NOV 06 1997 Sta. 37 (20)

ENGINEERING DATA TRANSMITTAL

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5. Proj./Prog./Dept./Div.: B&W Hanford Company	6. Design Authority/ Design Agent/Cog. Engr.: M. B. Enghusen	7. Purchase Order No.: NA
8. Originator Remarks: This document was prepared to close the Unreviewed Safety Question for the 324 Facility related to HEPA Filter Failure.		9. Equip./Component No.: NA 10. System/Bldg./Facility: 324 Facility
11. Receiver Remarks: 11A. Design Baseline Document? [] Yes [X] No None		12. Major Assm. Dwg. No.: NA 13. Permit/Permit Application No.: NA 14. Required Response Date: NA

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 Desig-nator	(G) Reason for Trans-mittal	(H) Origi-nator Dispo-sition	(I) Receiv-er Dispo-sition
1	HNF-1774	-	0	Closure Of 324 Facility Potential HEPA Filter Failure Unreviewed Safety Question	N/A	2	1	1

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
		Design Authority N/A			
		Design Agent N/A			
1	1	Cog.Eng. M. B. Enghusen 11/6/97 L1-02			
1	1	Cog. Mgr. M. S. Wright 11/6/97 L1-02			
		QA N/A			
1	1	Safety N/A 11/6/97 L6-57			
		Env. N/A			

18.	19.	20.	21. DOE APPROVAL (if required)
11-6-97 Signature of EDT Originator Date	11/6/97 Authorized Representative for Receiving Organization Date	11/6/97 Design Authority/ Cognizant Manager Date	Ctrl. No. [] Approved [] Approved w/comments [] Disapproved w/comments

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

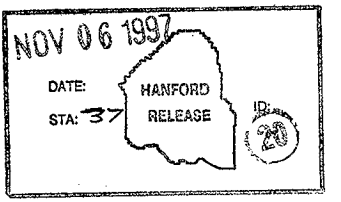
Closure of 324 Facility Potential HEPA Filter Failure Unreviewed Safety Questions

M. B. Enghusen
B&W Hanford Company, Richland, WA 99352
U.S. Department of Energy Contract DE-AC06-96RL13200

EDT/ECN: 611750 UC: 610
Org Code: 19200 Charge Code: K4M11
B&R Code: EW 3130020 Total Pages: ~~27~~ 28

Key Words: HEPA, USQ, High Efficiency Particulate Air, Filter, 324 Building, 324 Facility

Abstract: This document summarizes the activities which occurred to resolve an Unreviewed Safety Question (USQ) for the 324 Facility involving Potential HEPA Filer Breach. The facility ventilation system had the capacity to fail the HEPA filters during accident conditions which would totally plug the filters. The ventilation system fans were modified which lowered fan operating parameters and prevented HEPA filter failures which might occur during accident conditions.



Release Approval — Date — Release Stamp

Approved for Public Release

Closure Of 324 Facility Potential HEPA Filter Failure Unreviewed Safety Question

Prepared By: M. B. Enghusen
B&W Hanford Company

November 6, 1997

Table Of Contents

List Of Appendices

1.0 Summary

The purpose of this report is to demonstrate that the modifications to the 324 Facility Zone I exhaust ventilation system placed the facility within the assumptions of the 324 Building Safety Analysis Report (SAR), PNL-SAR-324, and that a Discovery Unreviewed Safety Question (USQ) for "324 Facility Potential HEPA Filter Breach" has been resolved.

During the preparation of the 324 Facility Fire Hazard Analysis a fire accident scenario was presented in which a small fire would start in the hot cells which would plug the High Efficiency Particulate Air filters. The filters would fail and contaminated material would be released to the environment. This accident scenario did not match the accident scenarios presented in the 324 Building Safety Analysis Report. The Zone I exhaust system was reviewed by the cognizant plant forces which showed that in 1969 the 324 building hot cell Zone I exhaust system was modified by installing new charcoal filters downstream of the HEPA filters and increasing the size of the exhaust fans. The charcoal filters were installed to remove radioactive gasses and new fans were installed to overcome the charcoal filter air flow resistance. The new exhaust fans were larger and provided higher static pressure and flow capacity. The increased static pressure provided by the fans during no flow conditions was sufficient to fail the Zone I High Efficiency Particulate Air (HEPA) filters if they were to plug during the fire scenarios presented in the draft FHA and the 324 Building SAR.

The failure of the HEPA filters during a remote fire in the hot cells was not analyzed in the 324 Building SAR. The Plant Review Committee (PRC) reviewed the fan modifications and determined that a Discovery condition existed. The facility was placed in a safe condition and the Unreviewed Safety Question Evaluation (USQE) was completed and reviewed by the PRC which indicated a USQ existed. The USQE was transmitted to DOE which then declared the USQ.

In order to recover from the USQ, the fans were modified in September to reduce the capacity of the fans while maintaining sufficient flow to provide contamination control. The changes to the fans reduced the maximum possible static pressure which ensured the HEPA filters would not fail when plugged with particulates. The fan modifications returned the facility to the conditions presented in the 324 Building SAR and the USQ has been resolved.

