



“*NADI*” Centrifugal Fans

Installation & Maintenance Manual

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1.0 GENERAL

The NADI Radial / Centrifugal fans are designed and built for industrial application. These fans are normally supplied in any one of the 9 arrangements as detailed in drawing OIM-001. The outlet orientation would be in any one of the position as illustrated in Drawing no. NADI 1084.

- 1.1 The Technical specification of the unit supplied is shown on the name plate attached to the fan unit. Further information is shown on the despatch note accompanying the units. All information should be cross checked and if doubt or clarification is required then NADI Airtechnics or its agent should be consulted. The fan will be generally as per relevant GA DRG.REF NO.....
- 1.2 All NADI FAN equipment must be installed by personnel trained in the appropriate disciplines.
- 1.3 Further a copy of this document should be placed with the fan unit before attempting installation.

1.4 **CAUTION:** Being a rotating machine the fan has the potential for causing serious injuries, if operators get close to the fan impeller blade or shaft or pulley/coupling when in operation or attempt is made to stop it by hand or any mechanical obstruction. If bird screens / shaft guard / belt guard have not been ordered and if fan is likely to operate with its rotating parts exposed or easily accessible (without protective duct / guard) then more care should be taken by operators & other individuals working in the vicinity of the fan

- 1.5 Being a fan driven by an electric motor please ensure that the earthing / wiring / the starter, the cable size and the electrical installation are in keeping with the statutory safety regulations as well as Electrical Authority / Factory Inspectors regulations with sufficient factors of safety.
- 1.6 It is further paramount that all installation and maintenance instructions are correctly and fully adhered to.
- 1.7 **Special Note:** Prior to despatch, all fan units have been inspected and mechanically run. Due consideration is given to the smooth running of the unit, electrical inputs and rotational speed. Every fan is dynamically balanced in accordance with ISO 1940 Grade Q 6.3. The Vibration are measured to be within acceptable limits of VDI 2056. The performance will be as per Tolerance specified in IS 4894 (or any other standard agreed with the customer). Hence NADI expects that if handled correctly and installed professionally then, the fan should give long trouble-free service.

(Please see section 9.9 for further information)



2.0 INSPECTION UPON RECEIPT

- 2.1** Immediately upon receipt, the fan equipment should be visually inspected for any transit damage or loss. This includes the hand rotation of the impeller within the fan casing. If damper is supplied, the free movement of the damper blades should be checked by hand and other appropriate manual tests that the customers trained personnel think should be carried out on fan accessories.

Motors, 'V' Pulleys / Couplings / Bearing blocks & Belt guards are especially prone to Transit damage and therefore these must be meticulously examined.

Transit damage to be intimated to Insurance Co. Within 24 hours of receipt.

- 2.2** Should any damage, concern or technical queries result then NADI Airtechnics, or its agents should be contacted stating fan type, NADI Job number and fan serial number.

(Please see section 5 for further information).

3. Handling & Storage (up to 4 weeks)

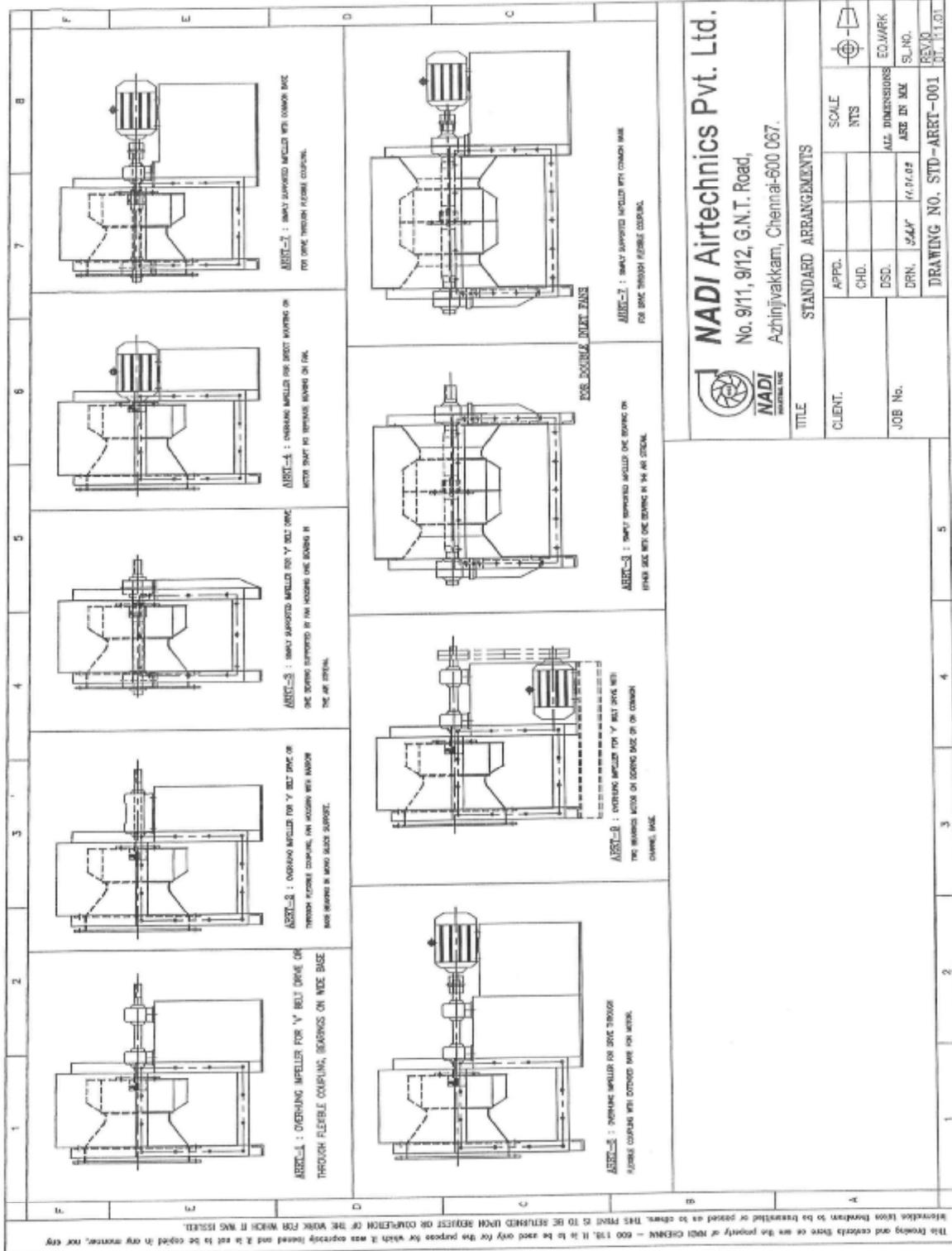
- 3.1** Please use the lifting lugs and lifting hooks provided on the fan for lifting by means of mechanical methods. Do not put lifting slings any where on the fan shaft or the impeller. Fans in Arrangement 3 & /or Double inlet fans especially, must be handled with extra care as these are more susceptible to damage by mishandling.

- 3.2** If the fan is not erected promptly after it is received, it should be stored in a dry location with the bearings and all machined surfaces, including the shaft, protected against dust, moisture, corrosion and physical damage.

- 3.3** If fan must be exposed to the elements, extreme care must be taken to protect against these elements with particular attention given to the bearings, shaft-bearing journals, impeller blades & motor.

- 3.4** It is recommended that the fan shaft may be rotated at Regular intervals (to prevent BRINELLING of bearing) and frequent inspection to be made of the equipment to verify that protection is adequate to preclude damage to the equipment or entry of water into the bearing.

