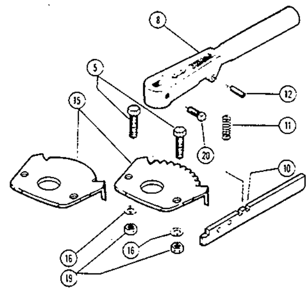
ASSEMBLY PART NUMBER

BASE NUMBER* X X X X   0 0 X — TRIM: **1** Standard **2** Corrosion Resistant **3** Sanitary

STANDARD TRIM: Iron handle, steel throttle plate, latch and fasteners.
CORR. RESISTANT TRIM: Iron handle, stainless steel throttle plate, latch and fasteners.
SANITARY TRIM: Bronze handle, stainless steel throttle plate, latch, and fasteners.

2 & 10 Position Locking Handle



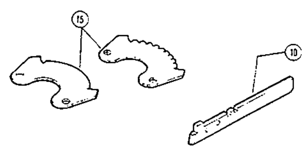


PARTS—STANDARD TRIM

REF. NO.	COMPONENT DESCRIPTION		2"-4"	5"-6"	8"	10"	12"
	*ASS'Y. BASE PART NO. -10 POSITION -2 POSITION		24227-001 24232-001	24228-001 24233-001	24229-001 24234-001	24230-001 24235-001	24231-001 24236-001
5	SCREW	Steel	5650-24020		5650-28024		
8	HANDLE	Ductile Iron	24237-001	24238-001	24239-001	24240-001	24241-001
10	LATCH	Zinc Pltd. Steel	23719-001	23720-001	23721-001		
11	SPRING	Spring Steel	16238				
12	SPRING PIN	Spring Steel	5445-25014		5446-37516		
15	THROTTLE PLATE -10 POSITION -2 POSITION		24242-001 24247-001	24243-001 24248-001	24244-001 24249-001	24245-001 24250-001	24246-001 24251-001
16	LOCKWASHER	Steel	5900-006		5900-008		
19	NUT	Zinc Pltd. Steel	5327-024		5327-028		
20	SET SCREW	Steel	5717-22012		5717-22016		

PARTS—CORROSION RESISTANT TRIM

REF. NO.	COMPONENT DESCRIPTION		2"-4"	5"-6"	8"	10"	12"
	*ASS'Y. BASE PART NO. -10 POSITION -2 POSITION		24227-002 24232-002	24228-002 24233-002	24229-002 24234-002	24230-002 24235-002	24231-002 24236-002
5	SCREW	Stainless Steel	5652-24020		5652-28024		
8	HANDLE	Ductile Iron	24237-001	24238-001	24239-001	24240-001	24241-001
10	LATCH	Stainless Steel	23719-002	23720-002	23721-002		
11	SPRING	Stainless Steel	12250				
12	SPRING PIN	Stainless Steel	5448-25014		5448-37516		
15	THROTTLE PLATE Stainless Steel -10 POSITION -2 POSITION		24242-002 24247-002	24243-002 24248-002	24244-002 24249-002	24245-002 24250-002	24246-002 24251-002
16	LOCKWASHER	Stainless Steel	5901-006		5901-008		
19	NUT	Zinc Pltd. Steel	5328-024		5328-028		
20	SET SCREW	Stainless Steel	5718-22012		5718-22016		



NOTE: These Throttling Plates and Latch Apply to Sanitary Trim Handles Only.

PARTS—SANITARY TRIM

REF. NO.	COMPONENT DESCRIPTION		2"-4"	5"-6"	8"	10"	12"
	*ASS'Y. BASE PART NO. -10 POSITION -2 POSITION		22319-003 22324-003	22320-003 22325-003	22321-003 22326-003	22322-003 22327-003	22323-003 22328-003
5	SCREW	Stainless Steel	5652-24020		5652-28024		
8	HANDLE	Bronze	22306-003	22307-003	22308-003	22309-003	22310-003
10	LATCH	Stainless Steel	22381	23012	22382		
11	SPRING	Stainless Steel	12250				
12	SPRING PIN	Stainless Steel	5448-25014		5448-37516		
15	THROTTLING PLATE Stainless Steel -10 POSITION -2 POSITION		22373-002 22376		22374-002 22376		
16	LOCKWASHER	Stainless Steel	5901-006		5901-008		
19	NUT	Stainless Steel	5328-024		5328-028		
20	SET SCREW	Stainless Steel	5718-22012		5718-22016		

DIMENSIONS

VALVE SIZE	M	N
2"-4"	9.50	.85
5"-6"	11.00	1.07
8"-12"	15.00	1.13

HANDLE WEIGHTS (lbs.)

SIZE	2"-4"	5"-6"	8"-12"
2 or 10 Pos. Lkg.	2.3	2.9	6.5

APPENDIX - Q

System Layout Drawings

DWG NO. K0701-0101 SH 1 REV D

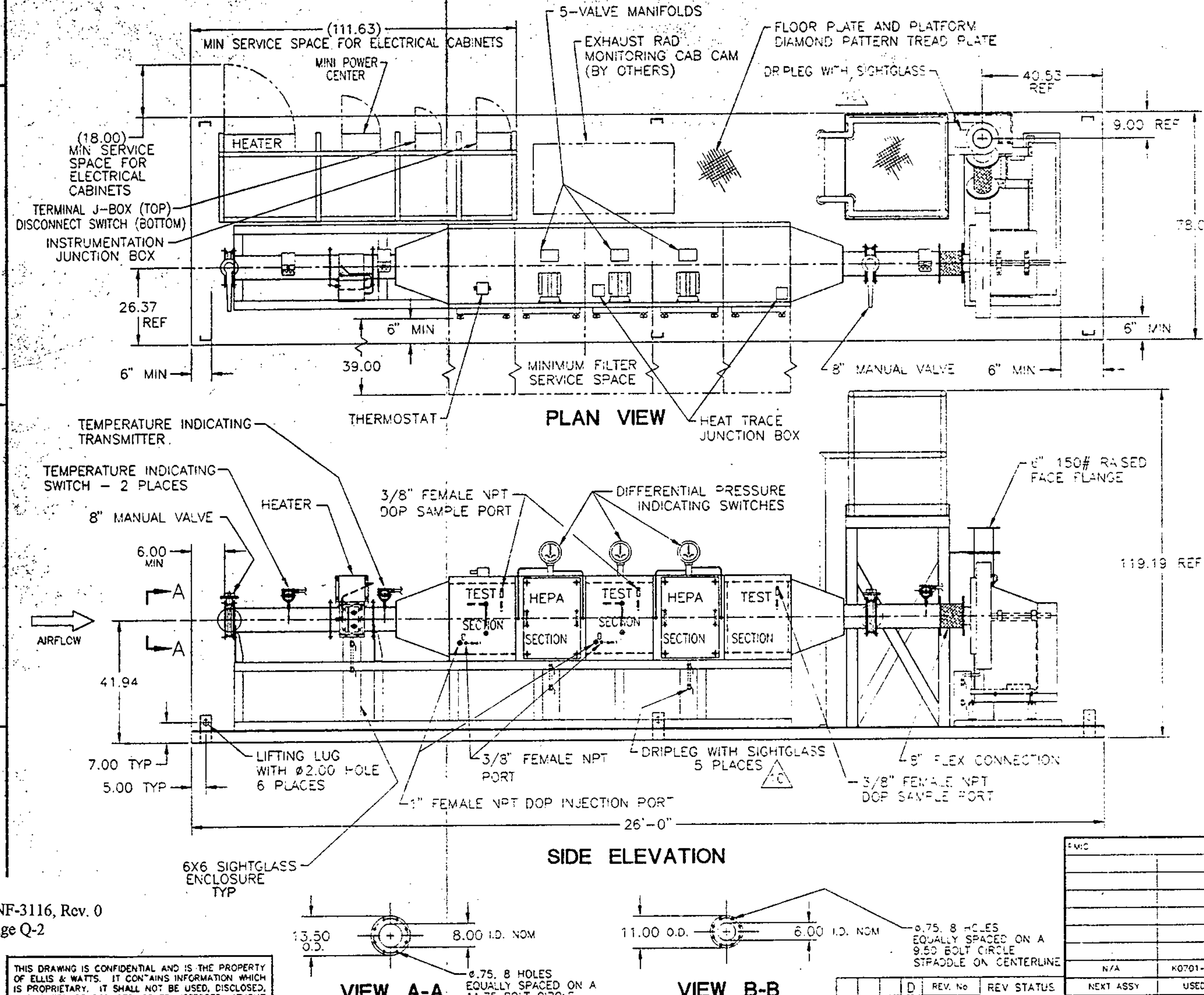
NOTES:

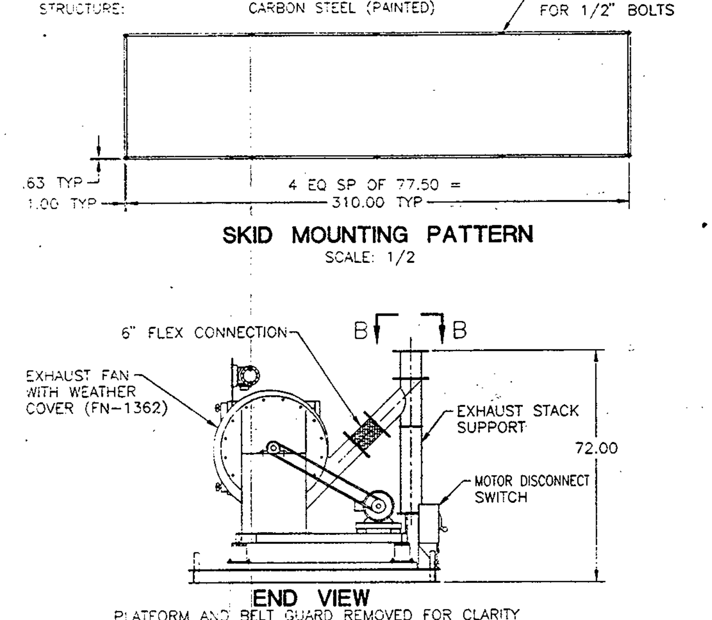
1. EXHAUST RAD MONITORING CAB CAM TO BE INSTALLED BY OTHERS.
2. SKID MOUNTING BY OTHERS.
3. WELDERS & WELDING PROCEDURES WILL BE IN ACCORDANCE WITH ASME SECTION IX.
4. PAINTING OF BASE, PLATFORM AND STRUCTURE WILL BE PER SECTION 3.5.4 EXCLUDING 3.5.4.4 OF SPEC. W-320-P1 REV. 0.
5. UNIT WILL BE SHIPPED LESS FILTERS INSTALLED.
6. HOUSING LEAK RATE TEST WILL BE PERFORMED PER E&W PROCEDURE ENG-204 REV. 3.
7. WELD INSPECTION WILL BE PER E&W PROCEDURE QA-111A REV. 0.
8. ALL CUSTOMER INTERFACE CONNECTIONS ARE NON-LOAD BEARING CONNECTIONS.
9. 1" THICK INSULATION WILL BE APPLIED TO UNIT FROM INLET MANUAL VALVE TO EXHAUST FLANGE ON FAN UNIT.
10. DRIPLEGS TO BE ENCLOSED WITH INSULATION AND HEAT TAPE.
11. STACK LOADS ON 6" OUTLET FLANGE WILL BE PER SKETCH ES-1 OF SPEC. W-320-P1 REV.0.
12. PIPE/TUBE WALL THICKNESS WILL BE 14 GA. MINIMUM. OF SPEC. W-320-P1 REV.0.
13. LIFTING OF SKID IS TO BE PERFORMED UTILIZING EQUAL WEIGHT DISTRIBUTION OF ALL SIX (6) LIFTING LUGS.