2.0 Background

In August, 1997, a draft 324 Facility Fire Safety Analysis (FHA) document (HNF-SD-HT-FHA-002, "324 Facility Fire Hazard Analysis") was issued for review by the facility representatives. The draft FHA presented a new accident scenario in which a small localized fire in the hot cells causes an oil filled window to fail. The fire releases the window oil which adds fuel to the fire. The smoke and particulates from the postulated fire contains a sufficient quantity of particulates to plug the High Efficiency Particulate Air (HEPA) filters in the hot cell Zone I exhaust system. The fans would continue to run providing sufficient differential pressure across the plugged HEPA filters to fail the filters. The hot cells would then have an open channel for dispersion of contamination from the process cells to the environment via the main stack.

A review of the Zone I exhaust system was conducted to evaluate this new fire scenario. The review of the Zone I exhaust system showed that in 1969 charcoal filters were installed downstream of the final HEPA filters. The Zone I exhaust fans were replaced at the same time to overcome the additional pressure drop provided by the charcoal filters. According to the installation drawings the new fans were designed to provide a static pressure of 15 inches water gauge (drawing H-3-28596, Revision 1, "HVAC Adsorption System Plan and Details"). This potential static pressure was validated using available vendor information typical of the installed fans. The HEPA filters installed in Zone I exhaust system are nuclear grade and purchased per specifications QPL-51068-7 compliant with MIL-F-068 Section 3.4.4 "Resistance To Pressure". The filters are normally operated up to a maximum of 5 inches water gauge at which time they are replaced. The HEPA filters are capable of handling a maximum of 10 ± 0.2 inches of water gauge differential pressure for one hour. The failure of the plugged HEPA filters during accident conditions was therefore considered credible .

3.0 Unusual Occurrence And Discovery USQ Determination

The 324 Building Safety Analysis Report (SAR), PNL-SAR-324, analyzes two accident scenarios involving hot cell fires. In section 6.3.1 "Hot Cell Fires" a fire in the hot cells is assumed to produce sufficient smoke to plug the exhaust HEPA filters. The smoke generated by the fire would then migrate into the areas around the hot cells and be routed through the Zone II exhaust system. The HEPA filters in the Zone II exhaust system would prevent the release of material to the environment. The probability of a fire resulting from this scenario is considered high, anticipated, however the consequences are low due to filtered release of material. In section 6.3.2 "Major Fire" a large fire is initiated in Zone II building areas located outside the hot cells. The fire is large enough to cause a hot cell window to fail and the fire to spread into the hot cells. The filters then plug and possibly breach which results in release of unfiltered contamination to the environment. For this accident scenario both the filtered and unfiltered releases from the Zone II exhaust system were analyzed. The probability of a fire resulting from this scenario is considered highly unlikely with a high consequence from the unfiltered release of material to the environment.

The modifications to the Zone I exhaust fans provided the potential for a plugged filter failure which is not analyzed by section 6.3.1 "Hot Cell Fire" accident in the 324 Building SAR. A Plant Review Committee meeting was held August 22, 1997, which concluded that this represented a Discovery condition. The 324 Facility was placed in a safe condition in which all work in hot cells which could initiate a fire was suspended and an Unusual Occurrence report was issued (UO number RL-PHMC-324FAC-1997-0010 and Management Directive 324-MD-001 "Control of Hot Work in 324 Facility Stabilization Project"). An Unreviewed Safety Question Evaluation (USQE), number 324-BWHC-97-002, was completed September 1, 1997, to determine if the fan modifications represented conditions which were not analyzed in the current 324 Building SAR. The USQE was reviewed by the Plant Review Committee on September 4, 1997, and the Discovery USQ was identified. Minor comments were also made on the USQE and a the USQE was revised September 4, 1997. The USQE was submitted to DOE (BWHC-9758040, G. O. Hayner to L. J. Olguin, "Unreviewed Safety Question Evaluation For 324 Facility", September 5, 1997 and FDH-9758040 R1, L. J. Olguin to J. E. Mecca, "Unreviewed Safety Question Evaluation For 324 Facility", September 8, 1997). The DOE declared the USQ on September 16, 1997 (97-TPD-177, J. D. Wagner to H. J. Hatch "Contract No. DE-AC06-96RL13200 - Unreviewed Safety Question Evaluation For The 324 Facility").

4.0 Recovery Actions

The hot cell Zone I exhaust system operating parameters were reviewed by management and the cognizant engineer which identified three possible recovery actions:

1. An interlock system could be installed which would monitor the filter differential pressure and shut off the exhaust fans if the filters differential pressure reaches the operating limits.

2. A vacuum breaker damper could be installed which would open when the differential pressure applied to the HEPA filters exceed operating limits thereby protecting the filters from failing.

3. The fans could be reduced in speed which would reduce the maximum differential pressure across the HEPA filters below 10 in. WG. while maintaining the current design conditions through the building and maintaining contamination control.

The fan modifications alternative was selected due to simplicity of the change and ability to meet the requirements presented in the 324 building SAR without additional OSR equipment, controls and testing.