- 3.5** For fans in up blast orientation (CW2 & ACW - 10) please close the fan outlet when in store or under erection. This will prevent water/other foreign matters from entering the casing.



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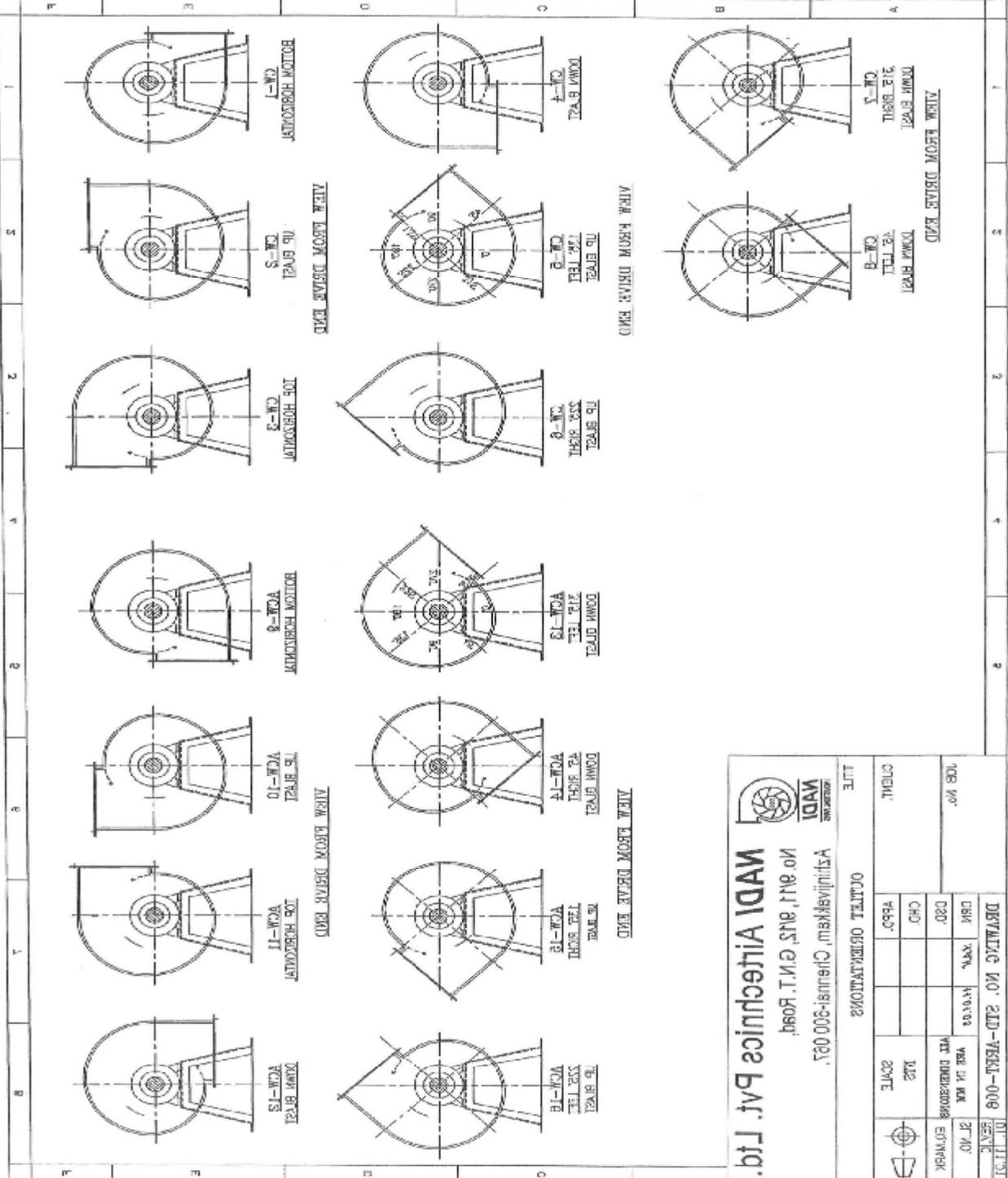
NADI AIRTECHNICS

STANDARD ARRANGEMENTS

APPRO.	SCALE	NTS	
CHD.			
DSC.		ALL DIMENSIONS ARE IN MM	ED. MARK
DRN.	1/20	1/10	SL. NO.
DRAWING NO. STD-ARET-001			REVISED

TITLE	CLIENT	JOB No.	5
STANDARD ARRANGEMENTS			

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JOB No.		DRAWING NO. STD-VKST-008		DATE	
CLIENT		OCCUPANT ORGANIZATION		SCALE	
DATE	BY	DATE	BY	DATE	BY
 MADI AIRTECHNICS Pvt. Ltd. No. 811, 812, G.N.T. Road, Azhivijayakkam, Chennai-600 087.					



4. Long Storage

If fans are required to be in store for more than 4 weeks then,

- 4.1 Fan must be stored in a covered shed and protected from rain / dust etc.
- 4.2 The fan wheel must be rotated once in 3 days and left in a different position to prevent BRINELLING of the bearing (Otherwise this may lead to Premature Bearing Failure when fan is commissioned).
- 4.3 For up-blast fan, the outlet & inlet must be closed with a steel sheet or wooden plate and bottom drain plug (if provided) must be kept open.
- 4.4 Once a month open and examine the bearing block cover to ensure that the grease is not contaminated by water or dust or become hard.
- 4.5 If fans have been in store for more than 3 months, the grease must be fully replaced and in some cases, the bearing may have to be removed, cleaned and refitted.

4.6 **Caution:** If fans are in storage for more than 4 -5 months and if above procedures have not been followed, the grease and even the bearing may require replacement. Do not attempt to start without consulting NADI or its agents.

- 4.7 Use only the correct type & quantity of grease as recommended in Section 10 "LUBRICATION".
- 4.8 Packing gland rope may have become Hard & dry. This may need to be oiled or replaced before commissioning the fan.
- 4.9 'V' Belts may require to be protected with French-Chalk Powder.

4.9A **Cautions:** Electric motors in long storage may have absorbed moisture. Do not attempt to start without removing the moisture and ensuring that the insulation resistance is at least 1 Meg Ohm. Bearing of the motor also may be affected same as Fan bearing (see 4.2 & 4.6).

Flame proof motor must be handled with special care. Contact motor manufacturer or NADI Airtechnics for this.



5. PRE-INSTALLATION - INSPECTION

5.1 INSPECTION OF THE MOTOR

- I. a) Invariably the motor is a totally enclosed fan ventilated type. Please therefore ensure that The motor Fan cover / Motor cooling fan is not damaged in transit. If it is damaged / dented then:
- b) Remove the cover and tap out the dent or replace cover as necessary. If the bolts for fixing the cover are broken, please replace them. Do run the motor only with all the fixing bolts in position & fully tight.
- c) Before refitting the cover examine the motor cooling fan to ensure that it is not damaged. Refit the cover, then rotate the motor shaft by hand to make sure that the cooling fan is not fowling with its cover.
- d) In rare cases, motor mounting foot or flange may have broken in transit. These may be checked.
- II. Check (and tighten if necessary) the 4 bolts fixing the motor to the motor Support stand.
- III. If motor has been in transit for more than 3 weeks, especially during rainy season, please check insulation value. This must be 1 meg.ohm at least

5.2 INSPECTION OF FAN

Depending on the type of FAN arrangement, different points should be considered for inspection upon receipt or pre-installation inspection.

