
	PERFORMANCE TEST PROCEDURE FOR HORIZONTAL CENTRIFUGAL PUMPS	PROCEDURE NO.	PT/HC-01
		PAGE	Page 1 of 3
		DATE	14/01/13


1.0	SCOPE		
	This procedure is applicable for performance testing of Horizontal Centrifugal Pumps to establish pump hydraulic performance, i.e., pump capacity, head developed, power absorbed and the pump efficiency, without reference to the final installation conditions.		
2.0	REFERENCE / ACCEPTANCE STANDARDS		
	Technical Specifications/Approved Data Sheet/QAP		
3.0	THE TEST LAYOUT.		
	The flow circuit will be in accordance with the layout drawing.		
4.0	MEASURING INSTRUMENTS DETAILS		
	Quantity	Instrument	Accuracy
	Flow rate (Capacity)	Electromagnetic Flow meter	± 1.5%
	Head	Bourdon Tube Pressure Gauge / Manometer	± 0.5 % FSD
	Power	Watt Meters	± 0.5 % FSD
		Current Transformers	Class 0.5S
	Speed	Non – Contact Digital Tachometer	± 1 RPM
	Vibrations	Vibrometer	± 5 Microns
	Noise	Sound Level Meter	± 2 db
	Temperature	Digital Temp. Indicator	± 0.1 Deg C
	All the measuring instruments shall have valid calibration certificates from appropriate authorities.		
5.0	TEST PROCEDURE		
5.1	The pump will be tested with calibrated Lab Motor / Job Motor at works of Flowmore Ltd., Unit-I or at Unit-II.		

	PREPARED BY	REVIEWED BY	APPROVED BY
NAME	V. KUMAR	P.K. SHARMA	I.C. JAIN
DATE	14/01/13	14/01/13	14/01/13

	PERFORMANCE TEST PROCEDURE FOR HORIZONTAL CENTRIFUGAL PUMPS	PROCEDURE NO.	PT/HC-01
		PAGE	Page 2 of 3
		DATE	14/01/13

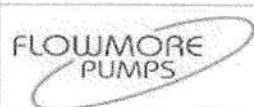
5.2	Test conditions will be varied by throttling a valve in the delivery pipe to obtain different head & flow conditions.
5.3	Prior to starting of the test, the pump shall run for sufficient time till the flow conditions are stabilized.
5.4	<p>The operating range during performance test for normal water handling application will be for from near shut off points to 125% of rated flow.</p> <p>However, for firefighting application, the operating range will be up to 150% of rated flow.</p> <p>The readings of Head, Discharge, Power, and Speed will be recorded at different points along the performance curve, i.e., one point as near as possible to the rated head& capacity (Duty point), three points above the duty point, two points below the duty point and one point near the shut off Head of the pump. Sufficient time gap between two consecutive readings will be allowed for flow conditions to stabilize and to attain accurate and consistent test results.</p>
5.5	Vibration and Noise level readings will be taken only for reference to ensure trouble free running of the pump without undue noise & vibrations at the time of testing. However, noise and vibration levels as per approved data sheet shall be guaranteed at site only.
5.6	<p>The pump performance will be evaluated by plotting and drawing following characteristics at rated speed</p> <p>(A) Capacity Vs Pump Head (b) Capacity Vs Pump Efficiency (c) Capacity Vs Pump Input power</p>
6.0	TEST CALCULATIONS
6.1	<p>FLOW CAPACITY (Q): - Flow Capacity is measured directly in m³/hour with the help of an Electromagnetic Flowmeter.</p>
6.2	<p>TOTAL PUMP HEAD(H) Total Pump Head (H) = Delivery Gauge Reading(H_d)± Suction Monometer Reading (H_s) + Gauge Position Correction (α) + velocity Head (V²/2g)</p> $V^2/2g = \frac{V_d^2 - V_s^2}{2g} \quad \text{where} \quad \begin{array}{l} V_d = \text{velocity in delivery pipe} \\ V_s = \text{velocity in Suction pipe} \\ g = \text{Acceleration due to gravity (=9.81 m/sec}^2) \end{array}$

	PREPARED BY	REVIEWED BY	APPROVED BY
NAME	V. KUMAR	P.K. SHARMA	I.C. JAIN
DATE	14/01/13	14/01/13	14/01/13




	PERFORMANCE TEST PROCEDURE FOR HORIZONTAL CENTRIFUGAL PUMPS	PROCEDURE NO.	PT/HC-01
		PAGE	Page 3 of 3
		DATE	14/01/13

6.3	<u>MOTOR INPUT POWER</u> If W_1 and W_2 are the readings in the two watt-meters, with watt-meters' constants a & b respectively, then Motor Input Power = $(W_1 \times a + W_2 \times b) \times \text{CT Ratio} / 1000$ KW and Pump Input Power = Motor Input Power x Motor Efficiency Motor efficiency shall be taken from the Type Test Report of the motor.
6.4	<u>PUMP EFFICIENCY (%)</u> Pump Efficiency = $\frac{\text{Capacity M}^3/\text{Hr (Q)} \times \text{Total Head MWC (H)} \times 100}{367.2 \times \text{Pump Input Power (KW)}}$
7.0	<u>PERFORMANCE AT SPECIFIED SPEED</u> The parameters calculated above pertain to the actual speed of rotation (N) during test which may be in deviation from the specified speed of rotation. Following formulae will be used to calculate performance at the specified speed Discharge (Q_s) = $Q (N_s / N)$ Total Head $H_s = H (N_s / N)^2$ Pump Input Power (BKWs) = $\text{BKW} (N_s / N)^3$
	Where..... Where a. Suffix's' implies quantity at specified conditions. b. Q= Discharge in M^3/Hr c. H= Total Head in MWC d. BKW= pump Input In KW e. N= speed of rotation in RPM during the Test Pump Efficiency will remain unchanged.
8.0	<u>TEST ANALYSIS / ACCEPTANCE NORMS</u> All the parameters calculated at specified speed will be plotted on a graph with discharge Q on X-axis and Total Head, Pump Input Power and Pump Efficiency on the Y- axis. Smooth average curves will be drawn through the plotted readings. Motor input power, at rated duty point shall be equal to or lower than the guaranteed motor input power (wherever agreed in approved data sheet) Head and Flow capacity at rated duty point shall be as per approved data sheet / technical specification.


	PREPARED BY	REVIEWED BY	APPROVED BY
NAME	V. KUMAR	P.K. SHARMA	I.C. JAIN
DATE	14/01/13	14/01/13	14/01/13

 UNIT-I-9TH MILE STONE, G.T. ROAD SAHIBABAD P.O MOHAN NAGAR,(U.P) – 201007 UNIT-II-28/A, SITE 4, INDUSTRIAL AREA, SAHIBABAD (U.P.)	<p align="center"><u>NDT PRCOEDURE</u> <u>PROCEDURE FOR LIQUID PENETRANT EXAMINATION</u></p>		WI NO. DATE PAGE NO.	FMP/NDT/PRO/PT/01 10.01.2013 1 of 4
---	--	--	------------------------------------	---




1.0	<u>SCOPE</u>
	This procedure is applicable for liquid penetrate examination of welds, castings, machined surfaces and forged materials in ferrous and non ferrous metallic material to detect discontinuities open to surface
2.0	<u>REFERENCE STANDARD</u>
	ASME B & PV Code Section-V ASME B & PV Code Section VII,Div-1 appendix 7 & 8 ASTM-E165
3.0	<u>SAFETY.</u>
3.1	Test shall be conducted in well-ventilated area
4.0	<u>NDE PERSONNEL</u>
	The liquid penetrante examination shall be performed by level-I/II certified personnel. Level-I personnel shall work under suppression of level-II/level-III personnel. Training, qualification and certification of NDE personnel shall be performed as SNT-TC-1A
5.0	<u>TECHNIQUE</u>
	Color contrast, solvent removable penetrate with non-aqueous solvent suspended developer shall be used
6.0	<u>EXTENT OF EXAMINATION</u>
	Extent of examination shall be as specified in the approved drawing/Inspection and Test plan
7.0	<u>EXAMINATION MATERIAL</u>
	Following penetrant materials shall be used Cleaner(ORION-115PR) Penetrant(ORION-115P) Developer(ORION-115D)
8.0	<u>CONTROLS OF EXAMINATION</u>
8.1	Chlorine & Fluorine content(maximum 1% by weight) for all liquid penetrant materials used for austenitic steel shall be obtained
8.2	These certificate shall include manufacturer's batch number and test result in accordance with Mandatory Appendix II of ASME Section-V
8.3	Records be maintained Records shall by the Incharge-QC
9.0	<u>Surface preparation.</u>
9.1	The test surface shall be free from irregularities that could mask the indications due to discontinuities. The surface to be examined and adjacent area within at least 25 mm shall be dry and free from dirt, grease, oil, scale or any other matter that could interfere with the examination. Surface preparation may be done by brushing, grinding, solvent cleaning, etc. Cleaning