The specific performance characteristics of the fans installed at 324 were not available from the vendor information. A typical performance curve for similar type fan operated at a specific fan revolutions per minute (RPM) is shown in Appendix A. If the fan speed is reduced, the performance curve will be lowered and the static pressure provided by the fan at the same flow rates will be reduced. This allows reduction in static pressure provided by the fan while still providing sufficient air flow capacity (at a reduced static pressure) for building contamination control. It needs to be noted that the static pressure at very low or no flow is the main concern of the USQ. This is the condition which represents the plugged filter upstream of the fans. The static pressure provided by the fans at this point is equal to the differential pressure across the HEPA filters. If the static pressure at this very low or no flow condition is greater that the capability of the HEPA filters, the filters will fail. At higher flow rates, the filters are not plugged and the static pressure provided by the fans is distributed across the entire ventilation system. Higher static pressures at the higher flow rates will therefore not cause a filter failure.

The Zone I fan modifications involved the identification of new sheaves and belts which would reduce the fan speed and corresponding performance curve. The motors used on the fans are constant speed and were not modified or changed. The existing fan speed was measured at 990 revolutions per minute (rpm). The cognizant engineer used vendor supplied tables for performance information to identify a new fan target speed of 740 rpm.

New sheaves were ordered and the fans were modified at the end of September, 1997 (work package 3I-97-00823). The operating characteristics of the new fans were tested by closing the blocking damper and measuring the static pressure and flow rates (work package 3I-97-00849, Appendix B) for the first modified fan. All the Zone I fans are identical in construction and performance and the first fan was tested to ensure that the modifications provided the required static pressures and flow rates. The static pressures and flow rates at the different damper positions was taken and recorded in the data sheets provided in Appendix C and recorded in the work package, Appendix B. The static pressure provided by the fan with the blocking damper closed was 6.67 inches water gauge (WG) at leakage rate of 1449 cubic feet per minute (CFM). As the blocking damper was opened and the flow rate through the fan increased the static pressure increased as expected by the fan operating curves. The static pressure increased from the 6.67 inches WG at 1449 CFM to 9.6 inches WG at 5, 416 CFM. This represents significant flow through the ventilation system and the static pressure is still below the HEPA filter capacity. Additional data was taken up to 10,309 CFM. about ½ fan capacity, which provided a static pressure of 10.50 inches WG. The data taken at the higher flow rates was considered conservatively high due to interferences from the operating non-modified fans on the modified fan via common inlet and outlet ductwork.

The performance data discussed above provided the information which demonstrated that the HEPA filters would not be subjected with sufficient DP to fail (i.e. static pressure at no or very low flow rates) if they were to plug. The data also showed that the fans had flow capacity, CFM, to support the building operation. The remainder of the fans were modified and the RPM of the fans were checked to ensure that all three Zone I fans were operating at the same speed.

Following all three fan modifications, the flow and differential pressure in the Zone I system was more easily controlled by the dampers. Prior to the modifications, the dampers operated in a mostly closed position and small changes in damper control made large changes in both flow and differential pressure readings in the ductwork. After the fans were modified, the control dampers operated in an open position which provided better flow and differential pressure control. The fan operation also had noticeably lower vibration resulting from both the lower fan speed and reduction in the ductwork turbulence by operating the dampers in a more open position.