The 4 most popular arrangements are given below:

- a. Arrangement - 4 (Drg. Nr. OIM-002) - Impeller mounted directly on the motor shaft.
- b. Arrangement - 8 (Drg. Nr OIM-002) - Impeller mounted on a shaft running on 2 externally mounted bearing and driven by a motor through a flexible coupling.
- c. Arrangement - 9 (Drg. Nr OIM-003) Overhung impeller mounted on shaft which is supported on 2 externally mounted bearings and driven through V belt & Pulley by a suitable motor. The entire assembly mounted on a common base frame of MS channel.
- d. Arrangement - 3 (Drg. Nr OIM-004 & OIM-005) Single inlet fan or double inlet fan with simply supported impeller(s) on a shaft with one bearing on either side of the impeller(s) Bearings are in the path of the air flow.



5.3 INSPECTION PROCEDURES FOR THE FAN/BLOWER IN ARRANGEMENT - 4

Relevant parts are shown in Drg. No. OIM-002

- I. Examine the fan/blower casing for external damages.
- II. Rotate the impeller by hand to ensure that it is rotating freely. If the impeller is not rotating freely, then:
 - a. Check if the motor shaft is touching the volute casing at the point of entry into the casing.
 - b. Ensure that the inlet cone is not fowling with the Impeller Front Shroud. If it is fowling, then the inlet cone and the impeller should be properly aligned by loosening and then retightening the motor bolts & inlet cone bolts.
 - c. Fans with packing gland may be a little hard to rotate due to the tightness of the packing rope. This will become free after the initial run.
- III. Check all other bolts also for tightness.

Caution:

- IV. Please use correct spanners for tightening the bolts. Avoid use of monkey spanner - pipe wrench - chisel and hammer.

5.4 INSPECTION OF THE FAN/BLOWER IN ARRANGEMENT 8

Relevant parts are identified in drawing No. OIM-002. Follow the entire inspection procedure applicable for arrangement 4 and then check the following also:

- a) If the impeller is fowling either with the volute casing or the inlet cone, then realign the impeller with the inlet cone. The inlet cone can be marginally realigned by loosening the bolts holding it to the fan inlet plate (door) i.e. Part no. 4 on the drawing. ensure that the bearing blocks (Housing) bolts are tight as they may cause lateral movement of the shaft.
- b) Please check that the coupling alignment is correct and the motor fan assembly is rotating freely (by hand).
- c) If fan is fitted with heat slinger, please ensure that the heat slinger is not fowling either with the guard or with the volute casing or with bolts of the shaft seal.
- d) Please OPEN the BEARING COVER - (ONLY ONE at a time) make sure the grease in the bearing is not dried up & there is no water or any other dust. If in doubt change the grease. Specification & Quantity of grease is given in Section 10 of this manual. Replace cover & tighten correctly AS otherwise the bearing will be damaged.
- e) If fan is fitted with single unit bearing & block assembly with sealed & self aligning bearing, it cannot be & should not be opened.



5.5 THE FAN/BLOWER IN ARRANGEMENT 9

Part list is shown in drawing OIM - 003. After going through all the steps in respect of inspection for arrangement 4 & 8, please also check the following:

- a) Is the pulley already fitted on to the fan shaft? If yes, please ensure that it is tightly fitted without lateral movement on the shaft. For pulleys with taper lock bush, ensure that the Allan bolts are fully tight.
- b) Examine pulley for transit damage. If any of the grooves are broken replace pulley. Ensure that all the grooves are clean and dry.
- c) If motor and fan pulleys are received separately packed, then identify which is the fan pulley and which is the motor pulley and mount them on to the respective shaft. Inter changing the pulleys by mistake can cause change in the fan speed. Slower fan speed may reduce the Fan performance but the higher speed could over load the motor and perhaps even damage the fan.

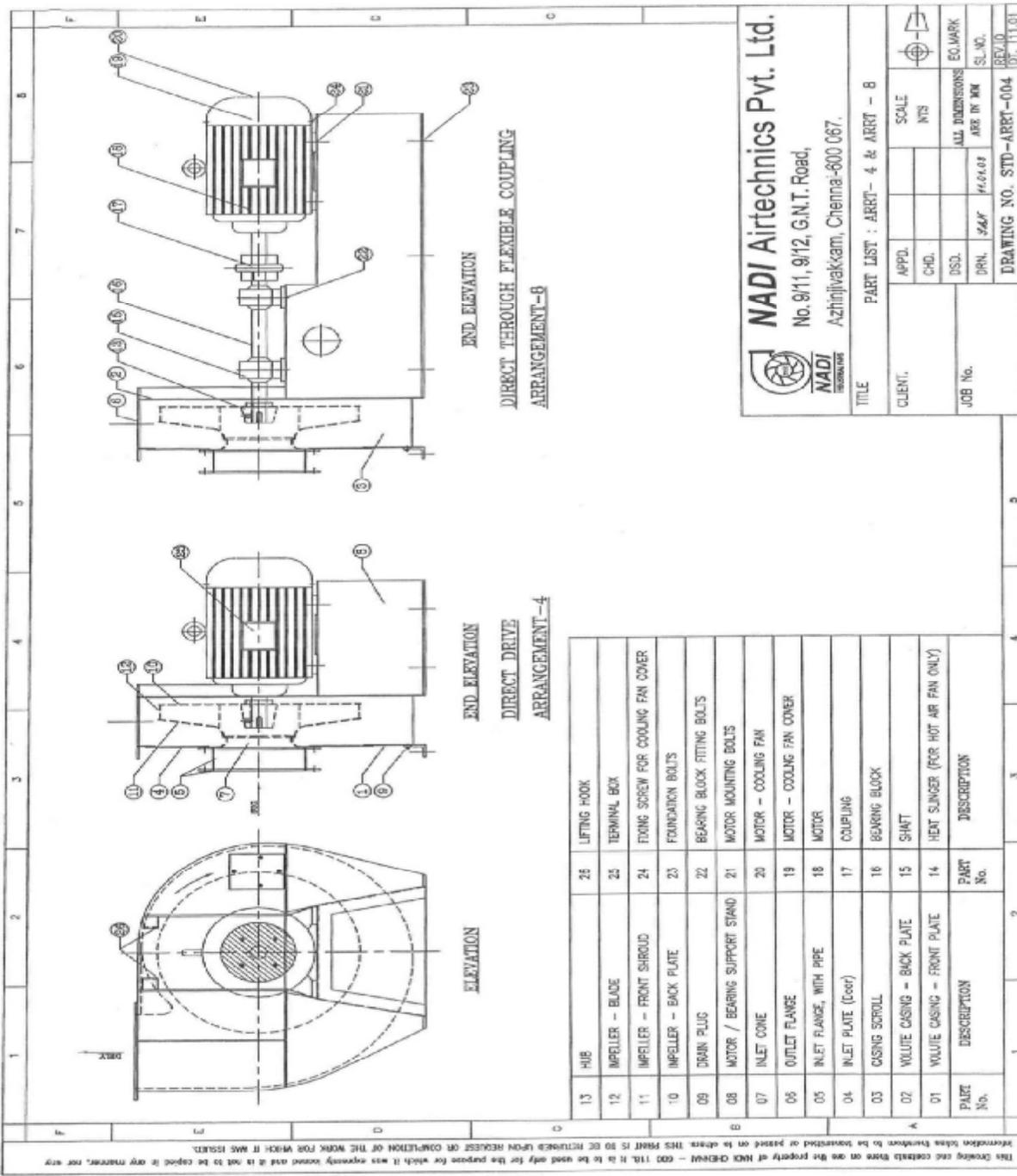
d) If in doubt please check the name plate of the fan and motor to know the respective RPM and then identify the pulleys for fan / motor.

e) Please ensure that both pulleys are properly aligned & rotating true (Without Wobbling).