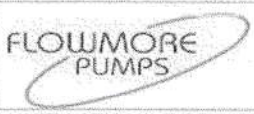
	PREPARED BY	APPROVED BY	ISSUED BY
NAME	SATISH SHARMA	DEEPAK GANDHI	DEEPAK GANDHI
DESIGNATION	ASST. MANAGER(Q.A)	MANAGER(QA)	MANAGER(QA)
SIGNATURE			
DATE	10.01.2013	10.01.2013	10.01.2013

NTPC RQP.NO 0000-999-QOM-Q- 455




 UNIT-I-9TH MILE STONE, G.T. ROAD SAHIBABAD P.O MOHAN NAGAR,(U.P) – 201007 UNIT-II-28/A, SITE 4, INDUSTRIAL AREA, SAHIBABAD (U.P.)	NDT PRCOEDURE		WI NO.	FMP/NDT/PRO/PT/01
	PROCEDURE FOR LIQUID PENETRANT EXAMINATION		DATE	10.01.2013
			PAGE NO.	2 of 4


	solvent shall meet the requirement of clause 8.0 Drying of the surface to be examined shall be accomplished by normal evaporation. A minimum time of 2 minutes shall be given for drying
10.0	STANDARD TEMPEARTURES
	The temperature of the penetrant and the surface of the object to be tested shall be neither below 10°C nor above 52°C Temperature maintenance Throughout the examination period
11.0	TEMPERATURE MAINTENANCE
	Throughout the examination period
12.0	Examination
12.1	PENETRANT APPLICATION
	Penetrant shall be applied over examination surface by brushing/Spraying.
12.2	PENETRATION TIME
	Penetrant shall be allowed to remain over test surface for all at least 10 minutes(dwell time)
12.3	EXCESS PENETRANT REMOVAL
12.4	After dwell time, the excess penetrant shall be removed by wiping with a lint cloth, repeating the operation until traces of penetrant have been removed. The remaining traces shall be removed by lightly wiping the surface with lint free cloth moistened with solvent. To minimize removal of penetrant from discontinuities care shall be taken to avoid the excess use of solvent. Flushing the surface with solvent, following the application of penetrant and prior to developing, is prohibited.
12.4	DRYING AFTER EXCESS PENETRANT REMOVAL
	The surface shall be dried by normal evaporation or wiping. Drying time shall not be less than 2 minutes
12.5	DEVELOPER APPLICATION
12.5.1	Developer shall be applied as soon as possible after penetrant removal and drying of of surface, but in any case within 10 minutes from time of penetrant removal and drying
12.5.2	A thin and uniform coating of the non-aqueous developer shall be applied over dry examination surface by spraying. Dry shall be normal evaporation.
12.5.3	Developing time for final interpretation begins immediately as soon as developer coating is dry. Drying shall be by normal evaporation.
13.0	INTERPRETATION
13.1	Final interpretation- shall be made within 10 to 30 minutes after developer coating is dry
13.2	CHARACTERIZATION OF INDICATION
	Close observation of the formation of indication during application may assist in

	PREPARED BY	APPROVED BY	ISSUED BY
NAME	SATISH SHARMA	DEEPAK GANDHI	DEEPAK GANDHI
DESIGNATION	ASST. MANAGER(Q.A)	MANAGER(QA)	MANAGER(QA)
SIGNATURE			
DATE	10.01.2013	10.01.2013	10.01.2013




 UNIT-I-9TH MILE STONE, G.T. ROAD SAHIBABAD P.O MOHAN NAGAR,(U.P) – 201007 UNIT-II-28/A, SITE 4, INDUSTRIAL AREA, SAHIBABAD (U.P.)	NDT PROCOEDURE			
	PROCEDURE FOR LIQUID PENETRANT EXAMINATION		WI NO.	FMP/NDT/PRO/PT/01
			DATE	10.01.2013
			PAGE NO.	3 of 4

	characterization and determining the extent of the indications, with a color contrast penetrant, developer forms a reasonably uniform white coating. Surface discontinuities are indicated by bleed out of the penetrant which is normally a deep red color that stains the developer.
13.3	A minimum light intensity of 1000 LUX is required on the test surface to be examined. A hand lamp(without reflector) of 100 watt/220 volt, when held horizontally at a distance of 350 mm(14") from the surface provided minimum light intensity of 1000 LUX within a circle of diameter 300 mm(12") directly below it.
14.0	POST CLEANING
	The test surface shall be thoroughly cleaned with cleaner as soon as practicable to remove any residue of the penetrant materials.
15.0	EVALUATION OF INDICATIONS
15.1	An indication of imperfections may be larger than the imperfection that causes it, but the size of the indications is the basis for evaluation and acceptance. Only indication with major dimensions greater than 1.5 mm shall be considered as relevant.
15.2	A linear indication is one having a length greater than times the width. A rounded indications is one of circular or elliptical shape with a length equal to or less than three times its width.
15.3	Any questionable or doubtful indication shall be reexamined to determine whether or not they are relevant.
15.4	All indication shall be evaluated in terms of acceptance standards as below.
16.0	ACCEPTANCE STANDARDS
16.1	ASME Sec-VII, DIVISION-1,APPENDIX-8(FOR WELDING, FORGED MATERIAL)
	All surface examined shall be free of (a) Relevant linear indication. (b) Relevant rounded indications grater then 5 mm. (c) Four or more relevant rounded indications in a line separated by 1.5 mm or less(edge to edge)
16.2	ASME Sec-VII, DIVISION-1,APPENDIX-7(FOR CASTINGS)
	All surface examined shall be free of (a) All cracks and hot tears. (b) Any group of more than six relevant linear indication other than those mentioned in (a) above, in any rectangular area of 38mm x 150 mm or less in any circular area having a diameter of 80 mm or less, these areas being taken in most unfavorable location relative to the indication being evaluated. (c) Other linear indications more than 6 mm long for thickness up to 19mm inclusive, more then 1/3 in length for thickness from 19 mm to 57 mm and more then 19 mm long thickness over 57 mm.(aligned acceptance imperfections separated from one another by a distance equal to the length of the larger imperfection are unacceptable

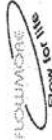
	PREPARED BY	APPROVED BY	ISSUED BY
NAME	SATISH SHARMA	DEEPAK GANDHI	DEEPAK GANDHI
DESIGNATION	ASST. MANAGER(Q.A)	MANAGER(QA)	MANAGER(QA)
SIGNATURE			
DATE	10.01.2013	10.01.2013	10.01.2013

NTPC RQP.NO 0000-999-QOM-Q- 455							
 UNIT-I-9TH MILE STONE, G.T. ROAD SAHIBABAD P.O MOHAN NAGAR,(U.P) – 201007 UNIT-II-28/A, SITE 4, INDUSTRIAL AREA, SAHIBABAD (U.P.)	<p style="text-align: center;"><u>NDT PRCOEDURE</u></p> <p style="text-align: center;"><u>PROCEDURE FOR LIQUID PENETRANT EXAMINATION</u></p> <table border="1" style="width: 100%;"> <tr> <td>WI NO.</td> <td>FMP/NDT/PRO/PT/01</td> </tr> <tr> <td>DATE</td> <td>10.01.2013</td> </tr> <tr> <td>PAGE NO.</td> <td>4 of 4</td> </tr> </table>	WI NO.	FMP/NDT/PRO/PT/01	DATE	10.01.2013	PAGE NO.	4 of 4
WI NO.	FMP/NDT/PRO/PT/01						
DATE	10.01.2013						
PAGE NO.	4 of 4						

	(d) A indications of non-linear imperfections which have any dimensions exceeding 5 mm
17.0	REJECTABLE INDICATIONS-
	Reject able indications shall be recorded. As a minimum the type of indications(linear or rounded), location and extent(length or diameter or aligned)shall be recorded
18.0	EXAMINATION RECORD
	The report shall be prepared as per Liquid penetrant Examination report format(Annexure-I)
19.0	Repair
	Unacceptable imperfection shall be repaired and reexamined as per this procedure to assure removal of reduction to an acceptance size. Where welding is required during or after repair of an imperfection, all required NDE shall be repeated.