5.0 Conclusions

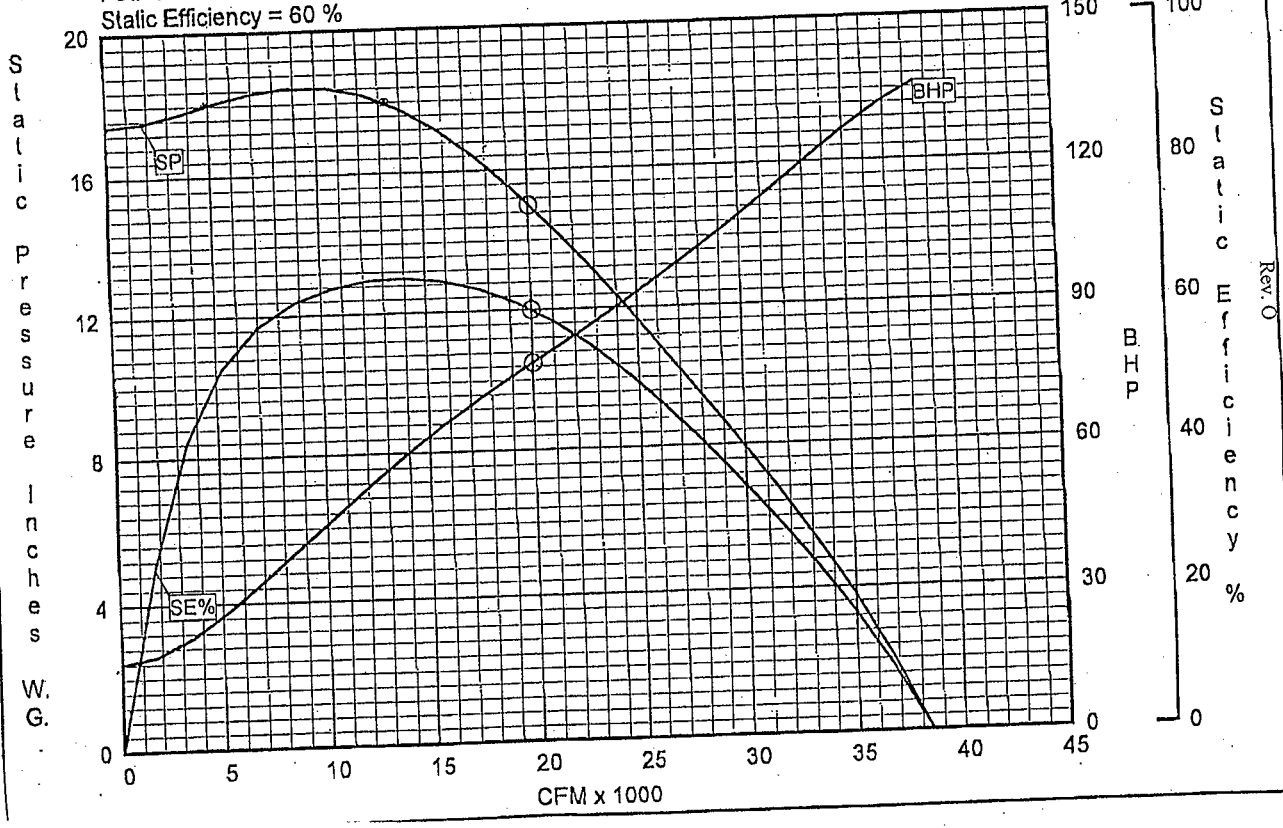
The maximum static pressure which can be provided by the Zone I exhaust fans is well below the limits for the HEPA filter operation. The Zone I HEPA filters will not fail due to particulate loading and the Zone I exhaust system is operating per the conditions presented in the 324 Building SAR. The Discovery USQ has been resolved. An Administrative change to the 324 Building SAR will be prepared which will enhance the Zone I and Zone II exhaust systems description sufficient to prevent similar changes in ventilation design.

Appendix A Typical Fan Performance Curve

Model M-33 I.E.
Impeller Diameter = 57.5 Inches
RPM = 985 Capacity = 0.59
Inlet Density = 0.075 lb./cu. ft.
Volume = 20000 Cu Ft / Min
Static Pressure = 15 In. W.G.
Power = 78.7 BHP
Static Efficiency = 60 %

Example Curve

Fan Equipment Co.,



HNF-1774
Rev. O

Appendix B Work Package For 324 Building Zone I Fan Modifications

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WORK DOCUMENT (W110)

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Page: 1

1. Document Number 3I-97-00849/W *GENERIC WORK ITEM*
2. Work Item Title ZONE I EXH.FAN PERFORMANCE VERIFICATION

3. Components
   Component Number: 3I-041060 — Name: 324 * EXHAUST FAN # 973
   Temporary Number — Name

4. System FAN *SUPPLY/EXHAUST FANS*

5. Location
   Facility 3I *324 BUILDING*
   Bldg/Rm 324 — Other EAST SIDE — Other

6. Symptom, Problem, or Condition
   NEED PERFORMANCE DATA TO VERIFY THAT EXHAUST FAN #973 AS REQUIRED AND MAINTAIN A STATIC SHUT OFF HEAD OF LESS THAT 10 IN.WG.

   WORK WITH JCS PKG. 3I-97-00823.

7. Originator Name GREGONIS,RA — Date 09/11/97
   Telephone No. 373-3851 MSIN L1-05

8. Charge Code K4A11

9. Priority 2
10. Phase Designator N/A

11. Cognizant Engineer GREGONIS,RA — Phone 373-3851

12. Planning Required Y

13. Screener/Ops Review — Signature: R. Gregonis — Date 9-25-97

14. Resolution By — Signature: R. Gregonis — Date 9-25-97

15. Approvals

Code	Description	Signature	Date
OP	OPERATIONS	B Foyman	9/25/97
CE	COGNIZANT ENGINEER	R.A. Gregonis	9/24/97
HP	HEALTH PHYSICS	W.T. Miller	9/25/97

16. Resources Required

Res Code	Description	No.	Act Hrs
V&B	VENT AND BALANCE	2	20
HCT	HOT CELL TECHNICIAN	1	0

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Page: 2

1. Document Number 3I-97-00849/W *GENERIC WORK ITEM*
2. Work Item Title ZONE I EXH.FAN PERFORMANCE VERIFICATION

54	Radiation Protection Technicia	1	_____

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==========WORK DOCUMENT (W110)==========

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1. Document Number 3I-97-00849/W *GENERIC WORK ITEM*
2. Work Item Title ZONE I EXH.FAN PERFORMANCE VERIFICATION

==========

17. Pre-Work Review — Signature B Forman — Date 9/27/97
18. Tagout Number ~~324-97~~ N/A mm 9/25/97
19. Work Release — Type F — Signature B Forman — Date 9/27/97
20. Work Suspension (See Work Suspension Sheet)
PIC _____ _____
21. PIC PIC Org.