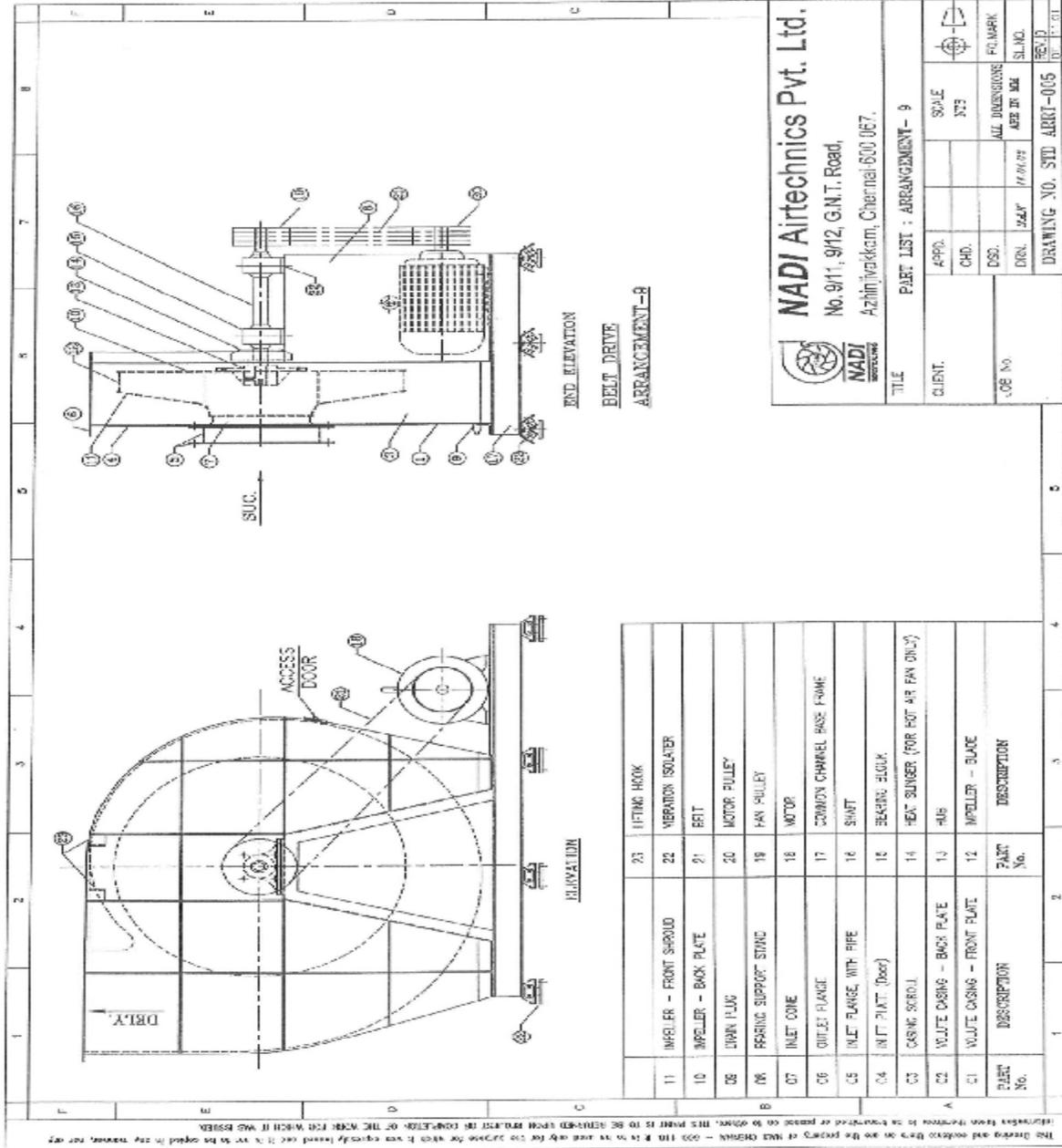
f) Also ensure that the belts are not cut or damaged in transit.

g) Ensure that you have Fenner "PB" belts of same size or if they are not "PB" belts, then the belts must have identical batch numbers to ensure that they are of same length. We only supply "Fenner" space saving wedge belts.

h) Ensure that the slide rail is not broken or damaged in transit. Once again check all bolts and nuts for tightness.



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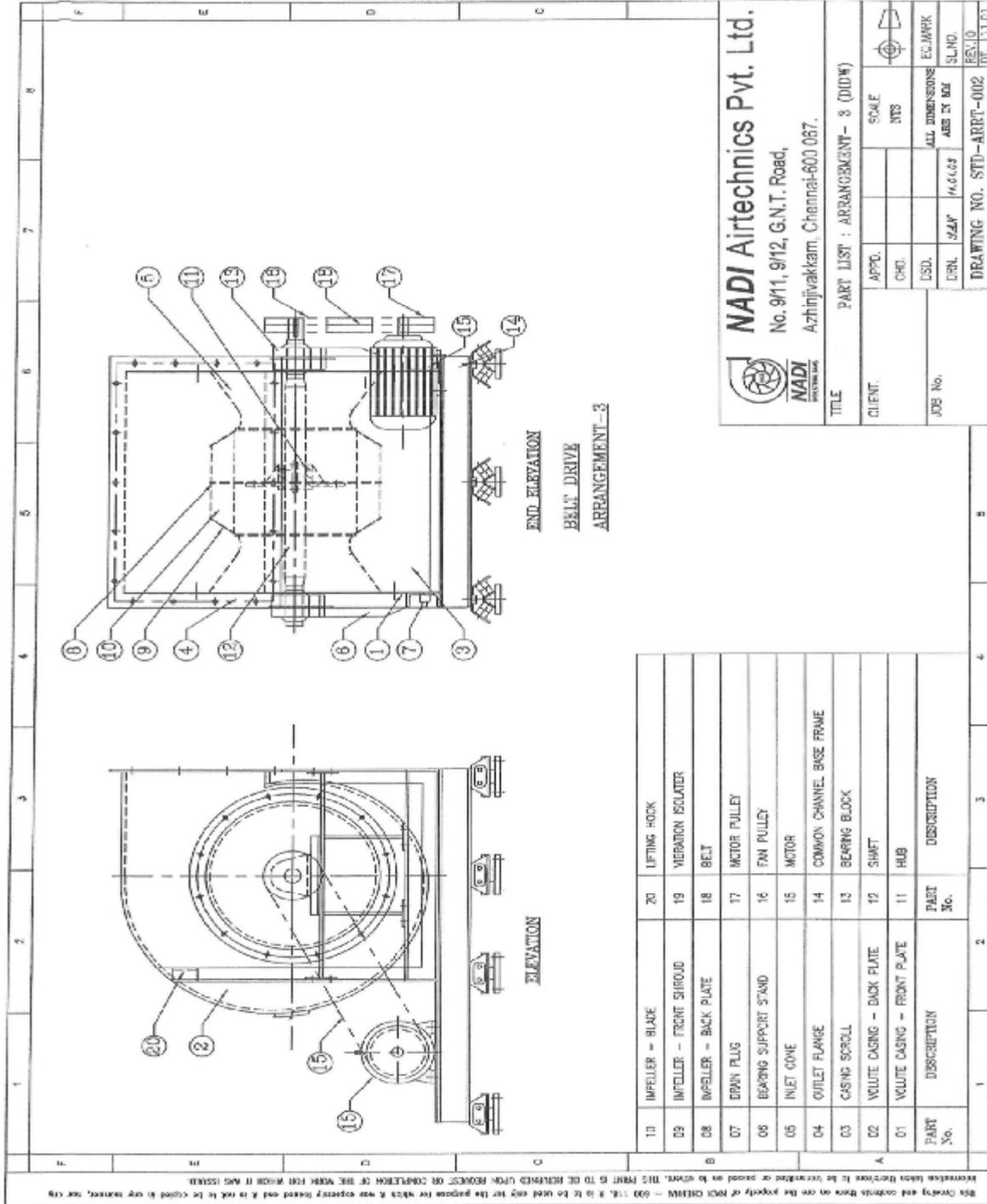
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TITLE: BELT DRIVE ARRANGEMENT- 8
 CLIENT: []
 JOB NO. []
 SCALE: 3/4" = 1'-0"
 DATE: 11/01/07
 ALL DIMENSIONS ARE IN MM
 P.O. MARK
 S.L. NO.
 REV. 10