REVISIONS

ZONE	LTR	DESCRIPTION	DATE (YR-MO-DA)	BY	APPROVED	ENGINEERING APPROVED	Q.A. APPROVED
	A	REVISED PER ECN-K0701-09	96-01-17	JPC	DPP 96-01-17	MAD 96-01-17	CEH 96-01-17
	B	REVISED PER ECN-K0701-10	96-03-05	TEL	DPP 96-03-06	MAD 96-03-06	CEH 96-03-06
	C	REVISED PER ECN-K0701-19	96-04-29	TEL	DPP 96-04-29	MAD 96-04-29	CEH 96-04-29
	D	REVISED PER ECN-K0701-21	98-07-08	AJG	7/8/98	7/14/98	7/14/98

CUSTOMER:	WESTINGHOUSE HANFORD CO.
SPECIFICATION NO:	W-320-P1 REV 0
ELLIS & WATTS JOB NO:	K0701
PERFORMANCE:	
FILTER CAPACITY:	1000 CFM @ 1" W.G. CLEAN
FAN CAPACITY:	RANGE: 180 SCFM @ 19" S.P. TO 360 SCFM @ 42" S.P. NOMINAL FLOW: 230 SCFM
DESIGN TEMPERATURE:	150°F
DESIGN PRESSURE:	±50" W.G.
HEPA FILTER EFFICIENCY:	99.97% ON 0.3 MICRON PARTICLES
EST. WEIGHT:	3885 LBS EMPTY 3985 LBS OPERATING
MATERIALS:	
VALVES:	316 STAINLESS STEEL
PIPE:	304 STAINLESS STEEL
HOUSINGS:	304 STAINLESS STEEL
BASE:	CARBON STEEL (PAINTED)
FAN:	STAINLESS STEEL
STRUCTURE:	CARBON STEEL (PAINTED)





SYM	NOMENCLATURE	CAGE CODE	IDENTIFYING NO.	MATERIAL / SPECIFICATION	UNIT WT.	ZONE	FIND NO.

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE FRACTIONS ± N/A, DECIMALS .XX = .50, XXX = N/A, ANGLES ± N/A. DO NOT SCALE DRAWING

ELLIS & WATTS
DIVISION OF DYNAMICS CORPORATION OF AMERICA
CINCINNATI, OHIO

TITLE: FILTER TRAIN, VENTILATION EXHAUST AIR

DRAWN BY	TEL 95-11-01
CHECKER	CCL 95-12-01
ENGINEER	DPP 95-12-01
QUALITY ASSURANCE APPROVAL	JPL 95-12-01
ENGINEERING APPROVAL	MAD 95-12-01

SIZE	CAGE CODE	DWG. NO.	REV.
D	98437	K0701-0101	D

SCALE 1/20 UNIT WT. SHEET 1 OF 1

NEXT ASSY	USED ON
N/A	K0701-0101

APPLICATION

REV STATUS OF SHEETS: REV. No D, SHEET No 1

APPENDIX - R

Visual Inspection

1 PURPOSE

This Acceptance Test Procedure (ATP) has been prepared to demonstrate that the Electrical/HVAC/Instrumentation systems of C-106 Tank Process Ventilation System functions as required by project criteria.

This ATP has been revised to incorporate ECNs W320-480, -506, -512, -522, and -542, and to incorporate changes due to equipment modifications in accordance with LOI 97-03.

NOTE: Sections 8, 9, 10.1, 10.2, 10.4, and 10.7.1 were completed during ATP Rev 0 and have already been signed off. These sections will not be tested during ATP Rev 1, and signatures pertinent to sections will be transferred to this ATP, Rev 1.

2 REFERENCES

2.1 DRAWINGS

H-2-818468, Sh 1, Rev 0	HVAC Overall Flow Diagram
H-2-818480, Sh 1, Rev 1	HVAC Process Building Plan & Sections
H-2-818480, Sh 2, Rev 1	HVAC Process Building Sections & Details
H-2-818480, Sh 3, Rev 1	HVAC Process Building Details
H-2-818480, Sh 4, Rev 1	HVAC Process Building Instrument Connections
H-2-818481, Sh 1, Rev 2	Piping Process Bldg Skid Plan
H-2-818481, Sh 2, Rev 2	Piping Process Bldg Skid Section
H-2-818481, Sh 3, Rev 2	Piping Process Bldg Skid Plans
H-2-818481, Sh 4, Rev 2	Piping Process Bldg Skid Sections
H-2-818558, Sh 3, Rev 1	Project W-320 P&ID Details
H-2-818558, Sh 4, Rev 1	Project W-320 P&ID Interlock Schedule
H-2-818559, Sh 2&4, Rev 3	Project W-320 P&ID Tk 241-C-106
H-2-818561, Sh 1, Rev 4	Project W-320 P&ID Tk 241-C-106 HVAC
H-2-818561, Sh 2-7, Rev 3	Project W-320 P&ID Tk 241-C-106 HVAC
H-2-818569, Sh 1, Rev 1	Instrument Location Plan Tank 241-C-106
H-2-818569, Sh 2, Rev 1	Instrument Location Plan Sections & Details
H-2-818571, Sh 1, Rev 0	Instrumentation Process Building Plan
H-2-818571, Sh 2, Rev 1	Instrumentation Process Building Section & Detail

H-2-818575, Sh 1, Rev 1	Instrumentation Leak Detector Elements Assembly & Installation
H-2-818577, Sh 1, Rev 0	Instrumentation Tank C-106 Purgemeter Installation and Details
H-2-818585, Sh 1, Rev 1	Instrumentation Exh Stack Rad Mon Installation Detail
H-2-818585, Sh 2, Rev 1	Instrumentation Exh Stack Rad Mon Arrangement
H-2-818585, Sh 3, Rev 1	Instrumentation Exh Stack Rad Mon Connection Diagram
H-2-818586, Sh 1, Rev 1	Instrumentation Instrument Rack IR-1361 Detail
H-2-818586, Sh 2, Rev 1	Instrumentation Instrument Rack IR-1361 Sections & Details
H-2-818586, Sh 3, Rev 1	Instrumentation Instrument Rack IR-1361 Connection Diagram
H-2-818587, Sh 1, Rev 1	Instrumentation Process Building Skid Plan
H-2-818587, Sh 2, Rev 1	Instrumentation Process Building Skid Elevations & Section
H-2-818587, Sh 3, Rev 1	Instrumentation Process Building Skid Sections & Details
H-2-818588, Sh 1, Rev 0	Instrumentation Instr Enclosure IE-1361 Assembly
H-2-818588, Sh 2, Rev 0	Instrumentation Instr Enclosure IE-1361 Section & Details
H-2-818588, Sh 3-6, Rev 0	Instrumentation Instr Enclosure IE-1361 Connection Diagram
H-2-818590, Sh 1, Rev 0	Instrumentation Operator Control Station
H-2-818596, Sh 1, Rev 0	Instrumentation Instrument Cabinet CP-01 Assembly
H-2-818596, Sh 3-5, Rev 0	Instrumentation Instrument Cabinet CP-01 Connection Diagram
H-2-818601, Sh 2, Rev 0	Instrumentation Loop Diagram Tank Press & Slurry Winch
H-2-818601, Sh 5, Rev 0	Instrumentation Loop Diagram Slurry Pres/Flo & Bldg HVAC
H-2-818601, Sh 7, Rev 1	Instrumentation Loop Diagram Chilled Water System
H-2-818601, Sh 8, Rev 0	Instrumentation Loop Diagram Pump Pit LD & Exh Skid Temp

H-2-818601, Sh 9, Rev 0	Instrumentation Loop Diagram HEPA Filter Press Diff
H-2-818601, Sh 10, Rev 0	Instrumentation Loop Diagram Exhaust Stack Rad Monitor
H-2-818601, Sh 13, Rev 0	Instrumentation Loop Diagram Valve HV-13638/13669 Psn
H-2-818601, Sh 14, Rev 0	Instrumentation Loop Diagram Common Alarms/TMACS Comm
H-2-818603, Sh 1-6, Rev 0	Instrumentation Loop Diagram Process Bldg 241-C-91
H-2-818674, Sh 1-3, Rev 1	Electrical C-Farm Conduit Plan
H-2-818674, Sh 4, Rev 0	Electrical C-Farm Misc Details
H-2-818675, Sh 2, Rev 0	Electrical C-Farm Elem Diagrams HC-1361 & HC-1362
H-2-818675, Sh 3, Rev 0	Electrical C-Farm Elem Diagrams FN-1361, ANN at MO-211
H-2-818675, Sh 4, Rev 0	Electrical C-Farm Elem Diagrams FN-1362; Exh Skid/HVAC ANN
H-2-818675, Sh 5, Rev 0	Electrical C-Farm Elem Diagrams Service Bldg/Chiller Skid
H-2-818675, Sh 6, Rev 0	Electrical C-Farm Elem Diagrams Prcs Bldg ANN & Rad Alms
H-2-818675, Sh 8, Rev 0	Electrical C-Farm Elem Diagrams Valve Cont/Slurry Pmp ANN
H-2-818678, Sh 1-3, Rev 1	Electrical Process Bldg Plan & Details
H-2-818678, Sh 4, Rev 2	Electrical C-Farm Proc Bldg Skid/Wire Run List
H-2-818678, Sh 5, Rev 1	Electrical Process Bldg Plan & Details
H-2-818680, Sh 1, Rev 0	Electrical C-Farm One-Line Diagram
H-2-818681, Sh 1&2, Rev 0	Electrical C-Farm Elect Equip Skid Details

2.2 SPECIFICATIONS

W-320-C5, Rev 0, Construction Specification "C Tank Farm".
W-320-C6, Rev 0, Construction Specification "Process Building Skid"

2.3 ENGINEERING CHANGE NOTICES (ECN)

Prior to final test approval, mark up the controlled copy of this ATP with all of the ECNs written against it.

2.4 VENDOR INFORMATION

No. 22668

PO 82295	Pressure Differential Switch (PDISH-13614/PDISH-13615)
PO 82296	Pressure Gage (PI-13629/PI-13630/PI-13631)
PO 82297	Gamma Radiation Element Radiation Indicator (RE-1361/RIT-1361)
PO 82298	Resistance Temp Sensor (TE-13620/TE-13621/TE-13622/TE-13625)
PO 82299	Pressure Regulator (PCV-13628/PCV-13629/PCV-1367)
PO 82300	Pressure Safety Valve (PSV-13629)
PO 82301	Temp Switch High/Low (TE-TSHL-13623/TE-TSHL-13624)
PO 82303	Control Valve/Solenoid Valve (HV-13638/HV-13669)
PO 82304	Flow Integrator Indicator (FQI-13629)
PO 82307	Pressure Differential Xmtr (PDT-13611/PDT-13612/PDT-13613)
PO 82307	Pressure Indicator Xmtr (PIT-1361/PIT-13616)
PO 82307	Pressure Transmitter (PT-13611)
PO 82407	Leak Detection Relay
PO 82408	Leak Detection System
PO 82417	Single Loop Controller (PIC-1361)
PO 82418	Annunciator (ANN-1361)
PO 82418	Annunciator (ANN-1362)
PO 10050-7 -GINR	Exhaust Stack Vacuum Pumps Enclosure (P-1366/P-1367) (W-320-P41)
PO WAT-XXD K27208-3	Chromalox Heater Control Panels (Intrinsically Safe) for Heating Coils HC-1361/HC-1362.

3 RESPONSIBILITIES

3.1 GENERAL

Each company or organization participating in this ATP will designate personnel to assume the responsibilities and duties as defined herein for their respective roles. The designees shall become familiar with this ATP and the systems involved to the extent that they can perform their assigned duties.

3.2 NHC PROJECT ENGINEER

3.2.1 Signs Execution and Test Approval page when test is complete and accepted.

3.2.2 Provides a distribution list for the approved and accepted ATP.

3.3 FDNW PROJECT MANAGER

3.3.1 Designates a Test Director.

3.3.2 Signs Execution and Test Approval page when test is complete and accepted.

3.3.3 Signs exception form when all exceptions have been resolved.

3.4 TEST DIRECTOR

3.4.1 Coordinates and directs acceptance testing.

3.4.2 Coordinates testing with FDNW Utilities.

3.4.3 Coordinates testing with FDNW Craft.

3.4.4 Before start of test, obtains all outstanding ECNs against referenced documents of Section 2 and distributes the approved testing schedule to FDNW Project Manager and NHC Project Engineer.

3.4.5 Notifies concerned parties (includes FDNW Project Manager, FDNW Principal Lead Engineer, and NHC Project Engineer) when a change is made in the testing schedule.