Resolution/Retest
NOTE

THIS WORK WILL VERIFY THE PERFORMANCE OF THE MODIFIED ZONE I EXHAUST FANS. JCS PACKAGE 3I-97-823 INSTALLED NEW BELTS AND SHEAVES TO REDUCE THE SPEED OF THE FANS IN ORDER TO DROP THE MAXIMUM SHUT OFF HEAD TO LESS THAN 10 IN.WG. THE DAMPER LINKAGE ON THE DOWNSTREAM BLOCKING DAMPER WILL BE DISCONNECTED AND A VICE GRIP WILL BE INSTALLED TO ALLOW THE MANUAL OPERATION OF THE DAMPER DURING THE TEST. EXHAUST FAN #973 WILL BE TESTED AT SEVERAL AIR FLOW RATES AND FAN STATIC PRESSURES WILL BE MEASURED. THE RESULTS OF THIS WORK PKG. WILL VERIFY WHETHER OR NOT THE FAN SHUT OFF HEAD HAS BEEN REDUCED BELOW THE MAXIMUM ALLOWABLE STATIC OF 10 IN.WG.

1] PRE-JOB SAFETY MEETING.

INITIAL/DATE RHH 9/27/97

***NOTE: PERFORM WORK PER HVAC COG. ENGR. DIRECTION. USE PROCEDURE 7-GN-056 AS REFERENCE. RECORD MEASUREMENTS ON DATA SHEETS PROVIDED. TESTING MAY BE TERMINATED AND THE SYSTEM RETURNED TO STABLE NORMAL CONFIGURATION AT ANYTIME AT THE DISCRETION OF THE COG. ENGINEER.

***NOTE: FAN OPERATIONAL STATUS SHALL BE REDUCED VENTILATION PER PROCEDURE 324-PWR-001 WITH EXHAUST FANS 974 AND 975 OPERATING AND 973 ON STANDBY.

2] INSTALL VICE GRIP PLIARS ON DAMPER SHAFT OF THE BLOCKING DAMPER DOWN STREAM OF THE FAN AND WHILE MAINTAINING THE DAMPER IN A CLOSED POSITION DISCONNECT THE DAMPER LINKAGE FROM THE DAMPER MOTOR ON EXHAUST FAN #973. WITH ANOTHER PAIR OF VICE GRIP PLIARS LOCK THE DAMPER IN THE CLOSED POSITION.

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1. Document Number 3I-97-00849/W *GENERIC WORK ITEM*
2. Work Item Title ZONE I EXH.FAN PERFORMANCE VERIFICATION

INITIAL/DATE KAM 9/27/97

3] START EXHAUST FAN #973. MANUAL OVERRIDE MAYBE REQUIRED TO KEEP ALL THREE ZONE I EXHAUST FANS RUNNING AT THE SAME TIME.

INITIAL/DATE KAM 9/27/97

***NOTE: USING BOTH PAIRS OF VICE GRIP FLIARS, ONE AS A MANUAL DAMPER CONTROL HANDLE AND THE OTHER AS A LOCKING DEVICE ADJUST DAMPER TO VARIOUS OPEN POSITIONS AS REQUIRED BELOW. MEASURE AND RECORD DATA ON DATA SHEETS PROVIDED AND IN SPACES PROVIDED BELOW. ADDITIONAL TESTING MY BE REQUIRED AT THE DISCRETION OF THE HVAC COG. ENGINEER.

4] TESTING

***NOTE: ALLOW THE HVAC SYSTEM TO COME TO EQUILIBRIUM AFTER DAMPER HAS BEEN MOVED AND VERIFICATION FROM POWER OPERATOR THAT THE HVAC SYSTEM IS OPERATING IN A NORMAL STABLE MODE.

	DAMPER POSITION	FAN STATIC PRESSURE	EXHAUST AIR FLOW RATE
TEST 1	CLOSED	6.705 IN.WG.	4449 CFM
TEST 2	1/8 OPEN	7.047 IN.WG.	4778 CFM
TEST 3	1/4 OPEN	7.481 IN.WG.	3,8440 CFM
TEST 4	3/8 OPEN	8.158 IN.WG.	4,460 CFM
TEST 5	1/2 OPEN	8.826 IN.WG.	5,281 CFM

***NOTE: HVAC COG. ENGINEER TO VERIFY SUFFICIENT DATA HAS BEEN TAKEN BEFORE PROCEEDING TO THE NEXT STEP.

5] RETURN EF-973 TO OPERATIONAL STATUS PRIOR TO TEST.

INITIAL/DATE KAM 9/27/97

6] RECONNECT DAMPER LINKAGE TO DAMPER OPERATOR AND REMOVE VICE GRIP PLIARS.

INITIAL/DATE KAM 9/27/97

14] HOUSEKEEP WORK AREA AND DISPOSE OF ALL WASTE IN PROPER

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Page: 5

1. Document Number 3I-97-00849/W *GENERIC WORK ITEM*
2. Work Item Title ZONE I EXH.FAN PERFORMANCE VERIFICATION

RECEPTACLES.