PART No.	DESCRIPTION	PART No.	DESCRIPTION
11	IMPELLER - FRONT SHROUD	23	LIFTING HOOK
10	IMPELLER - BACK PLATE	22	VIBRATION ISOLATOR
09	IMPELLER - BACK PLATE	21	BRIT
08	DRIVE PULLEY	20	MOTOR PULLEY
07	FRAMING SUPPORT STAND	19	FAN PULLEY
06	INLET CONE	18	MOTOR
05	OUTLET FLANGE	17	COMMON CHANNEL BASE FRAME
04	INLET FLANGE WITH PIPE	16	SHIRT
03	CASING SCROLL	15	BEARING SLEEVES
02	VOLUTE CASING - BACK PLATE	14	HEAT SINKER FOR HOT AIR FAN ONLY
01	VOLUTE CASING - FRONT PLATE	13	IMPELLER - BLADE

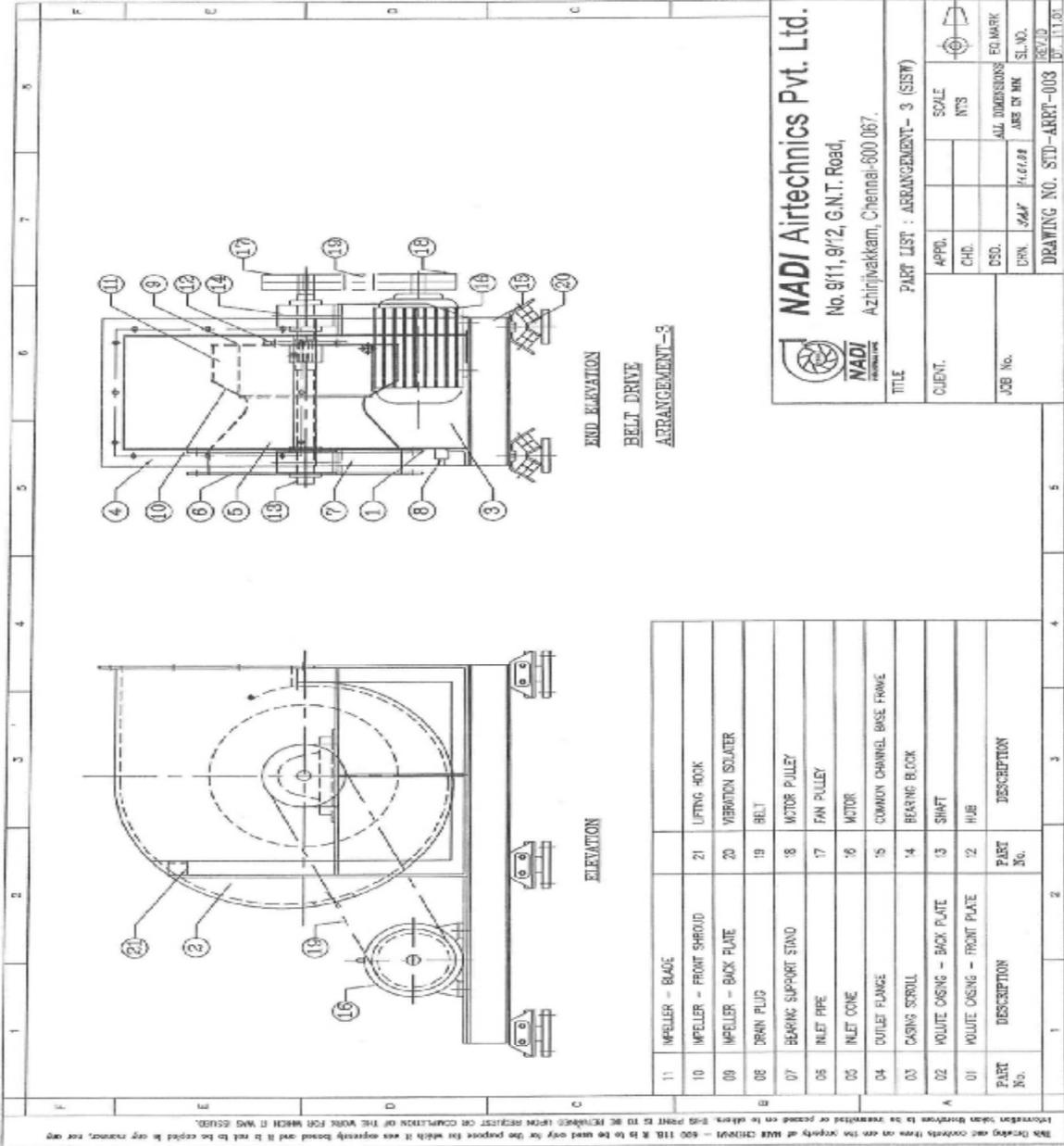


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TITLE		PART LIST : ARRANGEMENT - 3 (DDW)	
CLIENT	APPRO.	SCALE	NTS
JOB No.	CHKD.		
	USD.	ALL DIMENSIONS ARE IN MM	
	DRN.	JAF	16.6.03
			REV. NO.
			REV. 10
			REV. 11
			REV. 12
			REV. 13
			REV. 14
			REV. 15
			REV. 16
			REV. 17
			REV. 18
			REV. 19
			REV. 20

PART No.	DESCRIPTION	PART No.	DESCRIPTION
10	IMPELLER - BLADE	20	LIFTING HOOK
09	IMPELLER - FRONT SHROUD	19	VEGATION ISOLATOR
08	IMPELLER - BACK PLATE	18	BELT
07	DRUM PLUG	17	MOTOR PULLEY
06	BEARING SUPPORT STAND	16	FAN PULLEY
05	INLET CONE	15	MOTOR
04	OUTLET FLANGE	14	COMMON CHANNEL BASE FRAME
03	CASING SCROLL	13	BEARING BLOCK
02	VALUTE CASING - BACK PLATE	12	SHAFT
01	VALUTE CASING - FRONT PLATE	11	HUB
PART No.	DESCRIPTION	PART No.	DESCRIPTION

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PART No.	DESCRIPTION	PART No.	DESCRIPTION
11	IMPELLER - BLADE	21	LIFTING-HOOK
10	IMPELLER - FRONT SHROUD	20	VIBRATION ISOLATOR
09	IMPELLER - BACK PLATE	19	BELT
08	DRAIN PLUG	18	MOTOR PULLEY
07	BEARING SUPPORT STAND	17	FAN PULLEY
06	INLET PIPE	16	MOTOR
05	INLET CONE	15	COMMON CHANNEL BASE FRAME
04	OUTLET FLANGE	14	BEARING BLOCK
03	CASING SCROLL	13	SHAFT
02	VOLUTE CASING - BACK PLATE	12	HUB
01	VOLUTE CASING - FRONT PLATE		
	DESCRIPTION	PART No.	DESCRIPTION

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TITLE: PART LIST : ARRANGEMENT- 3 (SISF)
 CLIENT: SCALE: NTS
 DSD: ALL DIMENSIONS EG MARK
 DRN: 564F /16/108 ARE BY MM SL NO.
 DRAWING NO. STD-ARRT-003 REV 20
 BY: TJJBL



5.6 Fans in other Arrangements

All other fan arrangements are derivation of one of the 4 arrangement mentioned above.