3.4.6 Schedules and conducts a pretest kickoff meeting with test participants when necessary.

3.4.7 Confirms that field testing and inspection of the system or portion of the system to be tested has been completed.

3.4.8 Stops any test which, in his or her judgment, may cause damage to the system until the problem has been resolved.

3.4.9 After verifying there is no adverse impact, may alter the sequence in which systems or subsystems are tested.

3.4.10 If a test is to be suspended for a period of time, ensures that the system is left in a safe mode.

3.4.11 Before restarting suspended test, reverifies the test prerequisites.

3.4.12 Initiates ECNs to document required changes to the ATP.

3.4.13 Reviews recorded data, discrepancies, and exceptions.

3.4.14 Signs Execution and Test Approval page when test has been performed.

3.4.15 Takes necessary actions to clear exceptions to the test, and signs exception form when exceptions have been resolved.

3.4.16 Obtains required signatures on the ATP Master prior to reproduction and distribution.

3.5 WITNESSES (Provided by Participating Organizations. One witness shall be a Title III acceptance inspector.)

3.5.1 Witness the tests.

3.5.2 Review results of testing.

3.5.3 Assist the Test Director when requested.

3.5.4 Sign Execution and Test Approval page when test has been performed.

3.5.5 Sign exception form when exception has been resolved.

3.6 RECORDER (Provided by FDNW)

3.6.1 Prepares a Field copy from the ATP Master.

3.6.2 Records names of all designated personnel on Field copy of ATP prior to start of testing.

3.6.3 Records test instrument identification numbers and calibration expiration dates, as required.

3.6.4 Initials and dates every test step on the Field copy as it is completed next to the step number or on a data sheet, when provided. Records test data. On data sheets where there is not room for both the initial and date, date may be entered at bottom of column.

3.6.5 Records exceptions on an exception form. Uses additional exception forms as needed. Notifies the Test Director at time the exceptions is made.

3.6.6 Signs Execution and Test Approval page when test has been performed.

3.6.7 After test is finished, assigns alpha numeric page numbers to added data sheets and exception forms. Records page numbers in the Table of Contents.

3.6.8 Transfers Field copy entries for each step to the Master in ink or type; signs, and dates. Transmits the completed Master to the Test Director for approval signature routing. Transmits the Field copy to Construction Document Control for inclusion in the official project file.

3.6.9 Signs exception form when exception has been resolved and transmits to Test Director.

3.7 TEST OPERATOR

3.7.1 Performs test under direction of the Test Director.

3.7.2 Provides labor, equipment, and test instruments required for performing tests that have not been designated as being provided by others.

3.7.3 Confirms that all equipment required for performing test will be available at the start of testing.

3.7.4 Signs the Execution and Test Approval page.

3.7.5 After the performance of the test, recycles the clean glycol solution, collected in containers, back into the C-106 Supply Air Chiller System or to the recycle center.

3.8 A-E ACCEPTANCE INSPECTION, DESIGN ENGINEER, AND PROJECT MANAGER

3.8.1 Evaluate results.

3.8.2 Sign for A-E Approval on Execution and Test Approval page.

4 CHANGE CONTROL

If a need for change is discovered in the course of running the test, the test shall be stopped. Required changes to this ATP must be processed in accordance with company procedures. However, this does not prevent the running of another portion of the test unaffected by the change.

5 EXECUTION

5.1 OCCUPATIONAL SAFETY AND HEALTH

Individuals shall carry out their assigned work in a safe manner to protect themselves and others from undue hazards and to prevent damage to property and environment. Facility line managers shall ensure the safety of activities within their areas to prevent injury, property damage, or interruption of operation. Performance of test activities shall always include safety and health aspects.

These tests involve working near energized equipment; all procedural requirements for working near energized equipment shall be followed, and an Energized Electrical Work Permit (A-6001-687) shall be completed.

5.2 PERFORMANCE

5.2.1 Conduct testing in accordance with FDNW Practice 134.500.8354 (Performance and Recording of Acceptance Test Procedures).

5.2.2 Perform test following the steps and requirements of this procedure.

5.2.3 As each step in Sections 7 through 11 are completed, the person completing the steps shall initial and date in the space provided. After each section is completed, initial and date in the space provided in Section 12.

5.3 RADIATION PROTECTION

Radioactive material will be used during this ATP to test the radiation detection alarm system. A Radiation Work Permit (RWP) shall be provided by the Operating Contractor. A copy of the RWP shall be included as an attachment to this ATP as part of the test data.

6 EXCEPTIONS

6.1 GENERAL

Exceptions to the required test results are sequentially numbered and recorded on individual ATP Exception Sheets (A-6002-213). This enables case-by-case resolution and approval of each exception.

Errors/exceptions in the ATP itself shall NOT be processed as test exceptions (see Section 4 CHANGE CONTROL).

6.2 RECORDING

6.2.1 Number each exception sequentially as it occurs and record it on an exception form.

6.2.2 Enter name and organization of the individual that identifies each exception.

6.2.3 Enter planned action to resolve each exception when such determination is made.

6.3 RETEST/RESOLUTION

Record the action taken to resolve each exception. Action taken may not be the same as planned action.

6.3.1 When action taken results in an acceptable retest, sign and date Retest Execution and Acceptance section of the exception form.

6.3.2 When action taken does not involve an acceptable retest, strike out the Retest Execution and Acceptance section of the exception form.

6.4 APPROVAL AND ACCEPTANCE

The Test Director provides final approval and acceptance of exceptions by checking one of the following on exception form:

6.4.1 Retest Approved and Accepted: Applicable when Retest Execution and Acceptance section is completed.

6.4.2 Exception Accepted-As-Is: Requires detailed explanation.

6.4.3 Other: Requires detailed explanation.

The Test Director signs and dates the exception form and obtains other approvals, if required.

6.5 DISTRIBUTION

A copy of the approved exception form is distributed to each participant. The signed original is attached to the ATP Master.

7 PREREQUISITES, EQUIPMENT/INSTRUMENTS, ABBREVIATIONS, GLOSSARY, AND ANNUNCIATORS

7.1 PREREQUISITES

The following conditions as applicable shall exist at start of testing for that portion of the system being tested.

3/3/98 7.1.1 NHC Project Engineer has been notified a minimum of 24 hours prior to start of the testing.

ECN #3 7.1.2 Systems and components have tag identification number in accordance with Drawings H-2-818559, Sh 2 and 4; and H-2-818561, Sh 1-7 (except for Exhaust Fan FN-1362 VSD operator panel control switches and status lights); and inspected for compliance with construction documents and vendor documents.

3/3/98 7.1.3 Reference documents (including this ATP) have been verified for correct revision number and outstanding ECNs.

3/3/98 7.1.4 A Prejob Safety Analysis has been prepared and a Prejob Safety Meeting has been conducted.

4/1/98 7.1.5 Instruments listed in Data Sheet 7.1.5 are in current calibration.

3/3/98 7.1.6 Verify the circuit breakers feeding power to the Exhaust Skid are labeled in accordance with Drawing H-2-818680.

3/3/98 7.1.7 Grounding of the Process Building 241-C-91 and the Exhaust Skid have been visually inspected and continuity tested.

3/3/98 7.1.8 The Exhaust Skid Main Disconnect switch is open (OFF position), and the Exhaust Fan FN-1362 Local Disconnect switch at Exhaust Skid is open (OFF position).

3/3/98 7.1.9 Exhaust Skid circuit breakers in C106-PP5 at Exhaust Skid, and disconnect switches, have been continuity tested.

3/3/98 7.1.10 Wiring from Exhaust Skid to MCC-N1 and wiring installed by FDNW on the Exhaust Skid and radiation monitor has been continuity tested and meggered as applicable.

3/3/98 7.1.11 The 120/240 V power panel breakers at power panel C106-PP5 at the Exhaust Skid are open (OFF position).

3/3/98 7.1.12 The supply circuit breaker to the Exhaust Skid from MCC-N1/2FMR is open (OFF position).

3/3/98 7.1.13 The supply circuit breaker to the Exhaust Fan VSD from MCC-N1/2FML, is open (OFF position).

3/3/98 7.1.14 MCC-N1 is energized.

3/3/98 7.1.15 Notify occupants in the 241-C-Farm that an evacuation horn/siren PAL-1361C will be tested and will be audible within 24 hours. Evacuation will not be required.

3/3/98 7.1.16 Verify the C-106 Supply Air Chiller system has been tested in accordance with acceptance test procedure WHC-SD-W320-ATP-006 and is ready for operation.

3/3/98 7.1.17 Annunciator wiring to the Chiller Skid has been continuity tested.

3/3/98 7.1.18 All worker safety equipment required to perform test is readily available.

✓ 3/3/98 7.1.19 Voice communications are available between Chiller Skid, Exhaust Skid, Process Building 241-C-91, Electrical Equipment Skid (EES) 241-C-51, and Operations Trailer MO-211.

✓ 3/3/98 7.1.20 Personnel and support staff responsible for directing the test described in this ATP understand the vendor information (VI) and are qualified to perform the test.

✓ 3/3/98 7.1.21 Methods of water disposal into Tank 241-C-106 have been approved by Facilities Management.

✓ 3/3/98 7.1.22 Acceptance test procedure WHC-SD-W320-ATP-011 for C-Farm Instrumentation has been completed.

✓ 3/3/98 7.1.23 Power is available to panels CB-01, CP-01, and IE-1363 at MO-211 and IE-1361 at Process Building 241-C-91. Annunciator ANN-1361 and ANN-1362 lights have been tested by use of the integral TEST pushbutton.

✓ 3/4/98 7.1.24 Valves have been aligned as shown in Data Sheet 7.1.24.

RA 4/1/98 7.1.25 Air inlet station with HEPA filter is available for installation at the portable exhaust hookup line 8"VT-1012-M8. (Attachment B)

R ↓ 7.1.26 The air outlet line 8"VT-1022-M8 from the Recirculation Fan FN-1361 is available to HX-1361 inlet. (Attachment B)

✓ 3/5/98 7.1.27 Seal Pot and floor drain trap in Rm 1 has been filled with water.

✓ 3/4/98 7.1.28 Air Monitor Corp has been notified to have their representative present to perform Site Acceptance Test of the Exhaust Stack Air Sampling and Radiation Monitoring System Cabinet. (Reference Section 11)

✓ 3/16/98 7.1.29 Verify level gages LG-1366 and LG-1367 are approximately half full in order to prove Pressure Relief Seal Loops are functioning.

RA 4/16/98 7.1.30 Backflow preventer BP-1362 has been appropriately tested.

✓ 3/15/98 7.1.31 Exhaust Skid including HEPA filter banks HEP-1361/HEP-1362 have been appropriately "in-place" tested for pressure decay leakage rate in accordance with Attachment C.

7.2 EQUIPMENT/INSTRUMENTS

Supplied by Test Operator unless otherwise noted.