INITIAL/DATE PGH 9/27/97

22. Reference Documents	Type
CRAFT LOG	OTHR
PRE-JOB SAFETY	OTHR
HJHA	OTHR
1-GN-56	OTHR
324-PWR-001	OTHR
324-97-007, REV. 2	RWP

	Signature	Date
23. Field Work Complete	K G Gregoire	10/15/97
24. Ops_Acceptance	[illegible]	11-5-97
25. Post Review	K G Gregoire	10/15/97

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Appendix C Fan Performance Data Sheets

DATA SHEET

JCS 3I-324-849 ATACHMENT

TEST NO. I ZONE I EXHAUST FAN #973/BUILDING 324 DATE 9-27-97

AIR FLOW INSTURMENT USED MICRO WHSL CODE # 702-28-09-019

LAST WHSL CALIBRATION DATE 8-19-97

DUCT SIZE 37 IN. DIA. DUCT AREA 7.47 FT^2

DATA POINT NO.	PITOT TRAVERSE POINTS	VELOCITY PRESSURE IN. WG.	VELOCITY FPM
1	1"	0	0
2	3"	0	0
3	5 7/16"	.012	439
4	8 3/8"	.020	566
5	12 5/8"	.026	645
6	24 3/8"	.004	253
7	28 5/8"	0	0
8	31 9/16"	0	0
9	34"	0	0
10	36"	.014	474

FAN STATIC PRESSURE

FAN INLET SP -6.67 IN. WG.

FAN OUTLET SP +.037 IN. WG.

FAN INLET VP .002 IN. WG.

FAN SP 6.705 IN. WG.

NOTE:

*FAN SP = SP_{OUTLET} - SP_{INLET} - VP_{INLET}

SP (static pressure)

VP (velocity pressure)

*Industrial Ventilation Handbook 18th Edition

AVERAGE VELOCITY 194 FPM

TOTAL AIR FLOW RATE 1449 CFM

COMMENTS:

AIR BALANCE TECH. [signature] 9-27-97
INITIAL/DATE

DATA SHEET

JCS 3I-324-849 ATACHMENT

TEST NO. II ZONE I EXHAUST FAN #973/BUILDING 324 DATE 9-27-97

AIR FLOW INSTURMENT USED MICRO WHSL CODE # 702-28-09-019

LAST WHSL CALIBRATION DATE 8-19-97

DUCT SIZE 37 IN. DIA. DUCT AREA 7.47 FT²

DATA POINT NO.	PITOT TRAVERSE POINTS	VELOCITY PRESSURE IN. WG.	VELOCITY FPM
1	1"	0	0
2	3"	.002	179
3	5 7/16"	.005	283
4	8 3/8"	.006	310
5	12 5/8"	.005	283
6	24 3/8"	.013	457
7	28 5/8"	.003	219
8	31 9/16"	.017	522
9	34"	.001	127
10	36"	0	0

FAN STATIC PRESSURE

FAN INLET SP − 7.05 IN. WG.

FAN OUTLET SP +.001 IN. WG.

FAN INLET VP .004 IN. WG.

FAN SP 7.047 IN. WG.

NOTE:

*FAN SP = SP_{OUTLET} - SP_{INLET} - VP_{INLET}

SP (static pressure)

VP (velocity pressure)

*Industrial Ventilation Handbook 18th Edition

AVERAGE VELOCITY 238 FPM

TOTAL AIR FLOW RATE 1778 CFM

COMMENTS: _____

AIR BALANCE TECH. [signature] 9-27-97
INITIAL/DATE

3I- 97-00849

DATA SHEET

JCS 3I-324-849 ATACHMENT

TEST NO. 111 ZONE I EXHAUST FAN #973/BUILDING 324 DATE 9-27-97

AIR FLOW INSTURMENT USED Micro WHSL CODE # 702-28-09-019

LAST WHSL CALIBRATION DATE 8-19-97

DUCT SIZE 37 IN. DIA. DUCT AREA 7.47 FT²

DATA POINT NO.	PITOT TRAVERSE POINTS	VELOCITY PRESSURE IN. WG.	VELOCITY FPM
1	1"	.015	491
2	3"	.018	537
3	5 7/16"	.016	507
4	8 3/8"	.017	522
5	12 5/8"	.016	507
6	24 3/8"	.018	537
7	28 5/8"	.015	491
8	31 9/16"	.007	335
9	34"	.020	566
10	36"	.026	645

FAN STATIC PRESSURE

FAN INLET SP — 7.44 IN. WG.

FAN OUTLET SP — .057 IN. WG.

FAN INLET VP .016 IN. WG.

FAN SP 7.481 IN. WG.