5.7 In double inlet fans or in arrangement 3 the impeller is mounted between 2 bearings and therefore one or both the bearings are in the path of the air flow. Hence it is doubly important to check that the bearing covers are fully tight and all the bolted support structures of the fan are fully tight.

6. General Erection Instruction: Foundations

6.1 A plan view of the base of the fan with foundation bolt pockets is given in the GA drawing with all essential dimensions. The fans must be mounted on a rigid and substantial foundation. Poured concrete, suitably reinforced should be used in the construction.

6.2 The foundation should weigh at least five times the weight of the supported equipment. The bottom of the foundation should be longer and wider than the finished top. Vertical sides can be used with a good footing course. An allowance for not less than 20 mm for grouting should be made when the top level of the foundation is being determined.

6.3 Suitable anchor bolts should be located accurately before the concrete is poured. When determining length of bolts required, allow for 30 - 40 mm for grout and overall leveling as well as nut thickness and extra threads for draw down. Pipe sleeves/foundation pockets should be provided around the anchor bolts to permit minor bolt adjustment after concrete has cured. If fans are not installed at ground level and it is necessary to use masonry or steel foundations, the 5:1 mass ratio should be observed. This foundation must be heavy enough to afford permanent rigid support and to absorb the normal amount of vibration that may develop from any cause. Installation should be located as near as possible to main supporting columns, structural beams or walls.

6.4 **Caution:** If fans are mounted on steel structures, these should be designed to take the combined Static & Dynamic load of the fan, motor & accessories. In this case, Anti Vibration mounting (Dunlop Cushy foot) may be used to achieve 70 - 80% isolation of vibrations.



6.5 FRICION PAD

In case friction pads are used these should be placed between the surface of the foundation platform and bottom of the fan base (or common channel base as the case may be). Friction pads are only to be used in conjunction with the restraining bolts.

6.6 ANTI-VIBRATION MOUNTING (Dunlop cushy foot)

If anti vibration mounting (Cushy foot) is used, then the bottom of the cushy foot should be fixed to the level floor with suitable screws in order to arrest movements of the cushy foot while lowering the fan. Please study the cushy foot catalogue and ensure that all cushy foot are placed in the same orientation with respect to the direction of vibrations, Cushy foets absorb vibration only when deflected in one direction.

6.7 CURING

Assuming that the machine foundation platform has already been cured, the concrete inside the foundation pockets should be allowed to cure properly before commissioning the fan.



7. Fan Locations & Ducting connection

- 7.1 The fan must be located at an appropriate place keeping in mind its noise level. Proximity to sensitive area / operators / source of fresh air supply & ease of access for inspection & maintenance.
- 7.2 Particular attention must be paid to its location with respect to other equipment which may generate heat or vibrations which can affect the fan bearing / belts / other parts.
- 7.3 In the case of SISW Fresh air supply fan, please ensure that the distance between open fan inlet and nearest wall / obstructions is equal to 1D (where D is the Diameter of the fan impeller).
- 7.4 Sometimes, DIDW fans are placed inside a room with 3 side of the room closed and one side acting as a filter area through which air enters the fan. Here also, the above (7.3) distance / location from walls should be maintained.

7.5 **Caution:** Be extremely careful when opening the door of rooms housing DIDW fans mentioned above (7.4). These may either open or close with a sudden force depending on the direction of opening. Such door may be provided with big shutters / windows which should be opened before opening the door. This will reduce the air pressure on the door due to the fan suction. The window can be closed after the door is closed.

8. Pre-Commissioning Checks

8.1 Assuming that the equipment has been installed in accordance with the foregoing instructions as well as those of the manufacturers of components, and that a check has been made for tightness of all hardware and mounting bolts, the fan will be ready to operate after some final safety checks to prevent injury to personnel or damage to the equipment.

8.2 Accessories / Ducting

a. Please ensure that belts are properly aligned and tensioned as otherwise there could be temperature-rise or premature failure. Estimated drive loss figures reproduced from AMCA Publications are enclosed.

b. Flexible canvas or Metallic bellows (for higher temperature) must be used to connect the ducting's with fan inlet / outlet or both. This will not only take care of minor misalignments, but also isolate the Fan / Duct vibrations from each other.

c. Ducting & Accessories must be suitably supported to ensure that its weight is not taken by the fan inlet & outlet flanges.

d. Ensure that dampers are secured & operating properly.

e. Ensure that filter / filter frames & flexible joints are secured well and have no chance of getting sucked into the fan.

8.3 **CAUTION:** Fan performance can be greatly reduced if inlet ducts & outlet ducts are not properly connected. Please see annexures to this manual, wherein copies of certain AMCA Publication are reproduced with suggested ducting connections.



- 8.4
- a. Check bearings for tightness of fasteners / alignment, proper lubrication, cleanliness, burrs or corrosion and pipe connections for cooling systems (Where applicable).
 - b. Check keys and wheel set screws for tightness. Check foundation bolts for tightness.
 - c. Check inside the fan housing and duct work for extraneous matter and debris, such as bolts, nuts, washers, piece of cotton, wood and or concrete cement.
 - d. Secure all access doors.
 - e. Turn impeller over by hand if possible to see that it rotates freely.
 - f. Ensure that 'V' Belts are tight and you have a matched set.
 - g. Check impeller position for proper clearance at inlet.
 - h. Close inlet volume control and/or dampers to lessen starting load on the motor.
 - i. Ensure that 'V' pulley grooves are clean.
 - j. Please ensure that there is no dust - cloth - waste - or any such foreign particle inside the fan casing or in the gap between the motor fan cover and the motor cooling fan.
 - k. In the case of V belt driven fan please ensure that the V belt alignment is proper and the belt tensions are in accordance with installation and maintenance provided by the respective manufacturer.

8.4A Water Cooling Jackets (WCJ)

Water cooling jackets are by and large obsolete in most parts of the world as they have been effectively replaced by more reliable Heat slingers which requires little or no maintenance. If, however WCJ is specifically provided, please ensure that the water supply is steady and well controlled. Normally this should not exceed 3 - 5 liters/min. (Depending on fan size / temperature / speed). Gravity flow is enough. If excess pressure or amount of water is supplied, the water will leak through the sides and enter the bearings. If this happens, remove and clean the bearing as well as the grease. In Water cooling jackets with a packing gland (with adjustable nut), a slight leakage of water is permissible as long as this does not get past the retaining disc and enter the bearing.

Caution: If fans are covered with glass wool insulation, please leave a tip clearance equal to $1/2 D$ between the heat slinger periphery and the beginning of insulation, so as to allow free air flow (D =diameter of heat slinger). Please also ensure that insulation thickness does not protrude beyond the heat slinger front face.



8.5 Electrical Connections

Before energising the motor please ensure the following:

- a. The motor used is of the rated Horse Power, Speed and Voltage.
- b. The electrical cable used should be designed to withstand the starting current as well as the full load current of the motor when in operation.
- c. Please ensure that the correct type of starter (DOL or Fully automatic star delta or auto transformer starter) have been used in accordance with our recommendations Consult motor manufacturers for specific application.
- d. It must be noted here that the starting current will depend on the type of starter used. It could be 6 times the full load current in the case of a DOL starter, 3 times of full load current in the case of Star Delta Starter and twice the full load current in the case of auto transformer starter.