7.2.1 Multimeter (MM), 4 required, consists of:

2 - 600 V ac/dc
2 wire, 0 - 10 megohms
4 mA to 20 A, adjustable
Remote clamp-on current probe, ac/dc, 200 A
Test lead set with clips

Instrument No. 1051 Expiration Date 9/16/99

Instrument No. 95|45-08-027 Expiration Date 6-16-99

Instrument No. N/A Expiration Date N/A

Instrument No. N/A Expiration Date N/A

7.2.2 Shorting Jumpers: 2 feet long, #12 AWG

7.2.3 Shorting Jumpers with ON-OFF switch: 2 feet long, #12 AWG

7.2.4 Variable Test Pressure Source (VTPS): 0 - 15" H_2O 817-35-40-019 4-22-9

7.2.5 Variable Test Vacuum Source (VTVS): 0 - (-)10" H_2O 817-35-40-018 8-15-9

7.2.6 Transmitter Calibrator/Simulator: Selectable 2-wire (loop powered by internal battery) and source, adjustable 4 - 20 mA

~~DECADE BOX 817-63-02-002 7-17-98~~

Instrument No. 817-13-55-022 Expiration Date 2-20-99

DEC 817-13-55-027 5-29-98 2 DECADE BOX ECN 760

7.2.7 RTD Readout/Calibrator/Simulator: Platinum 100 ohm DIN

DECADE BOX 817-63-02-002 7-17-98

Instrument No. N/A Expiration Date N/A

7.2.8 Thermocouple Readout/Calibrator/Simulator: 3 required, Type K

Instrument No. N/A Expiration Date N/A

Instrument No. ↓ Expiration Date ↓

Instrument No. ↓ Expiration Date ↓

7.2.9 Portable Anemometer, electronic, with remote probe: 0 -20" H_2O, 0 - 3,000 ft/min

Instrument No. 799-28-01-007 Expiration Date 2/4/99

7.2.10 Thermometer, electronic, with remote and immersible probe: For air/gas, 0 to 500 °F (nominal)

Instrument No. N/A Expiration Date N/A

7.2.11 Radiation Test Sources: Provide with uniform gamma radiation field up ~~to 10~~ MIN 20 mR/hr supplied and handled by Operating Contractor. ECO 265

Source ID No. C-830 Expiration Date 7/15/98

7.2.12 Container (bucket to hold glycol solution): 5 gal (nominal), quantity as required to catch possible leak points.

7.2.13 Phase rotation meter: No. I.D-N/A , Calibration Date N/A

7.3 ABBREVIATIONS AND GLOSSARY OF TERMS

7.3.1 Abbreviations

APPENDIX - S

Housing Leak Test

ATTACHMENT C

PRESSURE DECAY LEAKAGE RATE TEST - EXHAUST SKID

1. VERIFY / CLOSE inlet valve HV-13654 AND open outlet valve HV-13655. ECN # 789
2. VERIFY drain valve HV-136136 is CLOSED.
3. VERIFY drain valve HV-136122 is CLOSED.
4. VERIFY drain valve HV-136125 is CLOSED.
5. VERIFY drain valve HV-136127 is CLOSED.
6. REMOVE flex connector from fan outlet and blank off fan outlet.
7. INSTALL calibrated pressure indicating device accurate to ±0.1 in H_20 in first filter test port.
8. INSTALL calibrated temperature indicating device accurate to ±0.5 °F in second filter test port.
9. CONNECT a calibrated vacuum source (with safety relief mechanism, isolation valve, and flow control device) to third filter test port.
10. ISOLATE LG-1361, -1362, -1363, -1364 and PDISH-13618, -13619, and -13620.
11. START vacuum source until a test pressure of -50.0 in H_20 is achieved. Maintain test pressure constant until the temperature inside the exhaust skid remains constant within ±0.5 °F for a minimum of 10 minutes. Close shutoff valve to vacuum source.
12. RECORD initial time, pressure, and temperature. Record barometric pressure.
13. RECORD pressure readings once a minute until pressure decays to 75% of the test pressure, or for a maximum of 15 minutes.

Time	Pressure, in H_20	Time	Pressure, in H_20
Start Time- 14:10	50	8 min-	39.1
1 min-	48.4	9 min-	37.9
2 min-	47.0	10 min- 9:20	37.5
3 min-	45.6	11 min-	
4 min-	44.3	12 min-	
5 min-	43.0	13 min-	
6 min-	41.6	14 min-	
7 min-	40.4	15 min-	

Barometric Pressure, in Hg: BP = 29.41
Initial Temperature, °F: Ti = 56.3
Final Temperature, °F: Tf = 55.2

14. RECORD final time, pressure, and temperature.

15. CALCULATE the leak rate using Data Sheet #1.

16. IF the calculated leak rate is less than 10 SCFM, then RECORD "PASS" on Data Sheet #1 and proceed to Step 17. Otherwise, RECORD "RETEST" on Data Sheet #1.

17. IF a retest is needed, then PERFORM the following:

    a. DISCONNECT vacuum source.

    b. CONNECT a pressure source (with safety relief mechanism, isolation valve, and flow control device) to third filter test port.

    c. PRESSURIZE the test boundary to a pressure adequate to locate leaks (not to exceed +50 in H_2O).

    d. With test boundary under pressure, apply bubble solution to LOCATE leaks.

    e. RELIEVE pressure and REPAIR leaks. DISCONNECT pressure source.

    f. REPEAT Steps 9 through 15 using a new table and new data sheets.

18. RELIEVE vacuum from filter train housing and remove vacuum source.

19. DISCONNECT the test equipment.

20. REINSTALL the filter test port plugs.

21. CLOSE ECN # 789 ~~OPEN inlet valve HV-13654~~ OUTLET VALVE HV-13655 and isolation valves for LG-1361, -1362, -1363, -1364 and PDISH-13618, -13619, and -13620.

22. REMOVE blank from fan outlet and REINSTALL flex connection to fan outlet.

23. Test Director SHALL VERIFY that leak testing of installed exhaust skid is complete by signing below.

D. M. Steinkamp — 3/10/98

Test Director Signature — Date

23. Acceptance Inspector SHALL VERIFY that leak testing of installed exhaust skid is complete by signing below.

[signature] — 3/10/98

Acceptance Inspector Signature — Date

DATA SHEET #1: LEAK RATE CALCULATION

(This page may be reproduced as necessary)

GIVEN

1. Test Volume V = 66.4 ft^3
2. Gas Constant R = 53.35 (ft·lb/lb·°R)

RECORDED TEST DATA

1. Δt = 9.33 minutes
2. Convert °F to °R

   Ti = 56.3 °F + 460 = 516.3 °R

   Tf = 55.2 °F + 460 = 515.2 °R

3. Convert P (in H_2O) to P (lb/ft^2)

   Pi = 50 in H_2O x 5.204 = 260.2 lb/ft^2

   Pf = 37.5 in H_2O x 5.204 = 195.15 lb/ft^2

4. Convert BP (in Hg) to BP (lb/ft^2)

   BP = 29.41 in Hg x 70.73 = 2080.1693 lb/ft^2

5. Convert gage pressure to absolute pressure

   Pi(abs) (lb/ft^2) = Pi (lb/ft^2) + BP (lb/ft^2)

   Pi(abs) = 2080.1693 lb/ft^2 + 260.2 lb/ft^2 = 2340.3693 lb/ft^2

   Pf(abs) (lb/ft^2) = Pf (lb/ft^2) + BP (lb/ft^2)

   Pf(abs) = 2080.1693 lb/ft^2 + 195.15 lb/ft^2 = 2275.3193 lb/ft^2

6. Leak Rate

$$Q=\left(\frac{Pi(abs)}{Ti}-\frac{Pf(abs)}{Tf}\right)\left(\frac{V}{R\cdot\Delta t\cdot(0.075 lb/ft^2)}\right)$$

Q = .2074 SCFM

Allowable leak rate: 10 SCFM

APPENDIX - T

Duct Leak Test

ATTACHMENT C

PRESSURE DECAY LEAKAGE RATE TEST - EXHAUST SKID

1. verify / CLOSE inlet valve HV-13654 and open outlet valve HV-13655. ECN # 789
2. VERIFY drain valve HV-136136 is CLOSED.
3. VERIFY drain valve HV-136122 is CLOSED.
4. VERIFY drain valve HV-136125 is CLOSED.
5. VERIFY drain valve HV-136127 is CLOSED.
6. REMOVE flex connector from fan outlet and blank off fan outlet.
7. INSTALL calibrated pressure indicating device accurate to ±0.1 in H_2O in first filter test port.
8. INSTALL calibrated temperature indicating device accurate to ±0.5 °F in second filter test port.
9. CONNECT a calibrated vacuum source (with safety relief mechanism, isolation valve, and flow control device) to third filter test port.
10. ISOLATE LG-1361, -1362, -1363, -1364 and PDISH-13618, -13619, and -13620.
11. START vacuum source until a test pressure of -50.0 in H_2O is achieved. Maintain test pressure constant until the temperature inside the exhaust skid remains constant within ±0.5 °F for a minimum of 10 minutes. Close shutoff valve to vacuum source.
12. RECORD initial time, pressure, and temperature. Record barometric pressure.
13. RECORD pressure readings once a minute until pressure decays to 75% of the test pressure, or for a maximum of 15 minutes.

Time	Pressure, in H_2O	Time	Pressure, in H_2O
Start Time- 14:10	50	8 min-	39.1
1 min-	48.4	9 min-	37.9
2 min-	47.0	10 min- 9:20	37.5
3 min-	45.6	11 min-	
4 min-	44.3	12 min-	
5 min-	43.0	13 min-	
6 min-	41.6	14 min-	
7 min-	40.4	15 min-	

Barometric Pressure, in Hg: BP = 29.41
Initial Temperature, °F: Ti = 56.3
Final Temperature, °F: Tf = 55.2

14. RECORD final time, pressure, and temperature.

15. CALCULATE the leak rate using Data Sheet #1.

16. IF the calculated leak rate is less than 10 SCFM, then RECORD "PASS" on Data Sheet #1 and proceed to Step 17. Otherwise, RECORD "RETEST" on Data Sheet #1.

17. IF a retest is needed, then PERFORM the following:

    a. DISCONNECT vacuum source.

    b. CONNECT a pressure source (with safety relief mechanism, isolation valve, and flow control device) to third filter test port.

    c. PRESSURIZE the test boundary to a pressure adequate to locate leaks (not to exceed +50 in H_2O).

    d. With test boundary under pressure, apply bubble solution to LOCATE leaks.

    e. RELIEVE pressure and REPAIR leaks. DISCONNECT pressure source.

    f. REPEAT Steps 9 through 15 using a new table and new data sheets.

18. RELIEVE vacuum from filter train housing and remove vacuum source.

19. DISCONNECT the test equipment.

20. REINSTALL the filter test port plugs.

21. Close ECN # 789 ~~OPEN inlet valve HV-13654~~ OUTLET VALVE HV-13655 and isolation valves for LG-1361, -1362, -1363, -1364 and PDISH-13618, -13619, and -13620.

22. REMOVE blank from fan outlet and REINSTALL flex connection to fan outlet.

23. Test Director SHALL VERIFY that leak testing of installed exhaust skid is complete by signing below.

D. M. Stenkamp — 3/10/98

Test Director Signature — Date

23. Acceptance Inspector SHALL VERIFY that leak testing of installed exhaust skid is complete by signing below.

Lloyd Snyder — 3/10/98

Acceptance Inspector Signature — Date

DATA SHEET #1: LEAK RATE CALCULATION

(This page may be reproduced as necessary)

GIVEN

1. Test Volume V = 66.4 ft^3
2. Gas Constant R = 53.35 (ft·lb/lb·°R)

RECORDED TEST DATA

1. Δt = 9.33 minutes
2. Convert °F to °R

   Ti = 56.3 °F + 460 = 516.3 °R

   Tf = 55.2 °F + 460 = 515.2 °R

3. Convert P (in H_20) to P (lb/ft^2)

   Pi = 50 in H_20 x 5.204 = 260.2 lb/ft^2

   Pf = 37.5 in H_20 x 5.204 = 195.15 lb/ft^2

4. Convert BP (in Hg) to BP (lb/ft^2)

   BP = 29.41 in Hg x 70.73 = 2080.1693 lb/ft^2

5. Convert gage pressure to absolute pressure

   Pi(abs) (lb/ft^2) = Pi (lb/ft^2) + BP (lb/ft^2)

   Pi(abs) = 2080.1693 lb/ft^2 + 260.2 lb/ft^2 = 2340.3693 lb/ft^2

   Pf(abs) (lb/ft^2) = Pf (lb/ft^2) + BP (lb/ft^2)

   Pf(abs) = 2080.1693 lb/ft^2 + 195.15 lb/ft^2 = 2275.3193 lb/ft^2

6. Leak Rate

$$Q=\left(\frac{Pi(abs)}{Ti}-\frac{Pf(abs)}{Tf}\right)\left(\frac{V}{R\cdot\Delta t\cdot(0.075\,lb/ft^2)}\right)$$

Q = .2074 SCFM

Allowable leak rate: 10 SCFM

APPENDIX - U

Airflow Capacity and Distribution

11 COLD TEST PROCESS VENTILATION SYSTEM PERFORMANCE

The following will perform cold tests for the system performance of the Heat Exchanger HX-1361, Air Recirculation Fan FN-1361 and the heater control system, Exhaust Fan FN-1362 and heater control system, and stack monitoring system.

NOTE: Sections 11.1, 11.2, and 11.3 will be performed during Chiller Operational test (ATP HNF-1831 [W320-ATP19]). Section 11.4 can be performed independent of Chiller operation.

11.1 PREPARATION

RD 3/28/98 11.1.1 Verify applicable steps specified in Sections 7, 8, and 10 have been completed.

RD 11.1.2 Place containers under the chilled water piping system at the connection points to the Process Building and the Heat Exchanger to catch possible leaks during filling and tests.

RD 11.1.3 To fill Heat Exchanger HX-1361 piping system from the Chiller Skid with glycol solution, verify makeup storage tank TK-1361 is pressurized to approximately 30 psi (PI-1367).