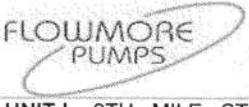
	PREPARED BY	APPROVED BY	ISSUED BY
NAME	SATISH SHARMA	DEEPAK GANDHI	DEEPAK GANDHI
DESIGNATION	ASST. MANAGER(Q.A)	MANAGER(QA)	MANAGER(QA)
SIGNATURE			
DATE	10.01.2013	10.01.2013	10.01.2013

ANNEXURE - I




	FLOWMORE LTD		QM/QC/PO1/F04 R-00
	DYE PENETRANT TEST REPORT		


Test Certificate No.								
W/O No :		PROJECT:	CUSTOMER:					
FIG & SIZE :		PUMP S. NO.:	P.O. NO.:					
TYPE/MAKE		BATCH NO.	DWELL TIME	REFERENCE CODE : ASTM-E165				
CLEANER	ORION - 115 PR		10 MIN	ACCEPTANCE STD : ASME SEC.VIII, DIV-1				
PENETRANT	ORION-115 P		10 MIN	REF. PROCEDURE : FWP/NDT/PRO/PT/1 Rev.00				
DEVELOPER	ORION-115 D			LIGHT INTENSITY : 1000 LUX				
TESTID	Component	IDENTIFICATION NO. MRS & HEAT	TEST DATE	MATERIAL	STAGE OF TESTING	LOCATION	OBSERVATION	Remarks

QC	CUSTOMER REPRESENTATIVE	TESTED BY NAME : STAMP :
----	-------------------------	--------------------------------




 <p>UNIT-I- 9TH MILE STONE, G.T. ROAD SAHIBABAD, P.O MOHAN NAGAR,(U.P) – 201007 UNIT-II- 28 A SITE -IV, INDUSTRIAL AREA SAHIBABAD GHAZIABAD U.P</p>	<p style="text-align: right;">NTPC RQP.NO 0000-999-QOM-Q- 455</p> <p style="text-align: center;">WORK INSTRUCTIONS</p> <p style="text-align: center;">PROCEDURE FOR ULTRASONIC TESTING OF HEAVY STEEL ROLLED / FORGED BARS</p>		<p>WI NO.</p> <p>DATE</p> <p>PAGE NO.</p>	<p>QCP/NDE/UT/01</p> <p>10/01/13</p> <p>1 of 3</p>
---	--	--	---	--

1.0	SCOPE
1.1	To detect and evaluate the discontinuities of heavy carbon, low alloy and alloy steel rolled bars or discs / forged bars or discs by contact, pulse echo method.
2.0	APPLICABLE CODE
2.1	SA-388 OF ASME and ASME Sec.VIII Div.2
3.0	PERSONNEL QUALIFICATION
3.1	The person employed for conducting examination shall be qualified in recommended practice of SNT-TC 1A(2001 edition)
4.0	EQUIPMENT
4.1	Ultrasonic Equipment- Pulse echo type equipment may be used for examination of frequencies between the range of 1 and 5Mhz and in case of Austenitic Stainless steel forgings equipment having capability down to 0.4Mhz shall be used. Equipment to be used shall have a valid calibration certificate, the time of examination.
4.2	Search Units- For normal beam, transducer of 3/8 inch (10 mm) to 1.1/8 inch(30 mm) diameter shall be used .Except for rolled bars / forged bars with nominal thickness 100 mm and over minimum size of transducer shall be 25 mm diameter or 25 mm square. For angle beam scanning search units of size 1/2"x 1"(13x25 mm) or 1"x1"(25x25 mm) shall be used. Transducers of other size may be used to explore discontinuity indications.
4.2.1	Nominal test frequency for normal transducer is 2.0 MHz. whereas for coarse grained austenitic steel forgings 1.0 MHz shall be used. Other frequencies may be used if desirable for better resolution, penetrability or detectability of flaws.
4.3	COUPLANT
	Couplant such as oil, water, water-starch solution shall be used. For Austenitic stainless steel forgings only potable water shall be used as couplant,
5.0	EXAMINATION PROCEDURE
5.1	Surface preparation- Unless otherwise specified, the forgings shall be machined to provide cylindrical surface for radial examination & flat surface for disc and rectangular forgings and for axial scanning. The surface roughness shall not exceed 250 micro inch (6 micro meter).The surface of forging shall be free of extraneous materials such as loose scale, paint, dirt etc.
5.2	Examination shall be performed after heat treatment for mechanical properties but prior to drilling holes, cutting keys, tapers, grooves or machining section to contour.
5.3	As far as possible, entire volume of the forging shall be subjected to examination. To ensure complete coverage, search unit at least 15% overlap with each pass.
5.4	Rate of search unit movement shall not exceed 6inch/sec(150 mm/sec.)
5.5	Wherever possible forgings shall be scanned in two perpendicular directions.

	PREPARED BY	APPROVED BY	ISSUED BY
NAME	SATISH SHARMA	DEEPAK GANDHI	DEEPAK GANDHI
DESIGNATION	ASST. MANAGER	MANAGER(QA)	MANAGER(QA)
SIGNATURE			
DATE	10.01.2013	10.01.2013	10.01.2013




 UNIT-I- 9TH MILE STONE, G.T. ROAD SAHIBABAD, P.O MOHAN NAGAR,(U.P) – 201007 UNIT-II- 28 A SITE –IV, INDUSTRIAL AREA SAHIBABAD GHAZIABAD U.P	<p style="text-align: right;">NTPC RQP.NO 0000-999-QOM-Q- 455</p> <p style="text-align: center;">WORK INSTRUCTIONS</p> <p style="text-align: center;">PROCEDURE FOR ULTRASONIC TESTING OF HEAVY STEEL ROLLED / FORGED BARS</p>	WI NO.	QCP/NDE/UT/01
		DATE	10/01/13
		PAGE NO.	2 of 3

5.6	Disc forgings shall be scanned using a straight beam from at least one flat face and radially from circumference, wherever practicable
5.7	Cylindrical section and hollow forgings shall be scanned radially and wherever possible in axial direction also.
5.8	Hollow forgings shall be scanned by angle beam technique from outside diameter surface also.
6.0	<p><u>SENSITIVITY SETTING WITH NORMAL BEAM PROBE</u></p> <p>With the attenuators set minimum level adjusts the instrument controls to obtain the first back reflection at 100% of the full screen height from opposite side of the forging / rolled product. At this sensitivity setting record the dB reading. This shall be the Primary Reference Level. The scanning of the item under testing shall be carried out at +6dB gain above primary reference level. Evaluation of all indications (discontinuities) shall be carried out at primary reference level of sensitivity setting. Recalibration of the instrument is required for significant changes in section thickness or diameter.</p>
	Any change in search unit, couplant, instruments setting or scanning speed from that used in calibration shall require recalibration. A calibration check shall be performed at least once every 8 hrs shift. When a loss of 15% or more in gain setting is indicated, recalibration of instrument shall be done and all material examined since last calibration shall be re-examined.
7.0	<p><u>ANGLE-BEAM CALIBRATION-</u></p> <p>This technique is applicable to rings and hollow forgings / rolled products, having outside to inside diameter ratio less than 2.0 and axial length more than 2.0 inch (50 mm).</p>
7.1	For plotting the DAC curve a separate calibration standard may be use. It shall have the same nominal Compositions, Heat Treatment, & thickness as the forging / rolled product represent.
7.1.1	The test surface finish on the calibration standard shall be comparable but no better than item to be examined.
7.1.2	Where a group of identical forging is made one of these forging may used as the separate Calibration Standard.
7.1.3	Cut on the Inner Diameter (ID) a Notch - Rectangular or 60° V - Notch having depth up to 3 % maximum of the thickness or 6 mm whichever is smaller, & length approximately 25 mm.
7.1.4	Similarly cut the same Rectangular or V- Notch notch on Outer Diameter (O.D.) of the item taken for making calibration block.
7.1.5 7.1.5	To draw the D.A.C curve, place the probe on the outer surface (on OD), adjust the dB setting till the echo height of first echo from the notch on inner diameter (I.D notch) comes to 80 % of the Full Scale Height & mark a point on the screen at peak of the said first back wall echo. Record the dB gain setting. This dB setting is primary reference level.
7.1.6	Without changing the dB setting (i.e. at the same primary reference level), probe shall be moved away now to get maximum echo from the notch on outer diameter (OD notch) Mark the

	PREPARED BY	APPROVED BY	ISSUED BY
NAME	SATISH SHARMA	DEEPAK GANDHI	DEEPAK GANDHI
DESIGNATION	ASST. MANAGER	MANAGER(QA)	MANAGER(QA)
SIGNATURE			
DATE	10.01.2013	10.01.2013	10.01.2013