NOTE:

*FAN SP = SP_{OUTLET} - SP_{INLET} - VP_{INLET}

SP (static pressure)

VP (velocity pressure)

*Industrial Ventilation Handbook 18th Edition

AVERAGE VELOCITY 514 FPM

TOTAL AIR FLOW RATE 3,840 CFM

COMMENTS:

AIR BALANCE TECH [signature] 9-27-97
INITIAL/DATE

DATA SHEET

JCS 3I-324-849 ATACHMENT

TEST NO. 10 ZONE I EXHAUST FAN #973/BUILDING 324 DATE 9-27-97

AIR FLOW INSTURMENT USED MICRO WHSL CODE # 702-28-09-019

LAST WHSL CALIBRATION DATE 8-19-97

DUCT SIZE 37 IN. DIA. DUCT AREA 7.47 FT²

DATA POINT NO.	PITOT TRAVERSE POINTS	VELOCITY PRESSURE IN. WG.	VELOCITY FPM
1	1"	.020	566
2	3"	.026	645
3	5 7/16"	.027	658
4	8 3/8"	.030	694
5	12 5/8"	.022	594
6	24 3/8"	.024	620
7	28 5/8"	.027	658
8	31 9/16"	.026	645
9	34"	.016	507
10	36"	.009	380

FAN STATIC PRESSURE

FAN INLET SP — 8.12 IN. WG.

FAN OUTLET SP — .060 IN. WG.

FAN INLET VP .022 IN. WG.

FAN SP 8.158 IN. WG.

NOTE:

*FAN SP = SP_{OUTLET} - SP_{INLET} - VP_{INLET}

SP (static pressure)

VP (velocity pressure)

*Industrial Ventilation Handbook 18th Edition

AVERAGE VELOCITY 597 FPM

TOTAL AIR FLOW RATE 4,460 CFM

COMMENTS:

AIR BALANCE TECH. [signature] 9-27-97
INITIAL/DATE

DATA SHEET

JCS 31-324-849 ATACHMENT

TEST NO. 1 ZONE I EXHAUST FAN #973/BUILDING 324 DATE 9-27-97

AIR FLOW INSTURMENT USED MICRO WHSL CODE # 702-28-09-019

LAST WHSL CALIBRATION DATE 8-19-97

DUCT SIZE 37 IN. DIA. DUCT AREA 7.47 FT^2

DATA POINT NO.	PITOT TRAVERSE POINTS	VELOCITY PRESSURE IN. WG.	VELOCITY FPM
1	1"	.024	620
2	3"	.033	728
3	5 7/16"	.034	738
4	8 3/8"	.035	749
5	12 5/8"	.030	694
6	24 3/8"	.030	694
7	28 5/8"	.035	749
8	31 9/16"	.034	738
9	34"	.020	566
10	36"	.039	791

FAN STATIC PRESSURE

FAN INLET SP −8.78 IN. WG.

FAN OUTLET SP −.077 IN. WG.

FAN INLET VP .031 IN. WG.

FAN SP 8.826 IN. WG.

NOTE:

*FAN SP = SP_{OUTLET} - SP_{INLET} - VP_{INLET}

SP (static pressure)

VP (velocity pressure)

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AVERAGE VELOCITY 707 FPM

TOTAL AIR FLOW RATE 5,281 CFM

COMMENTS:

AIR BALANCE TECH [signature] 9-27-97
INITIAL/DATE

DATA SHEET

JCS 3I-324-849 ATACHMENT

TEST NO. VII ZONE I EXHAUST FAN #973/BUILDING 324 DATE 9-27-97

AIR FLOW INSTURMENT USED MICRO WHSL CODE # 702-28-09-019

LAST WHSL CALIBRATION DATE 8-19-97

DUCT SIZE 37 IN. DIA. DUCT AREA 7.47 FT^2

DATA POINT NO.	PITOT TRAVERSE POINTS	VELOCITY PRESSURE IN. WG.	VELOCITY FPM
1	1"	.032	716
2	3"	.037	770
3	5 7/16"	.044	840
4	8 3/8"	.044	840
5	12 5/8"	.040	801
6	24 3/8"	.048	877
7	28 5/8"	.030	694
8	31 9/16"	.035	749
9	34"	.020	566
10	36"	.010	401

FAN STATIC PRESSURE

FAN INLET SP -9.60 IN. WG.

FAN OUTLET SP -.009 IN. WG.

FAN INLET VP .032 IN. WG.

FAN SP 9.577 IN. WG.

NOTE:

*FAN SP = SP_{OUTLET} - SP_{INLET} - VP_{INLET}

SP (static pressure)

VP (velocity pressure)

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AVERAGE VELOCITY 725 FPM

TOTAL AIR FLOW RATE 5,416 CFM

COMMENTS: _____

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JCS 3I-324-849 ATACHMENT

TEST NO. VII - 3/4 % ZONE I EXHAUST FAN #973/BUILDING 324 DATE 9-27-97

AIR FLOW INSTURMENT USED MICRO

WHSL CODE # 702-28-09-019

LAST WHSL CALIBRATION DATE 8-19-97

DUCT SIZE 37 IN. DIA.

DUCT AREA 7.47 FT²

DATA POINT NO.	PITOT TRAVERSE POINTS	VELOCITY PRESSURE IN. WG.	VELOCITY FPM
1	1"	.035	749
2	3"	.041	811
3	5 7/16"	.044	840
4	8 3/8"	.049	887
5	12 5/8"	.044	840
6	24 3/8"	.044	840
7	28 5/8"	.052	913
8	31 9/16"	.043	830
9	34"	.020	566
10	36"	.059	973

FAN STATIC PRESSURE

FAN INLET SP -10.07 IN. WG.

FAN OUTLET SP +.045 IN. WG.