RD 11.1.4 Verify PI-1368 indicates 18 ±2psi, and HV-13627 is OPEN. If PI-1368 does not indicate pressure of 18 ± 2psi, open valve HV-13627 + adjust PCV-1368 to 18 psig. ECN # 789

RD 3/28/98 11.1.5 On Chiller Control Panel, verify either CWP-1 or CWP-2 is RUNNING.

RD 11.1.6 Verify FIT-1364 indicates a flow in the range of 95 to 110 gpm. If not, adjust balancing valve HV-13622/HV-13624 as required.

RD 11.1.7 ~~Verify TI-13618 and TI-13619 read approximately the same.~~ See Below

RD 11.1.8 Verify/close valves HV-13636, HV-13635, and HV-136210.

RD 11.1.7 Record TI-13618 34 °F + TI-13619 40 °F. On chiller control panel, shut down chiller pumps CWP1/CWP-2. ECN # 789

RO 5/5/98 11.1.9 Valves have been aligned as shown on Data Sheet 11.1.9.

DATA SHEET 11.1.9		
Initial/Date	Valve	Position
RO 3/28/98	HV-13644	CLOSED
RO ↓	HV-13645	CLOSED
RO ↓	HV-13646	OPEN
RO ↓	HV-13647	OPEN
RO ↓	HV-13648	OPEN
RO ↓	HV-13649	OPEN
RO ↓	HV-13654	OPEN
RO ↓	HV-13655	OPEN
RO 5/5/98 ECN # 801	HV-136117	Closed ~~OPEN~~
RO ↓ 801	HV-136118	Closed ~~OPEN~~
RO ↓ 801	HV-136121	Closed ~~OPEN~~
RO ↓ 801	HV-136134	Closed ~~OPEN~~
RO 3/28/98	HV-136150	CLOSED
RO ↓	HV-136152	CLOSED

RO 3/28/98 11.1.10 Connect temporary air inlet station with HEPA filter to the portable exhaust hookup line 8"VT-1012-M8 in accordance with Attachment B, and open valve HV-136151.

RO 11.1.11 Remove HV-136142 and connect recirculation line 8"VT-1022-M8 to HX-1361 inlet in accordance with Attachment B.

RO 11.1.12 Call Hanford weather forecaster at 373-2716 and record relative humidity and outdoor air temperature.

Relative humidity = 18 % Temperature = 56 °F

RO 11.1.~~13~~ 16 ECN # 789 Turn 3-way valve HV-136200 to normally OPEN position (align to HX-1361). ON chiller control Panel, Start CWP-1/CWP-2. ECN # 789

RO 11.1.14 Slowly open HV-13636 and then HV-13635.

R 3/28/98 11.1.15 Visually inspect and verify that the chilled water piping system at the connection points to the Heat Exchanger HX-1361 do not leak.

R 11.1.~~16~~ 13 ECN #789 Open valve HV-136210. Ø Per telecon w/Randy Dykeman VC 7/17/98

R 11.1.17 At IE-1361, record input pressure PI-13611.

PI-13611 = 0 psi (should be 0 psi)

R 11.1.18 At IE-1361, ^OPEN VALVES HV-13642 AND ECN ~~770~~, 789 record differential pressure across condenser as indicated on PDISH-13611.

PDISH-13611 = 0 psid (should be 0 psid)

R 11.1.19 Record inlet air temperature reading as indicated on TISH-13620.

TISH-13620 = 69 °F

R 11.1.20 Record outlet air temperature reading as indicated on TISH-13621.

TISH-13621 = 79 °F

11.2 HEAT EXCHANGER HX-1361/AIR RECIRCULATION FAN FN-1361 AND HEATER CONTROL SYSTEM

The following will perform cold tests of the Air Recirculation Fan FN-1361 and Heating Coil HC-1361 control system.

R 3/28/98 11.2.1 Close heating coil HC-1361 Disconnect DS-3 and at ER-1361, and Disconnect DISC on SR Control Panel SCP-1361.

R 11.2.2 Turn HS-13622 at SCP-1361 to OFF position.

R 11.2.3 Verify Power ON light YL-13622A on SCP-1361 is LIT.

R ~~11.2.4 On SCP-1361, set TIC-13622 to MANUAL mode.~~ DELETE ECN #789

R 11.2.5 On SCP-1361, verify HTR ON light YL-13622B is NOT LIT.

R 11.2.~~6~~9 On SCP-1361, manually adjust TIC-13622 setpoint to ambient and record readings from TISH-13620, TISH-13621, and TIC-13622 are approximately the same.

TISH-13620: 64 °F TISH-13621: 44 °F TISH-13622: 50 °F

R 11.2.~~7~~8 ECN #789 On IE-1361 and on ANN-1362, ^Reset AND ECN #789 verify TAH-13620, TAH-13621, and TAH-13622 are in NORMAL condition.

R 11.2.~~8~~6 On IE-1361, DEPRESS switch HS-13635A. Verify FAN ON light YL-13635A is LIT and ammeter IISH-13635 is registering a normal reading (approximately 11 A).

R 11.2.~~8~~7 On ANN-1362, ^Acknowledge, Reset AND ECN #789 verify IAH-13635 is in NORMAL condition.

EXC #2	11.2.10	In the Process Building 241-C-91, at the Recirculation Fan FN-1361 discharge line (at HX-1361 inlet), and with a portable anemometer, measure and record discharge air flow: 3151 ft/min (should be 2475 ±50 ft/min).
RO 3/28/98	11.2.11	On SCP-1361, turn HS-13622 to ON position.
RO	11.2.12	Verify HTR ON light YL-13622B is LIT.
RO	11.2.13	On SCP-1361, manually adjust the setpoint to Process temperature reading as indicated on TIC-13622 and TI-13622. Gradually change the setpoint in 5 °F increments to desired value of 77 °F.
RO	11.2.14	Record readings on TI-13622 at each step from 62 °F to 77 °F. 64.5 69.7 74.4 76.1
RO	11.2.15	After the process is stabilized, ~~switch controller~~ Record Reading on TIC-13622 ~~to~~ 77.4 ~~AUTO mode~~.
RO	11.2.16	Record reading from PI-13611: 5.76 psi.
RO	11.2.17	Record reading from PDISH-13611: 7.5 psid.
RO 5/5/98	11.2.18	Record and verify that the reading on TISH-13620 81 is approximately 40 °F ~~less~~ MORE than the reading on TISH-13621 40. ECN # 801

NOTE 1: The following will verify that when the Recirculation Fan FN-1361 is shut down, the interlock (Interlock 5) will cause the heating coil HC-1361 to shut down.

WARNING: If the HC-1361 does not shut down (by observing the status of HTR ON light YL-13622) when FN-1361 is shut down, then immediately turn HTR ON/OFF switch HS-13622 to OFF and notify Test Director.

RO 3/28/98	11.2.19	On IE-1361, depress HS-13635B, verify that FAN OFF light YL-13635B is LIT and FAN ON light YL-13635A is NOT LIT.
RO	11.2.20	On SCP-1361, verify HTR ON light YL-13622B is NOT LIT.
RO	11.2.21	On IE-1361, depress HS-13635A, verify that FAN ON light YL-13635A is LIT and FAN OFF light YL-13635B is NOT LIT.
RO	11.2.22	On SCP-1361, verify HTR ON light YL-13622B is LIT.

NOTE: The Recirculation Fan FN-1361 shall be operating for the next section. If this section was completed at end of day, the Test Director may shut down Recirculation Fan FN-1361 by depressing switch HS-13635B on IE-1361. However, the Recirculation Fan FN-1361 must be restarted before proceeding to the following step.

11.3 TANK EXHAUST and HEATER CONTROL SYSTEM

The following will perform cold tests of the variable speed Exhaust Fan FN-1362, while simulating the tank pressure, and Heating Coil HC-1362 temperature control system.

RD 3/30/98 11.3.1 In CP-01, at TB-3, remove FU-4 (this disables Evacuation Horn PAL-1361C).

RD 11.3.2 At PIT-1361, on the 2-valve manifold (2VM) HV-13164, close block valve HV-136164-1A. Open the test port (TP) at valve HV-136164-1B and connect VTVS. Open valve HV-136164-1B.

RD 11.3.3 Verify that FN-1361 is operating.

RD 11.3.4 Verify final electrical equipment lineup in Step 8.4 has been completed.

RD 11.3.5 At PIT-1361, set VTVS at -10" WC and verify PIC-1361 at MO-211 indicates -10" WC.

RD 11.3.6 Verify PAH-1361A is FLASHING and audible is ON.

RD 11.3.7 Acknowledge and verify PAH-1361A is STEADY ON and audible is OFF.

RD 11.3.8 Verify on PIC-1361, the display indicates an alarming state LO PRESS, the red LED light is LIT, and audible is ON.

RD 11.3.9 On PIC-1361, depress the horn symbol membrane switch and verify the red LED light is NOT LIT, the display indicates a change to LPR and UNACKED, and audible is OFF.

RD 11.3.10 Depress the ▲ membrane switch and verify that the display indicates a change to ACKED.

RD 11.3.11 Reset and verify PAL-1361A is in NORMAL condition.

RD 11.3.12 Verify FAN OFF light YL-13640D is LIT.

RD 11.3.13 At the Exhaust Skid, close FN-1362 Exhaust Fan Disconnect Switch DS1 (ON position).

RD 11.3.14 At EES 241-C-51, on FN-1362 VSD panel face, perform the following:

RD 3/30/98 a. Depress REMOTE membrane switch HS-13639B and verify REMOTE status light YL-13639D is LIT.

RD b. Depress AUTO membrane switch HS-13639D and verify AUTO status light YL-13639E is LIT.

RD c. On the VSD Keypad, verify FAN RUN status light YL-13639A is NOT LIT.

RD d. Verify FAN RUNNING light YL-13640 is NOT LIT.

RD 11.3.15 At the Exhaust Skid, close Heating Coil HC-1362 disconnect switch (ON position).

RD 11.3.16 At Exhaust Skid, verify POWER ON light YL-13629A is LIT and the HEATER ON light YL-13629B is NOT LIT.

RD 11.3.17 At PIT-1361, increase VTVS until PIC-1361 is approximately -2.5" WC.

RD 5/5/98 a. DEPRESS HS-13640C, VERIFY FAN FN-1362 DOES NOT START. RD 5/5/98 b. ON PIC-1361 SET CONTROLLER TO AUTO MODE. ECN # 801

RD 11.3.18 At MO-211, Reset and verify PAH-1361A is in NORMAL condition.

RD 11.3.19 On PIC-1361, depress the horn symbol membrane switch and verify display indicates a change to "PIC-1361".

RD 11.3.20 At the EES, verify FAN RUNNING light YL-13640 is LIT and on the VSD Keypad the FAN RUNNING status light YL-13639A is LIT.

RD 11.3.21 At the Exhaust Skid verify Exhaust Fan FN-1362 starts.

RD 11.3.22 In MO-211, on CP-01, verify FAN ON light YL-13640C is LIT.

RD 11.3.23 At the Exhaust Fan FN-1362 discharge line, and with a portable anemometer, measure and record discharge air flow: 1150 ft/min.

RD 11.3.24 At PIT-1361, increase VTVS to 0" WC and, at the Exhaust Fan FN-1362 discharge line and with a portable anemometer, measure and record discharge air flow: 1560 ft/min (should be a greater flow rate than that recorded on previous step).

> SEE INSERT PAGE 56(1). ECN # 801

RD 11.3.25 Record TIT-13626 reading. 58°F Verify it is approximately the same as reading on TIT-13629. 60°F ECN # 801 RD 5/5/98

RD 11.3.26 Verify/Adjust TIC-13629 set point to 53 °F.

RD 11.3.27 At the Exhaust Skid, set the HEATER ON/OFF handswitch HS-13630 to ON position.

RD 11.3.28 Verify Heating Coil HC-1362 HEATER ON light YL-13629B is LIT.

RD 11.3.29 Record TIT-13629 reading: 60°F. Verify it is the same as the process variable temperature reading displayed on TIC-13629.

INSERT per ECN # 801

1.3.24

25/5/98 a. Verify PAL-1361A is flashing and Audible is ON.