FLOWMORE PUMPS		NTPC RQP.NO 0000-999-QOM-Q- 455	
UNIT-I- 9TH MILE STONE, G.T. ROAD SAHIBABAD, P.O MOHAN NAGAR,(U.P) – 201007 UNIT-II- 28 A SITE –IV, INDUSTRIAL AREA SAHIBABAD GHAZIABAD U.P		WORK INSTRUCTIONS	WI NO. QCP/NDE/UT/01
		PROCEDURE FOR ULTRASONIC TESTING OF HEAVY STEEL ROLLED / FORGED BARS	DATE 10/01/13
			PAGE NO. 3 of 3

	point on the screen at peak of that echo
7.1.7	Now to get the third point to draw D.A.C., without changing the dB setting (i.e. at the same primary reference level), probe shall be moved away to get second maximum echo from the notch on outer diameter (OD notch) Mark the point on the screen at peak of that echo
7.1.8	Draw a curve through the three points as marked on screen above This curve will be the amplitude Reference line or D.A.C curve.
7.2	Examination shall be performed at 6dB above primary reference level. Scanning shall be carried out over the entire area circumferentially in both clock-wise and counter clock-wise directions from OD surface. The forgings, which could not be tested by longitudinal beam in axial direction, shall be examined in both axial directions using angle beam search units.
8.0	RECORDING :- Following indication shall be recorded
8.1	Straight Beam
8.1.1	Indications equal to or more than 10% of Full Scale Height (FSH).
08/01/02	A reduction in back reflection echo exceeding 20% of original amplitude.
8.2	Angle Beam
8.2.1	Discontinuity indication equal to or exceeding 50% of reference line or reference notch shall be recorded.
9.0	ACCEPTANCE STANDARD
9.1	A forging shall be unacceptable if.
	1. Defect echo height is more than 20% of the Full Scale Height (FSH) at primary reference level during examination by normal beam probe. 2. Loss of Back Wall Echo (BWE) is more than 20% (I.e.BWE height is less than 80% of FSH) during examination by normal beam probe. 3. Angle beam examination result shows one or more discontinuities which produced indications exceeding the DAC curve drawn..

	PREPARED BY	APPROVED BY	ISSUED BY
NAME	SATISH SHARMA	DEEPAK GANDHI	DEEPAK GANDHI
DESIGNATION	ASST. MANAGER	MANAGER(QA)	MANAGER(QA)
SIGNATURE			
DATE	10.01.2013	10.01.2013	10.01.2013

APPROVED
Checked and Approved.

Date: 08-Apr-2019

*Approval doesn't absolve the EPC contractor of it's responsibility as specified in the Contract.

			MANUFACTURING QUALITY PLAN				PROJECT : BIFPCL(MAITREE KHULNA STPP,BANGLADESH(2X660 MW)						
			Item :		BHEL doc. No.PE-V0-421-554-A005		PACKAGE : VENTILATION SYSTEM						
			AXIAL FLOW FAN/ ROOF EXTRACTOR		Rev. No. R2		LOI NO:PSER:SCT:KLN-M1876:18:LOI-S(PKG-B)7020 OF 29.08.18						
							MAIN Supplier/ CONTRACTOR :BHARAT HEAVY ELECTRICAL LTD.						
							I						
							SHEET / 2						
S.N	COMPONENT/ OPERATION	CHARACTERISTICS	CATEGORY OF CHECK	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENTS	ACCEPTANCE NORM	FORMAT OF RECORD		INSPECTION AGENCY		REMARKS
(1)	(2)	(3)	(4)	(5)	M	M/B	(7)	(8)	(9)	D*	M	C	B
(10)													
(11)													
1.0 MATERIAL OF CONSTRUCTION													
1.1	Casing, Impeller blade & Hub	Physical & chemical	Major	Physical and chemical test	1 No. Sample / heat or lot		Relevant Material standard as per approved drawing/ data sheet	Material test report	v	P	V	V	
2.0 IN PROCESS INSPECTION													
2.1	Casing / Impeller fabrication	DPT of butt welding as applicable	Major	DP Test	20%		ASME SEC-V,Article-VI/ASTM E 165	No relevant Indication	DP test report	v	P	V	V
2.2	Impeller dynamic balancing	Residual Un-balance	Critical	Dynamic Balancing test	100%		ISO 1940 Gr. 6.3	ISO 1940 Gr. 6.3	Dynamic balancing report	v	P	V	V
2.3	Welding / Weldament Check	DPT of Weld	Major	NDT	20%	—	ASTM 165	No relevant Indication	Inspection report	v	P	V	V
3.0 FINAL INSPECTION													
3.1	Fan Assembly	Overall dimension	Major	Measurement	100%	Random one fan per size	Approved drg	Approved drg	Inspection report	v	P	W	W
3.2		Run test of fan for four hours or till stabilization of temperature rise whichever is earlier.	Critical	RPM,Current, vibration, noise and temperature rise	100%	Random one per size per visit from offered lot	Approved TDS/GA Drg	Approved TDS Vibration - Satisfactory level as per VDI-2056.Group-T Temperature rise -40-degree C maximum above ambieny temp. Noise-85dB(A) at 1mtr at Horizontal distance/1.5 meter elevation	Run test report	v	P	W	W
3.3		Performance test with job motor/shop motor (as applicable in technical specification)	Critical	Flow, rpm, static pressure, power consumption, static efficiency, noise level, vibration & temperature rise.	One of each type and size (To be randomly selected from complete lot)		Approved data sheet/Drawing	Approved TDS Vibration - Satisfactory level as per VDI-2056.Group-T Temperature rise -40-degree C maximum above ambieny temp. Noise-85dB(A) at 1mtr at Horizontal distance/1.5 meter elevation	Performance test report	v	P	W	W
3.4	Spray Galvanizing/ Painting	Visual, DFT	Major	Visual, Measurement	100%		BIFPCL painting schedule	BIFPCL painting schedule	Painting/Spray Galvanization report	v	P	V	V
3.5	Review of QA Documentation	Compliances	Major	Review	100%		Approved drawing/data sheet/Approved QAP		Test Reports	v	P	V	V
Notes :													
1. For fans with Motor power less than 2kW, manufacturer TC shall be reviewed and BIFPCL/Main Contractor witness of final inspection is not envisaged. However wherever Functional Guarantee is specified in Technical specification , those fans shall be witnessed by BIFPCL/Main Contractor.													
2. Material of construction shall be as per approved Drawing/Data Sheet/Technical Specification If MOC is not mentioned in approved drawing/datasheet/technical specification, then MOC as per manufacturer standard will be applicable.													
3. For acceptance of Motors, following system will be adopted :													
(i)	For motors less than 30kW : Acceptance of motor less than 30kW is based on COC of the manufacturer and the main contractor confirming as follows : "It is hereby confirmed that the above mentioned motor/motors was/were manufactured taking care of BIFPCL specific requirements regarding ambient temp., voltage & frequency variation, hot starts, pull out torque, starting KVA/KW, temp.rise, distance between center of stud & gland plate and tested in accordance with approved drawing/datasheets".												
(ii)	For motors 30kW and less than 50kW : Acceptance of Motor rating from 30kW & up to 50kW is based on BIFPCL review of routine test inspection report : 325/applicable standards duly witnessed by main contractor along with COC of the manufacturer and the Main Contractor confirming as follows : "It is hereby confirmed that the above mentioned motor/motors was/were manufactured taking care of BIFPCL specific requirements regarding ambient temp., voltage & frequency variation, hot starts, pull out torque, starting KVA/KW, temp.rise, distance between center of stud & gland plate and tested in accordance with approved drawing/datasheets".												
(iii)	For motors 50kW & above : As per BIFPCL APPROVED QUALITY PLAN (To be submitted seperately for BIFPCL review & approval).												
4. Latest revision of Standards & Specification shall apply. Only International Standards are applicable. Indian & Chinese Standards are not applicable.													
5. Materials shall be procured in compliance to Functional Technical Specification.													
6. Welding shall be carried out by Qualified Welders, with traceable WPO, in line with Approved WPS and Qualified PQR, as per ASME Section IX.													
7. Only approved welding consumables shall be used, as per Approved Welding Consumable list.													
8. NDT shall be carried out by Qualified Personnel with compliance to Approved NDT Procedures and Acceptance Norms, as per ASME Section V.													
9. Gauges and measuring Instruments, with valid calibration only shall be used.													
10. Cleaning and Painting of products shall be carried out as per Approved Painting Schedule.													
11. Finished Products shall be packed to comply with Approved Packing Schedule.													