8.6 Caution: The following guide line may be useful but customers are advised to consult our engineers or motor suppliers for correct starter recommendation.

8.7 DOL Starter

This is recommended for all fans up to 3 HP and fans in arrangement 4 up to 20 HP provided that adequate power supply is available for taking care of the starting current.

8.8 Star Delta Starter

When a fully automatic Star Delta starter is used it must conform to the following description: "fully automatic star delta starter with a 60 seconds timer with overload relay bi-passed in the star connection."

- 8.9
- a. The over load relay should be of adequate capacity to protect the motor against over load in the delta connection.
 - b. A 60 seconds timer is suggested because many fans requires at least 40 seconds to reach the required speed before changing from Star to Delta. But often the starter would trip within the first 30 Seconds itself. That is why a star delta starter has to conform to the specifications given above.
 - c. By trial and error, you can set the starter timer, so that it changes from Star to Delta at the right speed (not too soon or not too late).
 - d. Details of starting time & starting current etc observed during FACTORY runs can be obtained from NADI.
 - e. Auto transformer starter is to be used only under certain special condition and must be installed in consultation with us as well as the motor manufacturer.

8.9B CAUTIONS:

- a. Please ensure that the motor and the fan are individually & separately earthed.
- b. If motor takes longer than 40 seconds to accelerate to required speed, please stop further trials and contact NADI or its agents or Motor manufacturers.



9. Commissioning

- 9.1 Close the inlet damper and start the fan only for a few seconds to ensure that it is rotating in the right direction as indicated by the arrow on the fan casing.
- 9.2 Start the fan with the correct starter as specified in Section 8, keeping the inlet closed but the outlet opened to the atmosphere. In the case of star delta starter, please set the timer for changing from star to delta in 30 seconds or as specified by us for specific cases.

9.2A Caution:

SAFETY FIRST: Stay away from the open inlet / outlet of the fan when starting. Do not attempt to peep into the fan for a view of the running impeller. Stay away from Heat slinger / Belts / Pulleys & shaft when in motion.

- 9.3 The fan should now run freely without tripping (with damper closed). Run the fan for 10 minutes to ensure that there is no unusual noise, or fowling of stationery parts with rotating parts. In case of any unusual sound STOP Fan at once & examine the cause (or contact our representative).
- 9.4 Switch off the fan, carry out the necessary correction/rechecks and restart the fan after 10 minutes once again with the damper fully closed.

9.5 Caution:

Please do not stop and restart frequently as this may damage the motor and / or cause the starter to trip. Permissible no. of starts/ hour for each motor varies according to size and duty conditions. Please refer motor manufacturer's instruction as otherwise you may damage or burn the motor.

- 9.6 If the fan is not connected to the system the damper may be opened gradually while carefully noting the current consumption of the motor to ensure that it does not exceed the full load current of the motor.
- 9.7 Once the full load Current is reached the damper should not be opened beyond this point. In the case of high pressure fans (MHP series, P-50 & P-56 series) & Forward curved fan, there will be specific warning on the fan advising that the fan should not be run with the outlet open to atmosphere. This warning also means that if a damper is provided on the suction side the same should be gradually & partly opened (as above) keeping an eye on the current consumption. Such fan will consume excess power if the system resistance is less than specified.
- 9.7A The over load relay on the starter must be set to trip the motor at 5% overload.
- 9.8 Please ensure that the motor is protected against single phasing.



9.9 Permissible limits:

A. Fan performance:

As per IS 4894, the following tolerances in performance are permissible.

Air volume	-5%
Speed	±10%
Power input	+10%

B. Vibrations:

As per VDI guidelines 2056, maximum permissible vibrations in mm/sec. are as follows:

a.	For fans up to 15 KW	: 4.8 mm/sec.
b.	For fans between 16 - 75 KW	: 7.1 mm/sec.
c.	For fans between 76 - 300 KW	: 11 mm/sec.

These vibrations to be measured on the Fan Bearings with the Fan secured firmly on a solid foundation.

C. Bearing temperature:

For fans handling normal air and lubricated with Lithium soap based grease (Castrol AP2 & AP3 grease), the max. permissible temperature is 85°C (bearing outer rase)

For ID fans & Hot air fans and lubricated with Molycote High temperature grease , the max. Permissible temperature is 120°C at the bearing outer rase. In this case, it will be a C-3 clearance bearing. In certain cases, max. Permissible temperature can be 150°C also. Please refer NADI for this operating condition.

10. Lubrication:

10.1 Please use correct quantity and type of grease as per chart enclosed.

For fans handling normal air : Use Castrol AP2 / AP3 grease

For ID fans & Hot air fans : Use Molycote High temp. Grease capable of withstanding temperature up to 150°C.

10.2 Frequency of relubrication (complete change of grease) depends on the type and size of the bearings as well as speed (RPM) of the fan and its duty condition. Please see enclosed Re-lubrication chart.

10.3 Spherical roller bearings require to be relubricated most frequently. Typically, a 45 mm size bearing (22209 K) running at 2800 RPM would need to be relubricated once in 800 hours.

10.4 **Cautions:** Excess / in sufficient lubrication can both cause problems. The effect can be seen from the Time - Temperature graph enclosed herewith.

10.5 Frequency of relubrication should be as indicated in the enclosed chart.



11. Fan Maintenance

Due to different periods of operation, no rigid inspection and maintenance period can be recommended. It is suggested therefore that inspection and if necessary fan cleaning (by non-abrasive means) is carried out at regular intervals of at least 700 running hours or once in 2 months, whichever is sooner.

All fasteners of whatever type should be checked for tightness. The integrity of the rotating items should be checked.

Inspection of parts for wear should be made at regular intervals depending on site conditions but not less than three times each year. In a dust laden atmosphere, internal parts should be checked for possible erosion and dust accumulation on impeller blades once in a week or more if required.

Periodically check the rubber tire of the flexibling coupling for wear /undue temperaturise.

Periodically check and adjust the tension of the V Belts and also the temperaturise of the V Pulleys which is sure indicator of the condition of the V Belt drive system.

RUBBER-LINED / FRP LINED FANS:

Depending on the nature of application, fans must be frequently inspected and if necessary cleaned to remove the deposits of powder / dust / foreign material on the impeller.

As these fans are normally used in corrosive atmosphere, it is absolutely essential to ensure (by frequent inspection) that the lining is not damaged / cracked.

CAUTION: In continuous process plants, it is essential to periodically check bearing temperatures and vibrations as these are sure indicators of impending trouble. A timely stoppage of even a short duration may not only save expensive bearing & other parts but also prevent an unplanned major shut down.



12. Trouble shooting:

12.1 Excessive vibration:

Should excessive vibration develop check the following possibilities:

- a) Build up of dirt or foreign matter on wheel especially for ID fans, Rubber-lined / FRP lined fans.
- b) Sometimes fine balance weights made up of rubber and stuck to the impeller might have flown off leading to unbalance (for Rubber Lined Fans only).
- c) Bolts on bearings, Housings and motor loose.
- d) Ducting loads transferred onto the fan inlet / outlet.
- e) V belt drives improperly aligned, belts must have proper tension, pulleys must be balanced
- f) Check bearing clearance and alignment.
- g) Check coupling alignment.
- h) Check wheel for tightness on the shaft.
- i) Has foreign matter entered fan, causing damage to wheel shaft or bearings?
- j) Is the vibration coming form a source other than the fan? Stop the fan and determine if the vibration still exists. Disengage the motor from the fan and operate it by itself to determine if it produces vibration.
- k) Is shaft / impeller / pulley moving laterally?