____ b. Acknowledge and verify PAL-1361A is Steady ON and Audible is off.

____ c. Verify that PIC-1361 is Alarming and the red Led is On.

____ d. Depress horn symbol membrane switch and verify Audible is off and the red LED is NOT LIT.

____ e. Depress Δ membrane switch and verify the display indicates a change to ACKN.

RD 3/30/98 11.3.30 Record TIT-13635 reading: 61°F.

NOTE 1: The following will verify that when the Recirculation Fan FN-1362 is shut down, the interlock (Interlock 4) will cause the heating coil HC-1362 to shut down.

WARNING: If the HC-1362 does not shut down (by observing the status of HTR ON light YL-13629B) when FN-1362 is shutdown, then immediately turn HTR ON/OFF switch HS-13629 to OFF and notify Test Director.

RD 3/30/98 11.3.31 At PIT-1361, decrease VTVS to -4" WC and verify:

RD a. Exhaust Fan FN-1362 STOPS.

RD b. Heating Coil HC-1362 HEATER ON light YL-13629B is NOT LIT.

RD 11.3.32 In the EES, on the VSD, the FAN RUNNING light YL-13640 is NOT LIT, and on the VSD Keypad the FAN RUN status light YL-13639A is NOT LIT.

RD 11.3.33 In MO-211, on CP-01, verify FAN OFF light YL-13640D is LIT.

RD 11.3.34 Verify PAH-1361A is FLASHING and audible is ON.

RD 11.3.35 Acknowledge and verify PAH-1361A is STEADY ON and audible is OFF.

RD 11.3.36 Verify on PIC-1361, the display indicates an alarming state LO PRESS, the red LED light is LIT, and audible is ON.

RD 11.3.37 On PIC-1361, depress the horn symbol membrane switch and verify the red LED light is NOT LIT, the display indicates a change to LPR and UNACKED, and audible is OFF.

RD 11.3.38 Depress the ▲ membrane switch and verify that the display indicates a change to ACKED.

RD 11.3.39 At PIT-1361, increase VTVS to approximately -2.5" WC, ~~verify:~~ DEPRESS HS-13642, then verify.
ECN# 801 RD 5/5/98

RD a. Exhaust Fan FN-1362 is RUNNING.

RD b. Heating Coil HC-1362 HEATER ON light YL-13629B is LIT.

RD 11.3.40 At MO-211, Reset and verify PAH-1361A is in NORMAL condition.

RD ✓ 11.3.41 On PIC-1361, depress the horn symbol membrane switch and verify display indicates a change to "PIC-1361".

RD 3/30/98 11.3.42 In the EES, on the VSD, the FAN RUNNING light YL-13640 is LIT and the VSD Keypad FAN RUN status light YL-13639A is LIT.

RD 11.3.43 In MO-211, on CP-01, verify FAN ON light YL-13640C is LIT, then depress STOP pushbutton HS-13640D and verify FAN OFF light YL-13640D is LIT.

RD 11.3.44 Verify PAH-1361A and PAL-1361A are in NORMAL condition.

RD 11.3.45 Verify Exhaust Fan FN-1362 STOPS.

RD 11.3.46 Verify Heating Coil HC-1362 HEATER ON light YL-13629B is NOT LIT.

RD 11.3.47 In MO-211, on CP-01, depress START pushbutton HS-13640C and verify FAN ON light YL-13640C is LIT.

RD 11.3.48 Verify PAH-1361A and PAL-1361A are in NORMAL condition.

RD 11.3.49 Verify Exhaust Fan FN-1362 is RUNNING.

RD 11.3.50 Verify Heating Coil HC-1362 HEATER ON light YL-13629B is LIT.

RD 11.3.51 Set Heating Coil HC-1362 HEATER handswitch HS-13630 to OFF position.

RD 11.3.52 Open Heating Coil HC-1362 disconnect switch (OFF position).

RD 11.3.53 In MO-211, on CP-01, depress STOP pushbutton HS-13640D and verify FAN OFF light YL-13640D is LIT.

RD 11.3.54 Verify Exhaust Fan FN-1362 STOPS.

RD 11.3.55 At PIT-1361, on the 2-valve manifold (2VM) HV-13164, close valve HV-136164-1B. Disconnect VTVS and close the test port (TP) at valve HV-136164-1B. Open block valve HV-136164-1A.

RD 3/31/98 11.3.56 Turn 3-way valve HV-136200 to normally CLOSED position (align to CC-1361).

RD 11.3.57 Close valves HV-136210, HV-13636, and HV-13635.

RD 11.3.58 In CP-01, at TB-3, install FU-4 removed on step 11.3.1.

APPENDIX - V

In-Place HEPA Filter Test

APPENDIX TT
241-C 106 TANK EXHAUSTER 296-C-006
AEROSOL TEST DATA SHEETS

Last Full Revision: 0-0

Release Date: 8/20/96

USQ Screening Number: TF-97-0138

Approval Designator: ESQ

Current Modification: 0-A

USQ Screening Number: TF-98-0440, Rev. 1

Approval Designator: ESQ

PCA Incorporated: ETF-98-332

POSITION/ORG	DELEGATE	DATE
SOE V&B	R. Ward	5/20/98
OE/DST	J.E. Andrews	5/20/98
Mgr/V&B	D.A. Gilles	5/20/98
Nuclear Safety	S.U. Zaman	5/20/98
QA	W.L. Adams	5/20/98
ECO	P.C. Miller	5/20/98
Cognizant Engineer	D.B. Smet	5/20/98
Acceptance Review	K.W. Johnson	5/28/98
Approval Authority	T.A. Erickson	5/22/98

Justification: Modifications for Project W-320

Summary of Changes:
Corrected nomenclature, references, figures, and steps; added Administrative Controls 5.10 and 5.16.

TANK EXHAUSTER 296-C-6 SITE-SPECIFIC DATA	
GENERAL INFORMATION	
Stack:	18' (height); 6" i.d. (circular diameter)
Flow Test Ports:	FTPs A & C; 1" pipe w/cap; 3'-6" above pad FTPs B, D & E; 3/8" half cplng/plug; 3'-6" above pad FTPs F, G; 1" pipe w/cap; 11'-2" above pad
Scaffolding:	Work platform installed
Exhaust Fan:	FN-1362~~VTP EF 1306B~~; 230 cfm @ 53°F (variable: 180 std cfm @ 19 in. wg to 360 std cfm @ 42 in. wg)
HEPA Filters:	HEP-1361~~VTP FLT 1308~~, HEP-1362~~VTP FLT 1309~~ (in series); see H-2-818561
REFERENCES	
Include the following references if requested by Air Balance (AB), Operations (NPO), or Tank Farm Power Operator (OP) personnel: H-2-818561, Project W-320 P & ID Tk 241-C-106 HVAC. TO-060-050, Operate 296-P-16 ~~Portable~~ Exhauster ~~for TK105C & TK106C~~	
PRECAUTIONS & LIMITATIONS	
If vehicle entry into the tank farm is required, ensure requirements specified in HNF-IP-1266 AC 5.10 "Ignition Controls" and AC 5.16 "Dome Loading Controls" are met, as applicable~~A flagman is required for vehicle movement within the Tank Farm~~.	
PREREQUISITES	
No additional prerequisites. See 6-TF-156, Section 6.0.	

DATA SHEET 1

STEP 7.1	INSTRUMENT CALIBRATION DATA	
	AIR FLOW INSTRUMENT	PHOTOMETER
	Flow Instrument Type	Equipment Number
	Instrument Code Number	Instrument Code Number
	Instrument Cal Due Date	Instrument Cal Due Date
7.1.2 ~~7.1.1~~		~~WHC Cal Due Date~~
	AEROSOL GENERATOR	
	Model Number	Model Number
	Equipment Number	Equipment Number
	Functional Test Due Date	Functional Test Due Date
	Aerosol Type	Aerosol Type
	ADDITIONAL INSTRUMENT CALIBRATION DATA	
7.1.3 ~~7.1.2~~		
	COMMENTS:	

Initials/Date ______________________

DATA SHEET 2

STEP 7.2	VISUAL INSPECTION CHECKLIST	YES	NO	N/A
7.2.1	Filter housing access adequate?			
	Housekeeping adequate?			
	Lighting levels adequate?			
	Housing or ductwork damaged?			
	Test ports available (Figures 1 & 2)?			
	Test ports labeled?			
	Housing door or seal damaged or leaking?			
	Installed pressure gauges labeled?			
	Calibration labels current?			
	Instrumentation damaged (broken, disconnected)?			
	Filter damaged (tears, holes, frame separation)?			
	Evidence of moisture in housing (stains, water)?			
7.2.2	COMMENTS: ____________________			

Initials/Date ____________________

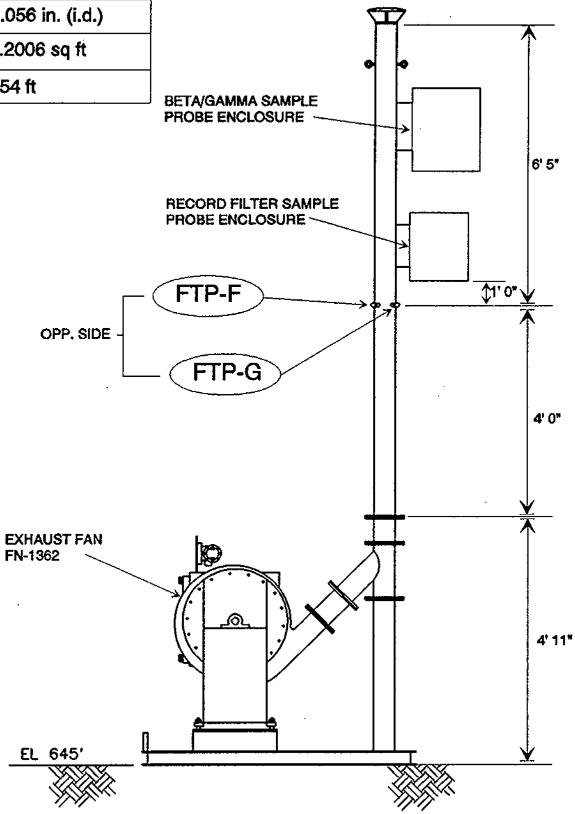
DATA SHEET 3

STEP 7.3	DIFFERENTIAL PRESSURE READINGS					
	FILTER*	DP GAUGE*	LOCATION	READING (in. wg)	LIMITS (in. wg)	RESULTS
7.3.1	1st Stage HEP-1361	PDISH-13618	Filter Housing		0.50 min. 5.00 max.	PASS FAIL
	2nd Stage HEP-1362	PDISH-13619			0.30 min. 3.00 max.	PASS FAIL
	Overall	PDISH-13620			0.30 min. 5.90 max.	PASS FAIL
7.3.2	Authorization to Proceed: If any DP reading is NOT within operating limits, then authorization to continue testing is required. Fac. PIC: ______________ Date: ________					
	COMMENTS: ______________					

* Equipment designations as labeled in field are prefixed by "VTP-".

Initials/Date ______________

STACK 296-C-6	
MEASUREMENT	FLOW TEST PORT
Humidity	F
Static Pressure	F
Temperature	F, G
Velocity Pressure	F, G
Stack Diameter:	6.056 in. (i.d.)
Stack Area:	0.2006 sq ft
Port Elevation:	654 ft



H-2-818585
156TTF1.WPG

FIGURE 1 - 241-C 106 TANK EXHAUSTER 296-C-6 AIR FLOW TEST PORTS

Type	Document No.	Rev/Mod	Release Date
CONTINUOUS	6-TF-156TT	0-A	5/28/98

DATA SHEET 4

STEP 7.4	SYSTEM AIR FLOW READINGS				
	Traverse Points* (in.)	PORT F		PORT G	
		VP (in. wg)	Velocity** (fpm)	VP (in. wg)	Velocity** (fpm)
7.4.1 7.4.2 7.4.3	1/2				
	7/8				
	1 3/8				
	2				
	4				
	4 5/8				
	5 1/8				
	5 1/2				
7.4.4	Port Totals (fpm)				
	Total fpm = Total Port F + Total Port G				
7.4.5	Average fpm = Total fpm ÷ 16				
7.4.6	Air flow (cfm) = Average fpm x 0.2006~~0.1964~~ sq ft				

* Traverse points measured relative to internal diameter (i.d.); none may be located within 0.5 in. of stack walls (40 CFR 60, App. A).