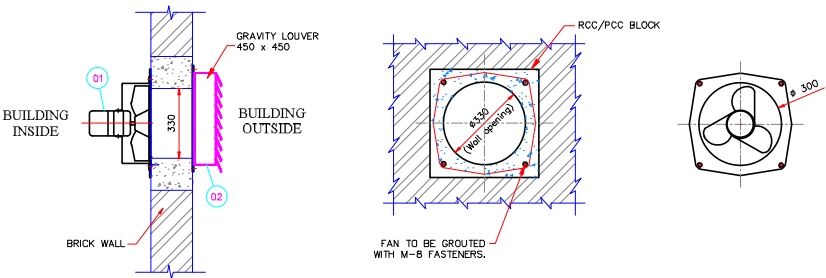
APPROVED
Checked and Approved.

Date: 08-Apr-2019

*Approval doesn't absolve the EPC contractor of it's responsibility as specified in the Contract.

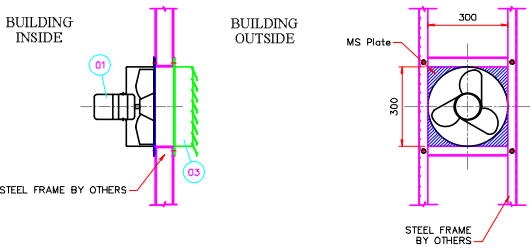
[illegible]

***Approval doesn't absolve the EPC contractor of it's responsibility as specified in the Contract.**



FAN FIXING DETAIL WITH BRICK WALL

FRONT VIEW



FAN FIXING DETAIL WITH STEEL STRUCTURE

Capacity (CMH)	Fan dia	Phase	Power	Fan Speed (RPM)	Qty. (Nos.)	Static Pressure (mmWG)	Fan Dynamic Load (Kg.)	MOC
1200	ø300	Single	90 watts.	1400	*	5	5.5	MS epoxy powder coated

[illegible]

Sl. No	DESCRIPTION	SPECIFICATION
1	Make	As per Approved Make
2	Type	Motorized and spring return fail safe type
3	Size	As per approved layouts.
4	Louver Blade	GI, 16G
5	Casing	GI, 16G
6	Shaft	18mm x 14mm dia circular rod
7	Fabrication Type	Box Type
8	Working	Normally open, in case of no power damper will be closed by spring action
9	Fire Rating	90 minutes (minimum)
10	Leakage Class	Class-1
MOC of The Following Material		
11	Spring	Spring steel grade 2
12	Linkage	GI
13	Bearing	GI
14	Gland Packing	Jamb Seal
15	Reference Code/ Standard	UL-555, 1955 (certified by CBRI)
16	Quantity	As per Approved Layout.
17	GA Drawing	Enclosed
Single Phase Actuator		
1	Make of Actuator	Belimo
2	Model No.	NFA S2 for 10MM and SFA S2 for 20 MM
3	Actuator Voltage	AC 240 V, 50 HZ, Single phase
4	Power Consumption	10 watt (max.)
5	Angle of rotation	95 degree (max.)
6	Switch Type	SPDT 2 Set
7	Torque	10 Nm/ 20 Nm
	Contact Rating	As per Technical specification
8	Degree of Protection	IP 54
9	Running Time	
a)	Motor	75 Seconds
b)	Spring Return	20 Seconds
10	Sound level	
a)	Motor	45 dB (max.)
b)	Spring Return	62 Db (max.)
11	Auxiliary Contacts	Limit switches for open & close position
12	Mode of Control	Open - Actuator energised
		Close - Actuator de-Energise & spring action
13	Inspection & Testing for fire damper	As per Item Categorisation Plan

Certifications

CERTIFICATE OF COMPLIANCE

Certificate Number20131231-R27629Report ReferenceR27629-20131230Issue Date2013-DECEMBER-31

Issued to:

SYSTEMAIR INDIA PVT LTD
A 19, SECTOR 64
NOIDA UP 201304 INDIA

This is to certify that
representative samples of

DAMPERS FOR FIRE BARRIER AND SMOKE
APPLICATIONS
Fire Dampers for use in static systems
Model Nos: FSD-A-L, FSD-A-S

Have been investigated by UL in accordance with the
Standard(s) indicated on this Certificate.

Standard(s) for Safety:

UL555 -FIRE DAMPERS

Additional Information:

See the UL Online Certifications Directory at
www.ul.com/database for additional information

Only those products bearing the UL Classification Mark should be considered as being covered by
UL's Classification and Follow-Up Service.

The UL Classification Mark Includes: UL in a circle with the word "CLASSIFIED" (as shown); a control
number (may be alphanumeric) assigned by UL; a statement to indicate the extent of UL's evaluation of
the product; and the product category name (product identity) as indicated in the appropriate UL
Directory.

Look for the UL Classification Mark on the product.


William R. Carney, Director, North American Certification Programs
UL LLC



Any information and documentation involving UL Mark services are provided on behalf of UL LLC (UL) or any authorized licensee of UL. For questions, please
contact a local UL Customer Service Representative at usa@ul.com/contact.

Page 1 of 1

CERTIFICATE OF COMPLIANCE

Certificate Number20180410-R27629Report ReferenceR27629-20180226Issue Date2018-APRIL-10

Issued to:

SYSTEMAIR INDIA PVT LTD
PLOT NO.-03, SECTOR-31
ECOTECH-1, SITE IV
KASNA, GREATER NOIDA Uttar Pradesh 201308 INDIA

This is to certify that
representative samples of

DAMPERS FOR FIRE BARRIER AND SMOKE
APPLICATIONS
Fire Dampers for use in static systems Models No: FSD (F)-
F-V-S-F90, FSD (F)-F-V-L-F90, FSD (F)-F-V-M-F90.

Have been investigated by UL in accordance with the
Standard(s) indicated on this Certificate.

Standard(s) for Safety:

UL 555 - Standard for Safety for Fire Dampers

Additional Information:

See the UL Online Certifications Directory at
www.ul.com/database for additional information

Only those products bearing the UL Certification Mark should be considered as being covered by UL's
Certification and Follow-Up Service.

Look for the UL Certification Mark on the product.


Bruce Mahrenholz, Director North American Certification Programs
UL LLC



Any information and documentation involving UL Mark services are provided on behalf of UL LLC (UL) or any authorized licensee of UL. For questions, please
contact a local UL Customer Service Representative at usa@ul.com/contact.

Page 1 of 1

22 systemair

systemair 23

CERTIFICATE OF COMPLIANCE

Certificate Number 20160202-R27629
Report Reference R27629-20160202
Issue Date 2016-FEBRUARY-02

Issued to: SYSTEMAIR INDIA PVT LTD
PLOT NO.-03, SECTOR-31
ECOTECH-1,SITE IV
KASNA
GREATER NOIDA UTTAR PRADESH 201308 INDIA

This is to certify that
representative samples of DAMPERS FOR FIRE BARRIER AND SMOKE
APPLICATIONS
Combination Fire and Smoke Dampers Models:

1.5 Hr. Fire endurance rating, Leakage Class I, Model
FSD(FS)-A-L-F90-C1,FSD(FS)-A-S-F90-C1

Have been investigated by UL in accordance with the
Standard(s) indicated on this Certificate.

Standard(s) for Safety: UL 555, Standard for Safety for Fire Dampers
UL 555S, Standard for Smoke Dampers

Additional Information: See the UL Online Certifications Directory at
www.ul.com/database for additional information

Only those products bearing the UL Certification Mark should be considered as being covered by UL's
Certification and Follow-Up Service.