FAN INLET VP .042 IN. WG.

FAN SP 10.073 IN. WG.

NOTE:

*FAN SP = SP_{OUTLET} - SP_{INLET} - VP_{INLET}

SP (static pressure)

VP (velocity pressure)

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AVERAGE VELOCITY 825 FPM

TOTAL AIR FLOW RATE 6,163 CFM

COMMENTS:

AIR BALANCE TECH. 9-27-97
INITIAL/DATE

3I-97-00849

DATA SHEET

JCS 3I-324-849 ATACHMENT

TEST NO. VIII 7/8 ZONE I EXHAUST FAN #973/BUILDING 324 DATE 9-27-97

AIR FLOW INSTURMENT USED micro WHSL CODE # 702-28-09-019

LAST WHSL CALIBRATION DATE 8-19-97

DUCT SIZE 37 IN. DIA. DUCT AREA 7.47 FT²

DATA POINT NO.	PITOT TRAVERSE POINTS	VELOCITY PRESSURE IN. WG.	VELOCITY FPM
1	1"	.022	594
2	3"	.044	840
3	5 7/16"	.047	868
4	8 3/8"	.050	896
5	12 5/8"	.048	877
6	24 3/8"	.043	830
7	28 5/8"	.050	896
8	31 9/16"	.044	840
9	34"	.030	694
10	36"	.002	179

FAN STATIC PRESSURE

FAN INLET SP −10.02 IN. WG.

FAN OUTLET SP +.070 IN. WG.

FAN INLET VP .035 IN. WG.

FAN SP 10.055 IN. WG.

NOTE:

*FAN SP = SP_{OUTLET} - SP_{INLET} - VP_{INLET}

SP (static pressure)

VP (velocity pressure)

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AVERAGE VELOCITY 751 FPM

TOTAL AIR FLOW RATE 5,610 CFM

COMMENTS: _____

AIR BALANCE TECH. [signature] 9-27-97
INITIAL/DATE

DATA SHEET

JCS 3I-324-849 ATACHMENT

TEST NO. IX 1009, ZONE I EXHAUST FAN #973/BUILDING 324 DATE 9-27-97

AIR FLOW INSTURMENT USED Micro

WHSL CODE # 702-28-09-019

LAST WHSL CALIBRATION DATE 8-19-97

DUCT SIZE 37 IN. DIA.

DUCT AREA 7.47 FT^2

DATA POINT NO.	PITOT TRAVERSE POINTS	VELOCITY PRESSURE IN. WG.	VELOCITY FPM
1	1"	.080	1133
2	3"	.087	1181
3	5 7/16"	.092	1215
4	8 3/8"	.099	1260
5	12 5/8"	.090	1202
6	24 3/8"	.090	1202
7	28 5/8"	.096	1241
8	31 9/16"	.092	1215
9	34"	.069	1052
10	36"	.053	922

FAN STATIC PRESSURE

FAN INLET SP -9.96 IN. WG.

FAN OUTLET SP +.070 IN. WG.

FAN INLET VP .084 IN. WG.

FAN SP 9.946 IN. WG.

NOTE:

*FAN SP = SP_{OUTLET} - SP_{INLET} - VP_{INLET}

SP (static pressure)

VP (velocity pressure)

*Industrial Ventilation Handbook 18th Edition

AVERAGE VELOCITY 1162 FPM

TOTAL AIR FLOW RATE 8680 CFM

COMMENTS: _____

AIR BALANCE TECH. [signature] 9-27-97
INITIAL/DATE

DATA SHEET

JCS 3I-324-849 ATACHMENT

TEST NO. X FAN IN SERVICE ZONE I EXHAUST FAN #973/BUILDING 324 DATE 9-27-97

AIR FLOW INSTURMENT USED MICRO WHSL CODE # 702-28-09-019

LAST WHSL CALIBRATION DATE 8-19-97

DUCT SIZE 37 IN. DIA. DUCT AREA 7.47 FT^2

DATA POINT NO.	PITOT TRAVERSE POINTS	VELOCITY PRESSURE IN. WG.	VELOCITY FPM
1	1"	.090	1202
2	3"	.116	1364
3	5 7/16"	.109	1322
4	8 3/8"	.130	1444
5	12 5/8"	.112	1340
6	24 3/8"	.104	1292
7	28 5/8"	.130	1444
8	31 9/16"	.161	1607
9	34"	.140	1499
10	36"	.107	1310

FAN STATIC PRESSURE

FAN INLET SP -10.50 IN. WG.

FAN OUTLET SP +.040 IN. WG.

FAN INLET VP .118 IN. WG.

FAN SP 10.422 IN. WG.

NOTE:

*FAN SP = SP_{OUTLET} - SP_{INLET} - VP_{INLET}

SP (static pressure)

VP (velocity pressure)

*Industrial Ventilation Handbook 18th Edition

AVERAGE VELOCITY 1,380 FPM

TOTAL AIR FLOW RATE 10,309 CFM

COMMENTS:

AIR BALANCE TECH. [signature] 9-27-97
INITIAL/DATE

DISTRIBUTION SHEET

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324 Facility Stabilization Project		ECN No. N/A

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