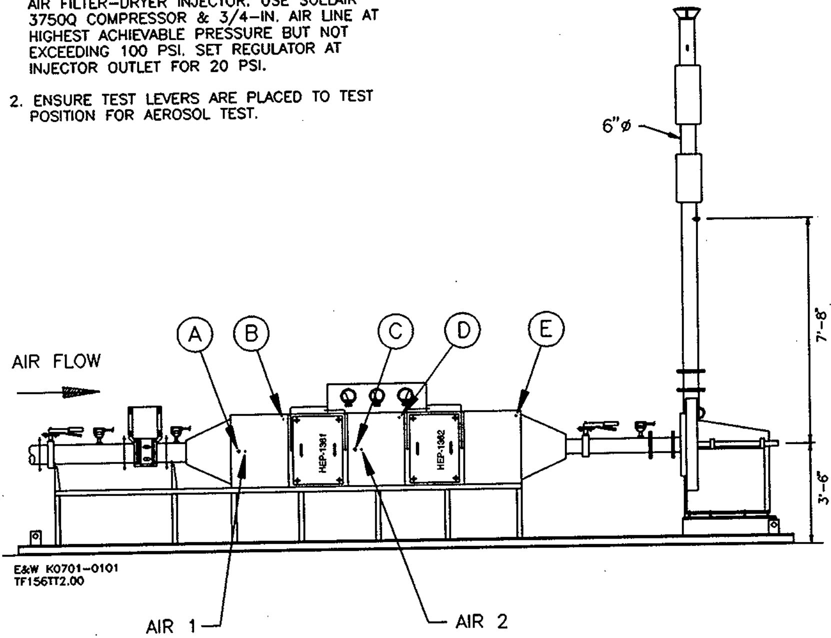
** Velocity (fpm) = $4005 \sqrt{VP}$

Initials/Date ____________________

NOTE:

1. INJECT COMPRESSED AIR FOR TEST USING AIR FILTER-DRYER INJECTOR. USE SULLAIR 3750Q COMPRESSOR & 3/4-IN. AIR LINE AT HIGHEST ACHIEVABLE PRESSURE BUT NOT EXCEEDING 100 PSI. SET REGULATOR AT INJECTOR OUTLET FOR 20 PSI.

2. ENSURE TEST LEVERS ARE PLACED TO TEST POSITION FOR AEROSOL TEST.



TEST	PORT	HEPA FILTER	
		HEP-1361	HEP-1362
BASELINE	INJECT	A	C
	SAMPLE	B	D
PENETRATION	INJECT	A	C
	SAMPLE	D	E

FIGURE 2 - 241-C 106 TANK EXHAUSTER 296-C-6 AEROSOL TEST PORTS

DATA SHEET 5 (Sheet 1 of 2)

STEP 7.5	1ST HEPA FILTER AEROSOL TEST READINGS (HEP-1361~~VTP-FLT-1308~~)		
7.5.1	TRIAL 1	TRIAL 2	TRIAL 3
	Generator: ______ psi	Generator: ______ psi	Generator: ______ psi
	(Scale X Reading = Eq. Input)	(Scale X Reading = Eq. Input)	(Scale X Reading = Eq. Input)
7.5.2	_____ X _____ = _____ C_b	_____ X _____ = _____ C_b	_____ X _____ = _____ C_b
7.5.3	_____ X _____ = _____ B_b	_____ X _____ = _____ B_b	_____ X _____ = _____ B_b
	_____ X _____ = _____ B_p	_____ X _____ = _____ B_p	_____ X _____ = _____ B_p
7.5.4	_____ X _____ = _____ C_p	_____ X _____ = _____ C_p	_____ X _____ = _____ C_p
STEP 7.8	AEROSOL PENETRATION CALCULATIONS*		
7.8.1	$P = 100\left(\frac{C_p}{C_b}\right)$	$P = 100\left(\frac{C_p}{C_b}\right)$	$P = 100\left(\frac{C_p}{C_b}\right)$
	$P = 100\left(\frac{\quad}{\quad}\right)$	$P = 100\left(\frac{\quad}{\quad}\right)$	$P = 100\left(\frac{\quad}{\quad}\right)$
	$P =$ ________ %	$P =$ ________ %	$P =$ ________ %
7.8.2	PASS = $P < 0.05\%$ FAIL = $P \geq 0.05\%$		
	PASS / FAIL	PASS / FAIL	PASS / FAIL
7.8.3	Fac. PIC signature required if <u>ANY</u> trial fails: Fac. PIC ______________________ Date:__________		

* Background concentrations (B_b, B_p) are for information only and are not part of percent penetration calculation.

Initials/Date ______________

DATA SHEET 5 (Sheet 2 of 2)

STEP 7.5	2ND HEPA FILTER AEROSOL TEST READINGS (HEP-1362~~VTP-FLT-1309~~)		
7.5.1	TRIAL 1	TRIAL 2	TRIAL 3
	Generator: ______ psi	Generator: ______ psi	Generator: ______ psi
	(Scale X Reading = Eq. Input)	(Scale X Reading = Eq. Input)	(Scale X Reading = Eq. Input)
7.5.2	______ X ______ = ______ C_b	______ X ______ = ______ C_b	______ X ______ = ______ C_b
7.5.3	______ X ______ = ______ B_b	______ X ______ = ______ B_b	______ X ______ = ______ B_b
	______ X ______ = ______ B_p	______ X ______ = ______ B_p	______ X ______ = ______ B_p
7.5.4	______ X ______ = ______ C_p	______ X ______ = ______ C_p	______ X ______ = ______ C_p
STEP 7.8	AEROSOL PENETRATION CALCULATIONS*		
7.8.1	$P = 100\left(\frac{C_p}{C_b}\right)$ $P = 100\left(\frac{\quad}{\quad}\right)$ $P =$ ______ %	$P = 100\left(\frac{C_p}{C_b}\right)$ $P = 100\left(\frac{\quad}{\quad}\right)$ $P =$ ______ %	$P = 100\left(\frac{C_p}{C_b}\right)$ $P = 100\left(\frac{\quad}{\quad}\right)$ $P =$ ______ %
7.8.2	PASS = $P < 0.05\%$ FAIL = $P \geq 0.05\%$		
	PASS / FAIL	PASS / FAIL	PASS / FAIL
7.8.3	Fac. PIC signature required if ANY trial fails: Fac. PIC ______________________ Date: __________		

* Background concentrations (B_b, B_p) are for information only and are not part of percent penetration calculation.

Initials/Date ______________

DATA SHEET 6

STEP 10	DISPOSITION		
~~10.1~~ 10.2 10.3	Vent & Balance Reviewer shall ensure data sheets are accurate, complete, and legible.		
	V&B Reviewer(print name)	Signature	Date
10.4 ~~10.3~~	Facility Person-In-Charge (PIC) shall ensure all caps, plugs, test levers, and instrumentation are restored to operating configuration:		
	System configuration restored:	Facility PIC	Date
10.5 10.7 ~~10.4~~ ~~10.6~~	Facility PIC record Work Request Number of items requiring additional maintenance and forward work package to Planner:		
	Work Request Number	Work Request Number	Date

COMMENTS: ____

PROCEDURE SIGNATURE HISTORY PAGE

APPENDIX - W

Air Heater Performance Test

11 COLD TEST PROCESS VENTILATION SYSTEM PERFORMANCE

The following will perform cold tests for the system performance of the Heat Exchanger HX-1361, Air Recirculation Fan FN-1361 and the heater control system, Exhaust Fan FN-1362 and heater control system, and stack monitoring system.

NOTE: Sections 11.1, 11.2, and 11.3 will be performed during Chiller Operational test (ATP HNF-1831 [W320-ATP19]). Section 11.4 can be performed independent of Chiller operation.

11.1 PREPARATION

RD 3/28/98 11.1.1 Verify applicable steps specified in Sections 7, 8, and 10 have been completed.

RD 11.1.2 Place containers under the chilled water piping system at the connection points to the Process Building and the Heat Exchanger to catch possible leaks during filling and tests.

RD 11.1.3 To fill Heat Exchanger HX-1361 piping system from the Chiller Skid with glycol solution, verify makeup storage tank TK-1361 is pressurized to approximately 30 psi (PI-1367).

RD 11.1.4 Verify PI-1368 indicates 18 ±2 psi, and HV-13627 is OPEN. If PI-1368 does not indicate pressure of 18 ± 2 psi, open valve HV-13627 + adjust PCV-1368 to 18 psig. ECN # 789

RD 3/28/98 11.1.5 On Chiller Control Panel, verify either CWP-1 or CWP-2 is RUNNING.

RD 11.1.6 Verify FIT-1364 indicates a flow in the range of 95 to 110 gpm. If not, adjust balancing valve HV-13622/HV-13624 as required.

RD 11.1.7 ~~Verify TI-13618 and TI-13619 read approximately the same.~~ See Below

RD 11.1.8 Verify/close valves HV-13636, HV-13635, and HV-136210.

RD 11.1.7 Record TI-13618 34 °F & TI-13619 40 °F. On chiller control panel, shut down chiller pumps CWP1/CWP-2. ECN # 789

5/5/98 11.1.9 Valves have been aligned as shown on Data Sheet 11.1.9.

DATA SHEET 11.1.9		
Initial/Date	Valve	Position
RO 3/28/98	HV-13644	CLOSED
RO ↓	HV-13645	CLOSED
RO ↓	HV-13646	OPEN
RO ↓	HV-13647	OPEN
RO ↓	HV-13648	OPEN
RO ↓	HV-13649	OPEN
RO ↓	HV-13654	OPEN
RO ↓	HV-13655	OPEN
RO 5/5/98 ECN # 801	HV-136117	Closed ~~OPEN~~
RO ↓ 801	HV-136118	Closed ~~OPEN~~
RO ↓ 801	HV-136121	Closed ~~OPEN~~
RO ↓ 801	HV-136134	Closed ~~OPEN~~
RO 3/28/98	HV-136150	CLOSED
RO ↓	HV-136152	CLOSED

RO 3/28/98 11.1.10 Connect temporary air inlet station with HEPA filter to the portable exhaust hookup line 8"VT-1012-M8 in accordance with Attachment B, and open valve HV-136151.

RO ↓ 11.1.11 Remove HV-136142 and connect recirculation line 8"VT-1022-M8 to HX-1361 inlet in accordance with Attachment B.

RO ↓ 11.1.12 Call Hanford weather forecaster at 373-2716 and record relative humidity and outdoor air temperature.

Relative humidity = 18 % Temperature = 56 °F

RO ↓ 11.1.~~13~~ 16 ECN # 789 Turn 3-way valve HV-136200 to normally OPEN position (align to HX-1361). ON chiller control panel, start CWP-1/CWP-2. ECN # 789

RO ↓ 11.1.14 Slowly open HV-13636 and then HV-13635.

3/28/98 11.1.15 Visually inspect and verify that the chilled water piping system at the connection points to the Heat Exchanger HX-1361 do not leak.

11.1.~~16~~ 13 ECN #789 Open valve HV-136210. Ø

11.1.17 At IE-1361, record input pressure PI-13611.

PI-13611 = 0 psi (should be 0 psi) Per telecon w/Randy Dykeman KC 7/17/98

11.1.18 At IE-1361, OPEN VALVE HV-13642 AND ECN ~~770~~, 789 record differential pressure across condenser as indicated on PDISH-13611.

PDISH-13611 = 0 psid (should be 0 psid)

11.1.19 Record inlet air temperature reading as indicated on TISH-13620.

TISH-13620 = 69 °F

11.1.20 Record outlet air temperature reading as indicated on TISH-13621.

TISH-13621 = 79 °F

11.2 HEAT EXCHANGER HX-1361/AIR RECIRCULATION FAN FN-1361 AND HEATER CONTROL SYSTEM

The following will perform cold tests of the Air Recirculation Fan FN-1361 and Heating Coil HC-1361 control system.

3/28/98 11.2.1 Close heating coil HC-1361 Disconnect DS-3 and at ER-1361, and Disconnect DISC on SR Control Panel SCP-1361.

11.2.2 Turn HS-13622 at SCP-1361 to OFF position.

11.2.3 Verify Power ON light YL-13622A on SCP-1361 is LIT.

~~11.2.4 On SCP-1361, set TIC-13622 to MANUAL mode.~~ Delete ECN #789

11.2.5 On SCP-1361, verify HTR ON light YL-13622B is NOT LIT.

11.2.~~6~~9 On SCP-1361, manually adjust TIC-13622 setpoint to ambient and record readings from TISH-13620, TISH-13621, and TIC-13622 are approximately the same.