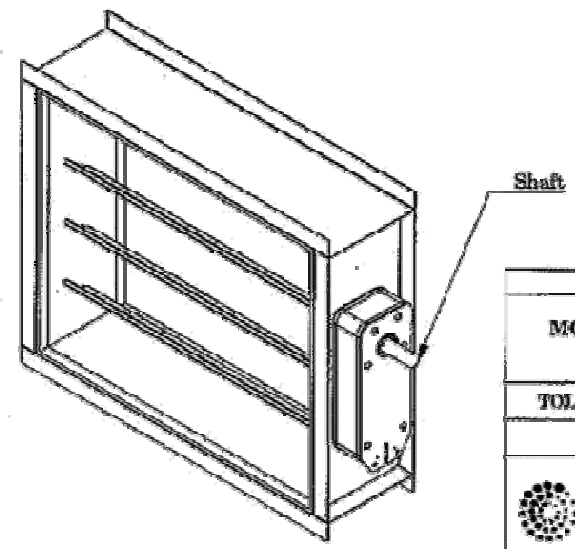
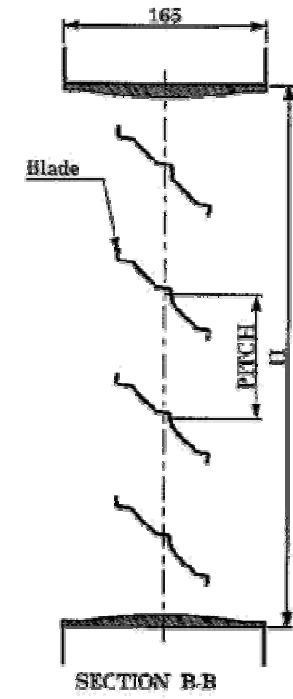
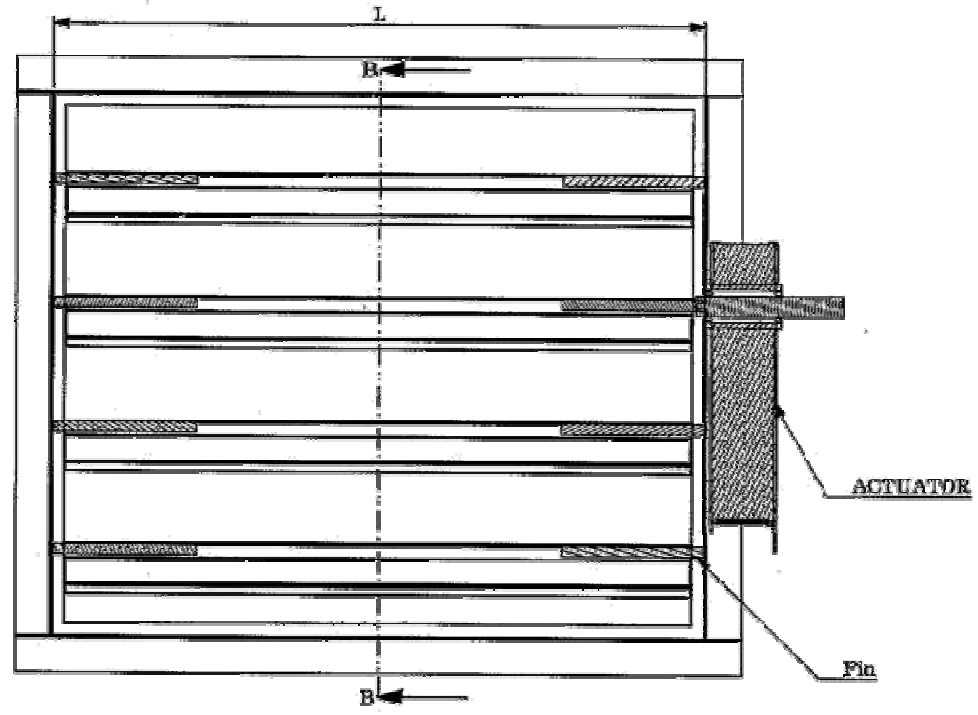
Look for the UL Certification Mark on the product.


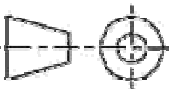

Bruce Mahrenholz, Director North American Certification Program
UL LLC

Any information and documentation involving UL Mark services are provided on behalf of UL LLC (UL) or any authorized licensee of UL. For questions, please
contact a local UL Customer Service Representative at <http://ul.com/about/locations/>



ALL DIMENSIONS ARE IN M.M. (IF IN DOUBT PLS. ASK DON'T SCALE THE DRAWING)



PART No.:-		MATERIAL:-	DATE:-		DRAWING No.:-	
MOTORIZED FIRE DAMPER WITHOUT SLEEVE			18-Mar-2011			
TOLERANCE:-	SCALE:-	DRN. BY:-	RAVI	CHK. BY:-		APPD. BY:-
±2	N.T.S.					
 systemair RAVISTAR		RAVISTAR INDIA PVT.LTD.				

Fire safety dampers



Fresh air is essential for people to feel good and to increase the life of your computers and machines. By investing in an energy efficient ventilation system from Systemair you get a healthy indoor environment while reducing your operating costs. Additionally, it prepares you for future environmental requirements and thus increases the value of your property. In other words, pure profit.

Systemair provides professional ventilation solutions for all types of buildings, from single-family and multi-family buildings to shopping centers, hospitals and industrial facilities. We adapt the solution to your particular type of business. Regardless if it is a new construction or a retrofit project, our products are second to none in quality, reliability and length of service life. You can always trust that Systemair delivers energy efficient ventilation solutions for health, comfort and success.

Fresh air is pure profit.



Bringing fresh air to places

Systemair was founded in 1974 with a pioneering idea in developing and introducing the circular in line centrifugal duct fan which has simplified ventilation systems. Our motto "The straight way", has now extended from a product concept to a business philosophy. Our range has grown -substantially to span a wide range of energy efficient fans, air handling units, air distribution products, air conditioning, air curtains and heating products. Our products are robust and easy to choose, install and use.

Today, our company is one of the global leaders having subsidiaries in 50 countries in Europe, North &

South America, Middle East, Asia and Africa. About 65 companies with 5,200 employees and 27 factories with a total manufacturing floor space of more than 300,000 m². The company is listed on the NASDAQ OMX Nordic Exchange

Operating from the core values of simplicity and reliability, our business concept is to develop, manufacture and market high-quality ventilation products. On the basis of our business concept and with our customers in focus, our aim is to be seen as a company to rely on, with the emphasis on delivery reliability, availability and quality.

Contents

Systemair worldwide.....	2-3
Systemair India.....	4-5

Technical data

Fire safety in ventilation system.....	6-8
Criteria for testing /certification.....	9-11
UL certified fire & smoke damper.....	12-15
Electrical connection diagram.....	16-17
Installation & operation instructions.....	18-21
Certifications.....	22-25

Systemair India

Systemair India (100% owned subsidiary of Systemair AB, Sweden) started operations in 2006. Today the company has its offices pan India in 9 cities- Noida, Hyderabad, Bengaluru, Chennai, Kochi, Kolkata, Pune, Mumbai & Ahmedabad. The team of 400 dedicated professionals are looking after- sales, technical support, production & logistics.

The company has manufacturing area totalling to 15000 sq mts in its 2 ultra-modern factories located at Greater Noida & Hyderabad. The strategically located production units manufacture high quality products to support the local market needs with minimum possible time for delivery.

The Greater Noida factory is a LEED Platinum certified building, with modern laboratories the ATD lab (Air Terminal Devices) and Acoustic laboratory.

The ATD lab built in compliance with EN & ASHRAE standards boasts of high precise measuring equipments and an independent control software to determine air flow patters & velocity profile of air terminal devices.

The Acoustic lab built in compliance with AMCA 210 & AMCA 300 standards uses AMCA nozzles for air flow measurement and AMCA specified pressure taps for pressure drop measurements. The lab can conduct test procedures for maximum air flow 45000 Cub. Ml./Hr. with a pressure handling capacity of 3000pa.

Certifications

- Axial fans certified as per AMCA international.
- BSI certificate of constancy of performance, EN12101-3: 2015 for Axial fans & A/JR Jet Fans tested to 300.C/2hrs.
- Follows ETL testing lab U.S.A for performance testing of air distribution products like grilles & diffusers.
- Combination fire & smoke dampers certified & listed as UL555 for 90 min fire rating & UL555 S for Class 1 leakage.
- Fire damper series FSD-A-L, FSD-A-S & FSD-A-M certified as per UL555 for 90 min fire rating.
- Fire dampers certified by CBRI Roorkee (as per UL555 for 120 mins) and also certified as per BS-476 Part 20.
- Fusible link fire dampers certified for 1.5 hrs of fire rating as per UL555
- Sound attenuators certified in SRL, UK for the static insertion loss as per BS 4718-1971.
- EUROVENT certified BA series of AHUs.
- EUROVENT hygienic certification for BA-H series of AHUs.
- BS/EN1886:2008 for casing strength, tightness, thermal resistance, thermal bridging & filter bypass leakage for AHU.
- EN13053 / 2006 for air flow-static pressure performance, heat transfer and heat recovery performance.

Product Range

The leading edge product range includes



Air Distribution & Fire Safety Products

Range of supply & exhaust diffusers, iris dampers, grilles & fire dampers.



Air Handling Units

Compact & modular AHU's used for industry, commerce, schools, hospitals etc. It also includes the Hygiene air handling units.



Fans

This includes circular & rectangular duct fans, roof fans, box fans & axial fans.



Greater Noida India: LEED certified Platinum rated manufacturing facility.

Fire Safety in Ventilation Systems

Fire Safety

Regarding fire safety of ventilation systems, the most important is to save lives and valuable inventory and to ensure good working conditions for the rescue team. A fire occurrence must be limited before it develops into a disaster. The requirements for personal safety and the emergency response capacity are very closely linked to the risk of fire spreading and stability of the building. Strategically, this means that in case of a fire, persons must be able to exit the building by themselves or with help from the rescue team.

Buildings, especially inventory contain an amount of com-bustible material. A correct fire safety system can prevent heat and smoke from spreading through the ventilation system. Should for example a too early destabilization of the building occur, a collapse can cause a disaster risk of a significant size. Fire safety in ventilation plants is thus necessary in modern buildings.

Fire control system

Systemair's fire control system has been prepared for easy & simple installations. It is configurable & therefore extremely flexible. The fire control system contains all the necessary functions such as monitoring, testing and verifying the operation of fire & smoke dampers, smoke dampers, smoke evacuation dampers and communicating with the unit and the smoke extract fan.

Key features:

- Disables the dampers and disconnects the fan/unit in case of a fire
- Weekly tests of dampers and the smoke extract fan, to ensure that they are operational
- Manual testing is possible
- Ensures that the dampers are open during normal operation, and ventilation is functioning as planned
- When smoke/fire is detected, you can choose to have all dampers closed and shut down the ventilation in the entire building or only in the current fire section
- Detailed error message on each damper
- 24V supply & control via the bus system for each damper.

The fire control system consists of the following components:

Control panel

- Display: to monitor & set the necessary parameters
- Alarm readout: for fire & service alarms and alarm log
- Reset: of the alarms above.
- Manual exercise of fire & smoke dampers, smoke dampers, smoke evacuation dampers and smoke extract fan

- Timer-setting for weekly exercise
- Control panel can be connected to max. 16 section controllers
- Event log for the latest 84 exercises and service receipts are saved automatically.

Section controller

- Max.62 damper units can be controlled and monitored
- When using more than 62 dampers an extra section controller must be connected as a "slave"
- Smoke detector (max. 10 pcs.)
- Temperature sensor with reset on the control panel 40 °C (default)
- Detailed error message on each damper
- Stop of the fan/unit
- External fire detection system or signal device
- Start and control of smoke fan
- Service signal
- Differential pressure transmitter for monitoring & control of fan
- IP 54 box enclosed
- Main power supply 230 V AC
- Power supply 24 V DC for 5 dampers
- The section controller can work without any control panel.

Damper module

- One damper module used by each fire & smoke damper, smoke damper or smoke evacuation damper
- Mounting bracket included
- Terminals and cable clamp for connection of damper and bus cable.

Power supply

- The section controller can supply the first 5 dampers
- Hereafter use a power supply for every 8 dampers
- Max. 100 m cable to the farthest damper
- Max. total bus length 1200 m.

Smoke detector for duct type

- Smoke detector for measuring/detection of smoke in the duct system
- Air velocity between 0.2 and 20 m/s.

Temperature sensor type

- The temperature sensor detects a set temperature due to fire and transmit the signal to the section controller.

Differential pressure transmitter

- Differential pressure transmitter incl. connector and measure hose, detects the pressure in the duct and transmits the signal to the section controller
- Monitors the exhaust fan operation
- Control of smoke fan operation by weekly exercising
- Pressure control of the smoke fan in a fire situation.

Damper-secured system

Damper-secured systems are most suitable for usage in all buildings for day time occupancy, where ventilation often will be stopped at night. These categories include for instance:

- Offices, industrial and warehouse buildings, certain garages, outbuildings and airport.
- Teaching rooms, school day-care centers, after-school facilities, day centers.
- Shops, shopping malls, places of public assembly, meeting rooms, canteens, restaurants, cinemas, discotheques and theatres.
- Elderly housing, treatment rooms and wards in hospitals, nursery homes, homes and institutions for people with physical or mental difficulties, nurseries and kinder- gartens.

Spreading of smoke and fire through the duct system

The duct system must be such designed, that the risk of smoke and fire spreading to other fire cells, fire sections or similar building units is not increased.

Penetration of fire sections must be ensured with fire- and smoke dampers BRS. Penetration of fire cells must be secured with smoke dampers RS. For usage category 1, 2 and 3, there will be some exceptions for penetration of fire cells, for example, if there is already established automatic fire alarm- and warning systems, sprinkler- and warning systems, smaller secondary rooms for short stay or if there is established a direct escape route to the outside from the room.

Systemair fire control system ensures that smoke dampers and fire- and smoke dampers closes by fire and by night stop.

Detection of fire must be made for each fire section in the exhaust duct. Smoke dampers between cells are activated by the shared detector of the current fire section.

At fire detection, you can choose to let supply- and exhaust fans continue to run, and only close the smoke dampers and fire- and smoke dampers that are operating the fire affected section.

Air intake- and exhaust dampers must also be closed. You can also choose to stop the supply- and exhaust fans. Then all smoke dampers and fire- and smoke dampers must close.

Weekly exercise of smoke dampers and ensuring that the dampers are open during normal operation. It is possible to do manual testing of dampers.

Smoke-ventilated system

Smoke-ventilated systems can be used in all buildings, but are especially suitable for usage in buildings whose upper floors are higher than 22 meters above the ground. Another category for example residential buildings & youth housing, where there is a requirement for 24 hours of operation of the ventilation system. In hotels, hostels, inns, dorms and guesthouses there is a requirement for full automatic fire alarm- & warning systems, if there are more than 10 beds.

Alternatively there must be established a damper-ensured system, which must be either for 24 hours of operation or with an automatic fire alarm- and warning system, which is required if there are more than 10 beds. Usage category 6 Elderly housing, treatment rooms and wards on hos-pitals, nurseries/homes, homes and institutions for people with physical or mental difficulties, nurseries and kinder-gartens. All buildings where a complete automatic fire alarm- and warning system is demanded.

A smoke-ventilated system must be such designed, that smoke in the system is discharged to the outside with reasonable safety. A smoke-ventilated system cannot be combined with fire-, flame- and/or smoke damper, which prevents the discharge of smoke that has entered the system. In a smoke-ventilated system, the smoke must run via a duct, by-passing parts of the system with large flow resistance or components in which the risk of clogging of the smoke particles from a fire is high. This includes filters, heat recovery components, heating- and cooling coils etc. A by-pass duct is equipped with a smoke evacuation damper that is closed at normal operation with voltage (currentless open). A smoke-ventilated system is generally performed as a duct class EI 30/E60 A2-s1,d0, which also includes ducts in installation shafts and unexploitable attics.

An exception to this is ducts in the ventilation room, ducts in the open air (outdoor) and ducts that only serve one fire section and are located within this. Ducts in an unexploitable attic, which only serves one fire section and are located within this, must be insulated with minimum 50 mm insulation class A2-s1,d0. Branches from a fire insulated duct should be fire insulated corresponding to the diameter of the branch, but a minimum of 0.2 m. For an extraction system, reasonable safety for the discharge of smoke to the outside can be achieved by: Smoke-ventilated system with smoke fan in operation, where all residential fire cells is performed with a minimum of 50 Pa smoke resistance.

For supply air systems, where the extract system in the operated fire sections or similar fire units are designed as smoke-ventilated system, can reasonable safety for the discharge of smoke to the outside be achieved by: Converted system, where the supply air system is designed as a smoke-ventilated duct system, supplemented with a smoke fan or coupled with the smoke fan in the extract system.

All residential fire units are performed with a minimum of 30 Pa smoke resistance. A smoke resistance including connected ducts and possible flexible connections must everywhere be performed as material class A2-s1,d0 with a melting point of at least 850 °C. The smoke fan can be the extract fan for the normal operation or a separate fan exclusively for smoke extraction. The connection point for the smoke fan must be at or above the upper channel system branching to the operating area, so that smoke will not be sucked down into a duct system with branches.

A smoke fan must be able to withstand the occurring temperature for 60 min. after the fire has started, valid from a normal-temperature operating fan with a minimum of 1 hours operation and at an ambient temperature of 20 °C without cooling from wind or rain. Functional requirement is documented by manufacturer.

The temperature at the smoke fan is set as a mixing temperature, consisting of 945 °C from the fire room, and 20 °C from the remaining rooms (the mixing temperature must be at least 100 °C). The fire room is usually determined as the fire cell with the largest air volume - for systems with variable air volume, uses the maximum air volume rate. For calculation of the maximum flue gas temperature, the maximum air volume in the fire room is used. For remaining rooms, use diversity factor 0.2 for the difference in air volume between minimum and maximum air volume without incalculating of other diversity factors.