TISH-13620: 64 °F TISH-13621: 44 °F TISH-13622: 50 °F

11.2.~~7~~8 On IE-1361 and on ANN-1362, Reset And ECN #789 verify TAH-13620, TAH-13621, and TAH-13622 are in NORMAL condition.

11.2.~~8~~6 On IE-1361, DEPRESS switch HS-13635A. Verify FAN ON light YL-13635A is LIT and ammeter IISH-13635 is registering a normal reading (approximately 11 A).

11.2.~~8~~7 On ANN-1362, Acknowledge, Reset And ECN #789 verify IAH-13635 is in NORMAL condition.

ECN #789

EXC #2	11.2.10	In the Process Building 241-C-91, at the Recirculation Fan FN-1361 discharge line (at HX-1361 inlet), and with a portable anemometer, measure and record discharge air flow: 3151 ft/min (should be 2475 ±50 ft/min).
RO 3/28/98	11.2.11	On SCP-1361, turn HS-13622 to ON position.
RO	11.2.12	Verify HTR ON light YL-13622B is LIT.
RO	11.2.13	On SCP-1361, manually adjust the setpoint to Process temperature reading as indicated on TIC-13622 and TI-13622. Gradually change the setpoint in 5 °F increments to desired value of 77 °F.
RO	11.2.14	Record readings on TI-13622 at each step from 62 °F to 77 °F. 64.5 69.7 74.4 76.1
RO	11.2.15	After the process is stabilized, ~~switch controller~~ Record Reading on TIC-13622 ~~to~~ 77.4 ~~AUTO mode~~.
RO	11.2.16	Record reading from PI-13611: 5.76 psi.
RO	11.2.17	Record reading from PDISH-13611: 7.5 psid.
RO 5/5/98	11.2.18	Record and verify that the reading on TISH-13620 81 is approximately 40 °F ~~less~~ MORE than the reading on TISH-13621 40. ECN # 801

NOTE 1: The following will verify that when the Recirculation Fan FN-1361 is shut down, the interlock (Interlock 5) will cause the heating coil HC-1361 to shut down.

WARNING: If the HC-1361 does not shut down (by observing the status of HTR ON light YL-13622) when FN-1361 is shut down, then immediately turn HTR ON/OFF switch HS-13622 to OFF and notify Test Director.

RO 3/28/98	11.2.19	On IE-1361, depress HS-13635B, verify that FAN OFF light YL-13635B is LIT and FAN ON light YL-13635A is NOT LIT.
RO	11.2.20	On SCP-1361, verify HTR ON light YL-13622B is NOT LIT.
RO	11.2.21	On IE-1361, depress HS-13635A, verify that FAN ON light YL-13635A is LIT and FAN OFF light YL-13635B is NOT LIT.
RO	11.2.22	On SCP-1361, verify HTR ON light YL-13622B is LIT.

NOTE: The Recirculation Fan FN-1361 shall be operating for the next section. If this section was completed at end of day, the Test Director may shut down Recirculation Fan FN-1361 by depressing switch HS-13635B on IE-1361. However, the Recirculation Fan FN-1361 must be restarted before proceeding to the following step.

11.3 TANK EXHAUST and HEATER CONTROL SYSTEM

The following will perform cold tests of the variable speed Exhaust Fan FN-1362, while simulating the tank pressure, and Heating Coil HC-1362 temperature control system.

RD 3/30/98 11.3.1 In CP-01, at TB-3, remove FU-4 (this disables Evacuation Horn PAL-1361C).

RD 11.3.2 At PIT-1361, on the 2-valve manifold (2VM) HV-13164, close block valve HV-136164-1A. Open the test port (TP) at valve HV-136164-1B and connect VTVS. Open valve HV-136164-1B.

RD 11.3.3 Verify that FN-1361 is operating.

RD 11.3.4 Verify final electrical equipment lineup in Step 8.4 has been completed.

RD 11.3.5 At PIT-1361, set VTVS at -10" WC and verify PIC-1361 at MO-211 indicates -10" WC.

RD 11.3.6 Verify PAH-1361A is FLASHING and audible is ON.

RD 11.3.7 Acknowledge and verify PAH-1361A is STEADY ON and audible is OFF.

RD 11.3.8 Verify on PIC-1361, the display indicates an alarming state LO PRESS, the red LED light is LIT, and audible is ON.

RD 11.3.9 On PIC-1361, depress the horn symbol membrane switch and verify the red LED light is NOT LIT, the display indicates a change to LPR and UNACKED, and audible is OFF.

RD 11.3.10 Depress the ▲ membrane switch and verify that the display indicates a change to ACKED.

RD 11.3.11 Reset and verify PAL-1361A is in NORMAL condition.

RD 11.3.12 Verify FAN OFF light YL-13640D is LIT.

RD 11.3.13 At the Exhaust Skid, close FN-1362 Exhaust Fan Disconnect Switch DS1 (ON position).

RD 11.3.14 At EES 241-C-51, on FN-1362 VSD panel face, perform the following:

RO 3/30/98 a. Depress REMOTE membrane switch HS-13639B and verify REMOTE status light YL-13639D is LIT.

RO b. Depress AUTO membrane switch HS-13639D and verify AUTO status light YL-13639E is LIT.

RO c. On the VSD Keypad, verify FAN RUN status light YL-13639A is NOT LIT.

RO d. Verify FAN RUNNING light YL-13640 is NOT LIT.

RO 11.3.15 At the Exhaust Skid, close Heating Coil HC-1362 disconnect switch (ON position).

RO 11.3.16 At Exhaust Skid, verify POWER ON light YL-13629A is LIT and the HEATER ON light YL-13629B is NOT LIT.

RO 11.3.17 At PIT-1361, increase VTVS until PIC-1361 is approximately -2.5" WC.

RO 5/5/98 a. DEPRESS HS-13640C, VERIFY FAN FN-1362 DOES NOT START. RO 5/5/98 b. ON PIC-1361 SET CONTROLLER TO AUTO MODE. ECN # 801

RO 11.3.18 At MO-211, Reset and verify PAH-1361A is in NORMAL condition.

RO 11.3.19 On PIC-1361, depress the horn symbol membrane switch and verify display indicates a change to "PIC-1361".

RO 11.3.20 At the EES, verify FAN RUNNING light YL-13640 is LIT and on the VSD Keypad the FAN RUNNING status light YL-13639A is LIT.

RO 11.3.21 At the Exhaust Skid verify Exhaust Fan FN-1362 starts.

RO 11.3.22 In MO-211, on CP-01, verify FAN ON light YL-13640C is LIT.

RO 11.3.23 At the Exhaust Fan FN-1362 discharge line, and with a portable anemometer, measure and record discharge air flow: 1150 ft/min.

RO 11.3.24 At PIT-1361, increase VTVS to 0" WC and, at the Exhaust Fan FN-1362 discharge line and with a portable anemometer, measure and record discharge air flow: 1560 ft/min (should be a greater flow rate than that recorded on previous step).

> SEE INSERT PAGE 56(1). ECN # 801

RO 11.3.25 Record TIT-13626 reading. Verify it is approximately the same as reading on TIT-13629. 58°F 60°F ECN # 801 RO 5/5/98

RO 11.3.26 Verify/Adjust TIC-13629 set point to 53 °F.

RO 11.3.27 At the Exhaust Skid, set the HEATER ON/OFF handswitch HS-13630 to ON position.

RO 11.3.28 Verify Heating Coil HC-1362 HEATER ON light YL-13629B is LIT.

RO 11.3.29 Record TIT-13629 reading: 60 °F. Verify it is the same as the process variable temperature reading displayed on TIC-13629.

INSERT per ECN # 801

1.3.24

5/5/98 a. Verify PAL-1361A is flashing and Audible is ON.

b. Acknowledge and Verify PAL-1361A is Steady ON and Audible is off.

c. Verify that PIC-1361 is Alarming and the red Led is ON.

d. Depress horn symbol membrane switch and verify Audible is off and the red LED is NOT LIT.

e. Depress Δ membrane switch and verify the display indicates a change to ACKN.

RD 3/30/98 11.3.30 Record TIT-13635 reading: 61°F.

NOTE 1: The following will verify that when the Recirculation Fan FN-1362 is shut down, the interlock (Interlock 4) will cause the heating coil HC-1362 to shut down.

WARNING: If the HC-1362 does not shut down (by observing the status of HTR ON light YL-13629B) when FN-1362 is shutdown, then immediately turn HTR ON/OFF switch HS-13629 to OFF and notify Test Director.

RD 3/30/98 11.3.31 At PIT-1361, decrease VTVS to -4" WC and verify:

RD a. Exhaust Fan FN-1362 STOPS.

RD b. Heating Coil HC-1362 HEATER ON light YL-13629B is NOT LIT.

RD 11.3.32 In the EES, on the VSD, the FAN RUNNING light YL-13640 is NOT LIT, and on the VSD Keypad the FAN RUN status light YL-13639A is NOT LIT.

RD 11.3.33 In MO-211, on CP-01, verify FAN OFF light YL-13640D is LIT.

RD 11.3.34 Verify PAH-1361A is FLASHING and audible is ON.

RD 11.3.35 Acknowledge and verify PAH-1361A is STEADY ON and audible is OFF.

RD 11.3.36 Verify on PIC-1361, the display indicates an alarming state LO PRESS, the red LED light is LIT, and audible is ON.

RD 11.3.37 On PIC-1361, depress the horn symbol membrane switch and verify the red LED light is NOT LIT, the display indicates a change to LPR and UNACKED, and audible is OFF.

RD 11.3.38 Depress the ▲ membrane switch and verify that the display indicates a change to ACKED.

RD 11.3.39 At PIT-1361, increase VTVS to approximately -2.5" WC, ~~verify:~~ DEPRESS HS-1364C, then VERIFY. ECN# 801 RD 5/5/98

RD a. Exhaust Fan FN-1362 is RUNNING.

RD b. Heating Coil HC-1362 HEATER ON light YL-13629B is LIT.

RD 11.3.40 At MO-211, Reset and verify PAH-1361A is in NORMAL condition.

RD 11.3.41 On PIC-1361, depress the horn symbol membrane switch and verify display indicates a change to "PIC-1361".

TD 3/30/98 11.3.42 In the EES, on the VSD, the FAN RUNNING light YL-13640 is LIT and the VSD Keypad FAN RUN status light YL-13639A is LIT.

TD 11.3.43 In MO-211, on CP-01, verify FAN ON light YL-13640C is LIT, then depress STOP pushbutton HS-13640D and verify FAN OFF light YL-13640D is LIT.

TD 11.3.44 Verify PAH-1361A and PAL-1361A are in NORMAL condition.

TD 11.3.45 Verify Exhaust Fan FN-1362 STOPS.

TD 11.3.46 Verify Heating Coil HC-1362 HEATER ON light YL-13629B is NOT LIT.

TD 11.3.47 In MO-211, on CP-01, depress START pushbutton HS-13640C and verify FAN ON light YL-13640C is LIT.

TD 11.3.48 Verify PAH-1361A and PAL-1361A are in NORMAL condition.

TD 11.3.49 Verify Exhaust Fan FN-1362 is RUNNING.

TD 11.3.50 Verify Heating Coil HC-1362 HEATER ON light YL-13629B is LIT.

TD 11.3.51 Set Heating Coil HC-1362 HEATER handswitch HS-13630 to OFF position.

TD 11.3.52 Open Heating Coil HC-1362 disconnect switch (OFF position).

TD 11.3.53 In MO-211, on CP-01, depress STOP pushbutton HS-13640D and verify FAN OFF light YL-13640D is LIT.

TD 11.3.54 Verify Exhaust Fan FN-1362 STOPS.

TD 11.3.55 At PIT-1361, on the 2-valve manifold (2VM) HV-13164, close valve HV-136164-1B. Disconnect VTVS and close the test port (TP) at valve HV-136164-1B. Open block valve HV-136164-1A.

TD 3/31/98 11.3.56 Turn 3-way valve HV-136200 to normally CLOSED position (align to CC-1361).

TD 11.3.57 Close valves HV-136210, HV-13636, and HV-13635.

TD 11.3.58 In CP-01, at TB-3, install FU-4 removed on step 11.3.1.

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