The air volume depends on the building's density and is typically smaller than the air volume. The volume must be sufficient to ensure the system's required smoke resistance, however pressure limited to a maximum of 100 Pa negative pressures at the upper branch to the operating area. This negative pressure must be maintained at maximum and minimum opening of diffusers and dampers in systems with variable air volume.

Criteria for Testing/Certifications

Underwriters' laboratories (UL LLC.) UL 555 /UL 555 S

Scope

1.1 These requirements cover fire dampers that are intended for use where air ducts penetrate or terminate at openings in walls or partitions; in air transfer openings in partitions; and where air ducts extend through floors as specified in the Standard for Installation of Air-Conditioning and Ventilating Systems, NFPA 90A. Fire dampers are intended for installation in accordance with codes such as the BOCA National Mechanical Code, SBCCI Standard Mechanical Code, ICBO Uniform Mechanical Code, and the International Mechanical Code.

1.2 Fire dampers are evaluated for use as either:

- Fire Dampers for Static Systems - For HVAC systems that are automatically shut down in the event of a fire or for air transfer openings in walls or partition
- Fire Dampers for Dynamic Systems - For HVAC systems that are operational in the event of a fire.
- Combination Fire and Smoke Dampers - For locations in HVAC systems where a fire damper and a smoke damper are required at a single location.
- Corridor Dampers - For locations in HVAC Systems where air ducts penetrate or terminate at openings in the ceilings of interior corridors when permitted by authority having jurisdiction.

1.3 Under these requirements a fire damper is subjected to a standard fire exposure, controlled to achieve specified temperatures throughout a specified time period, followed by the application of a specified standard hose stream. This exposure by itself is not representative of all fire conditions; conditions vary with changes in the amount, nature, and distribution of fire loading, ventilation, compartment size and configuration, and heat sink characteristics of the compartment. These requirements provide a relative measure of fire performance of fire damper assemblies under these specified fire exposure conditions. Any variation from the construction or conditions that are tested such as method of installation and materials has the potential to substantially change the performance characteristics of the fire damper assembly.

1.4 Fire dampers for static systems (no air flow through the damper) are intended to close automatically upon the detection of heat by a heat responsive device.

1.5 Under these requirements combination fire and smoke dampers, corridor dampers and fire dampers for dynamic systems are exposed to standardized heat and airflow conditions and are evaluated for dynamic closure under these conditions.

1.6 Combination fire and smoke dampers and corridor dampers shall also comply with the applicable requirements in the Standard for Smoke Dampers, UL 555S.

1.7 Fire dampers for dynamic systems are intended for use where the airflow is operational at the time of fire, such as in a smoke control system, or from other situations in which the fan system is operational at the time of a fire.

1.8 Where fire dampers are required in ducts that penetrate fire barriers and where the duct is also used as part of a smoke control system, the system designer shall ascertain which type of fire damper is appropriate for the application. Fire dampers for dynamic systems are evaluated only for dynamic closure under heated airflow conditions. Combination fire and smoke dampers and corridor dampers that have an elevated temperature rating are evaluated for dynamic closure under heated airflow conditions and they are also evaluated to operate under heated air conditions.

1.9 Tests conducted in accordance with these requirements are intended to demonstrate the performance of fire dampers during the period of fire test exposure and are not intended to determine acceptability of fire dampers for use after exposure to fire.

1.10 It is the intent that tests conducted in accordance with the test methods described herein develop data to enable regulatory authorities to determine the acceptability of fire damper assemblies for use in locations where fire resistance of a specified duration is required.

1.11 Fire dampers are intended to close automatically upon the detection of heat by the use of a fusible link or other heat responsive device.

1.12 These requirements do not cover:

- a) Performance of the fire damper assembly in walls, partitions, or floors constructed of materials other than those tested.
- b) The performance of the fire damper assembly when installed using methods other than those fire tested.
- c) Measurement of heat transmission through a fire-damper assembly.
- d) Measurement of the degree of control or limitation of the passage of smoke or products of combustion through the fire damper assembly.

A summary of the tests required to qualify dampers to the standard is as under:

Fire endurance test and hose stream test

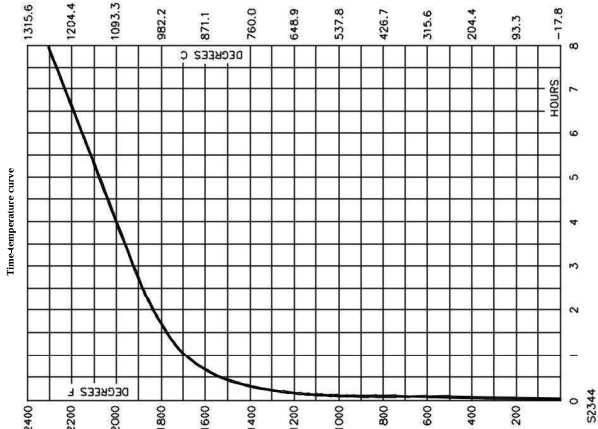
Dampers are exposed to a standard test fire for a period of either 1½ or 3 hours. This standard test fire is controlled to follow the time temperature curve illustrated. Immediately after conclusion of this fire test, the dampers are subjected to a high pressure hose stream test during which water, at a nozzle pressure of 30 psi for 1½ hour dampers and 45 psi for 3 hour dampers is applied to the dampers from a distance of 20 ft. The hose stream test provides an extreme shock that ensures the dampers are structurally strong enough to withstand the rigors of the severest fire conditions.

Operational reliability cycle test

Fire Smoke Dampers intended for operation by gravity or spring force (not driven by an actuator) must be cycled open and closed 250 times. Fire Smoke Dampers that are driven by an electric or pneumatic actuator must be cycled open and closed (by their actuator) 20,000 times. If the Fire Smoke Damper is also intended for use as a volume control damper, it must be cycled open and closed (by its modulating actuator) 100,000 times. These operational cycling tests are accomplished prior to the temperature degradation and leakage tests (described below) and ensure that the damper will function reliably after repeated operations.

Salt spray exposure test

A damper sample is exposed to salt spray in a test chamber for a period of 120 hours. After this exposure, the damper must close (and latch if a latch is provided). This test demonstrates a damper's ability to function after a more severe fouling than the damper is likely to experience during its intended application.



Smoke dampers are subject to the following test:

- 1. Cycling test
- 2. Temperature degradation/cycling test
- 3. Operation test
- 4. Air leakage test

Tests are carried out in according to the sequence as shown above on the same smoke damper.

Cycling test

The cycling test pre-conditions the smoke damper to become a used damper before other tests are carried out on the damper. A smoke damper shall continue to function as intended after being mechanically operated for 20,000 full-stroke (that is close and re-open) operations, while using the recommended actuator.

Temperature degradation/cycling test

The smoke damper (including its actuator) shall be subjected to this test before air leakage test. The smoke damper is positioned in an oven during the temperature degradation cycling test. The elevated temperatures are to be in increments of 100°F (56°C), and the minimum temperature is to be 250°F (121°C). The damper is to be exposed to the elevated temperature, ±5 percent, for 30 minutes in the completely closed position. After the 30-minute period and while at the elevated temperature, the damper shall function as intended while being operated through three complete operation cycles. The closing time shall not exceed 75 seconds nor shall the reopening time of the damper exceed 75 seconds. The damper is to be cycled by using the actuator that has also been subjected to the test temperature.

Operation test

Following the completion of the leakage test, smoke damper is then subject to an operation test at ambient temperature to rated pressure and airflow. This test is bidirectional in that the smoke damper is tested with air flow from both directions. The smoke damper shall function as intended, and without damage to the dampers or their components and shall completely close, during each of three opening and closing cycles. The test pressure/differential created in the closed position shall be not less than the Leakage Classification rating (that is 1000, 2000, or 3000 Pa)

Leakage test

The smoke damper is subject to the leakage test at ambient temperature. The amount of leakage measured during this test shall determine the leakage class of the smoke damper, in accordance to the criteria set out in table below. This test is bidirectional in that the smoke damper is tested with air flow from both directions. The smoke damper used for this test is to be the one previously subject to the Cycling Test and Temperature Degradation/Cycling Test. The smoke damper is cycled 3 times before leakage measurements are taken.

Leakage classifications

Classification	Leakage, ft ³ /min/ft ² (m ³ /s/m ² × 196), at standard air conditions		
	At 4.5 inches water (1.1 kPa)		
	I	8	
II	20		
III	80		
	At 8.5 inches water (2.1 kPa)		
	At 12.5 inches water (3.1 kPa)		
	I	11	14
II	28		35
III	112		140