12.2 Motor overloading / drawing excessive current:

If motor is overloading, please check if,

- a) Voltage & frequency are within limits.
- b) Fan rotation in right direction.
- c) Belts are not too tight.
- d) System resistance is reduced / there are leaks in the ducting or some inspection door has been left open.
- e) Bearing are seizing.
- f) Packing gland is too tight or impeller / shaft rubbing somewhere.



- g) Some wire connection (terminal screw) is loose or incoming cable is undersized.
- h) In ID Fans, motor might be selected for hot start and air temperature may be less than specified.

CAUTION: Please shut down fan immediately, if,

- a. Motor continuously overloading.
- b. Unusual noise or vibration on fans.
- c. Bearing vibrations / temperature is 15% more than specified permissible limits(Sec.9.9).
- d. Slightest lateral movement of shaft or pulley or impeller is observed.

12.3 Pulsation or surge in fan / ducting's:

This phenomenon particularly comes in High Pressure fans.

- a) When fan is throttled/ air delivery restricted causing fan to operate in the surge region / poor point of rating on the curve.
- b) Fan is too large for the application.
- c) Ducts vibrating at same frequency as fan pulsation
- d) Distorted inlet flow.



12.4 Insufficient AIR flow:

- a) Impeller installed or running backward in the wrong direction.
- b) Incorrect fan speed.
- c) Impeller not centered with inlet collar / inlet cone.
- d) Impeller / fan inlet dirty or clogged.
- e) Inlet flexible canvas blocking the airflow.
- f) Inlet guide vane damper improperly set.
- g) System resistance more than specified.
- h) Dampers closed.
- i) Duct internal insulation / lining come loose.
- j) Filters clogged.
- k) Duct velocities too high.

12.5 Insufficient Static pressure:

- a) Fan inlet and/or outlet conditions not same as when tested to IS 4894.
- b) Fan speed too low.
- c) Belts may be slipping.
- d) Motor speed may be wrong.
- e) Impeller running in the wrong direction.
- f) System resistance to flow less than estimated. This is a common occurrence and fan speed may be reduced suitably.
- g) Gas density less than specified due to higher temperatures.
- h) Improper running clearance between inlet cone and impeller front shroud.



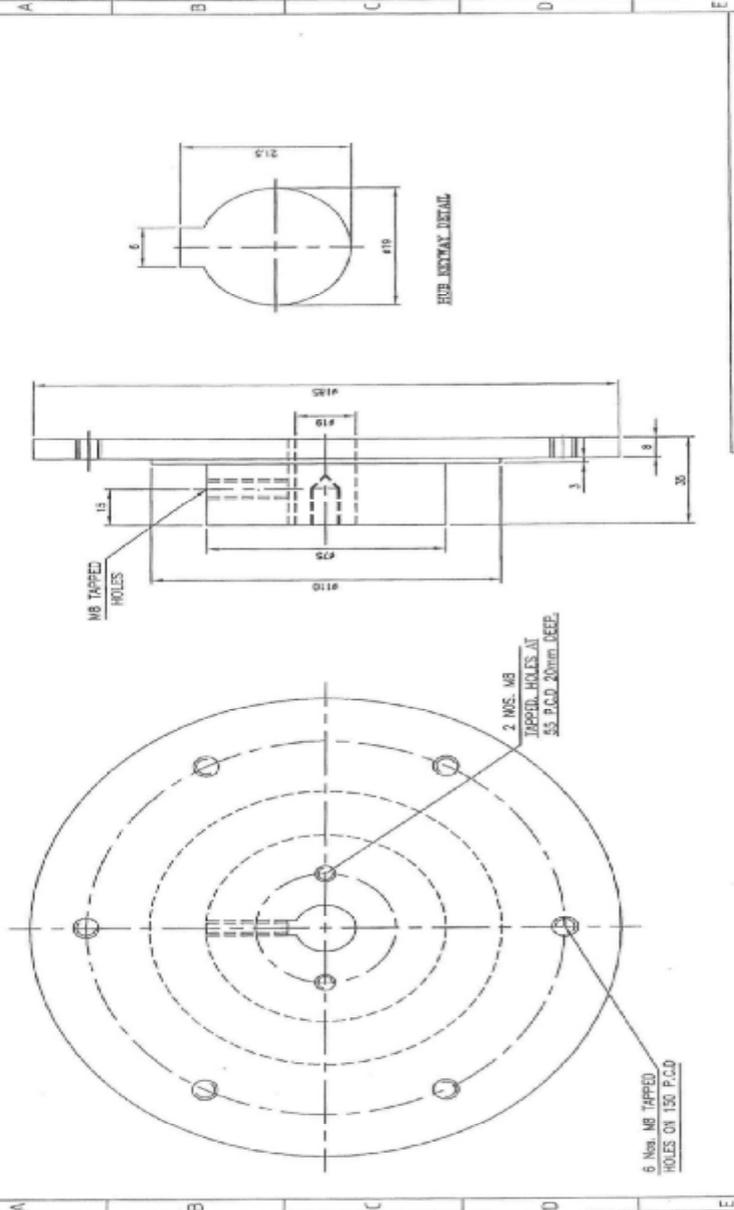
12.6 Recommended spares for Clean AIR Fans :

- a) Bearings / Adopter Sleeve & Bearing Housing. (Set)
- b) V - Belts / Coupling Tyre.
- c) Grease.
- d) Fuse & Starter Relay.

12.7 RECOMMENDED SPECIAL INSTRUMENTS FOR CONTINUOUS PROCESS PLANTS :

- a) Digital Thermometer for measuring Bearing Surface Temperatures.
- b) "BALMAC" Portable Vibration Meter for measuring the velocity of vibrations.

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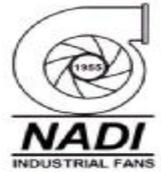


NADI Airtechnics Pvt. Ltd.
 No. 9/11, 9/12, G.N.T. Road,
 Azhivakkam, Chennai-600 067.

TITLE		HUB DETAIL OF PHX-150, CW-3	
ID NO:	APPR.	SCALE :	1 : 1
JOB NO:	CHKD.	ALL DIMENSIONS	ARE IN MM
DRAWING NO. 150-B	DRN.	SAN	11.01.03
REV. NO. 11.03		REV. 11.03	

REV	DATE	DETAILS OF REVISION
X	XX	XXX
1	15.01.03	ISSUED FOR MANUFACTURE
2	15.01.03	ISSUED FOR MANUFACTURE
3	15.01.03	ISSUED FOR MANUFACTURE
4	15.01.03	ISSUED FOR MANUFACTURE
5	15.01.03	ISSUED FOR MANUFACTURE
6	15.01.03	ISSUED FOR MANUFACTURE
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29	15.01.03	ISSUED FOR MANUFACTURE
30	15.01.03	ISSUED FOR MANUFACTURE

SUGGESTIONS FOR BETTER OPERATION AND PERFORMANCE



Proper fan installation, obtaining the best possible inlet and outlet conditions, will pay dividends in fan performance.

The ideal fan installation would have an open inlet or straight inlet duct and a straight discharge duct. Ideal conditions such as these are not always attained in actual installation.

When ideal conditions must be modified, the best arrangement for proper air flow should be considered.

Elbows and changes in duct section are the common problem involved.

The use of an elbow at the fan inlet causes non-uniformity of flow and may affect the fan performance seriously. Elbows located near the fan outlet can result in high pressure losses.

Allow as much straight ducts as possible between the fan and elbow; at least 1 or 2 duct diameters is preferred. Turning vanes will greatly improve elbow conditions at either fan inlet or outlet by maintaining a more uniform air velocity around the turn, thus reducing turbulence losses, and increasing fan performance.

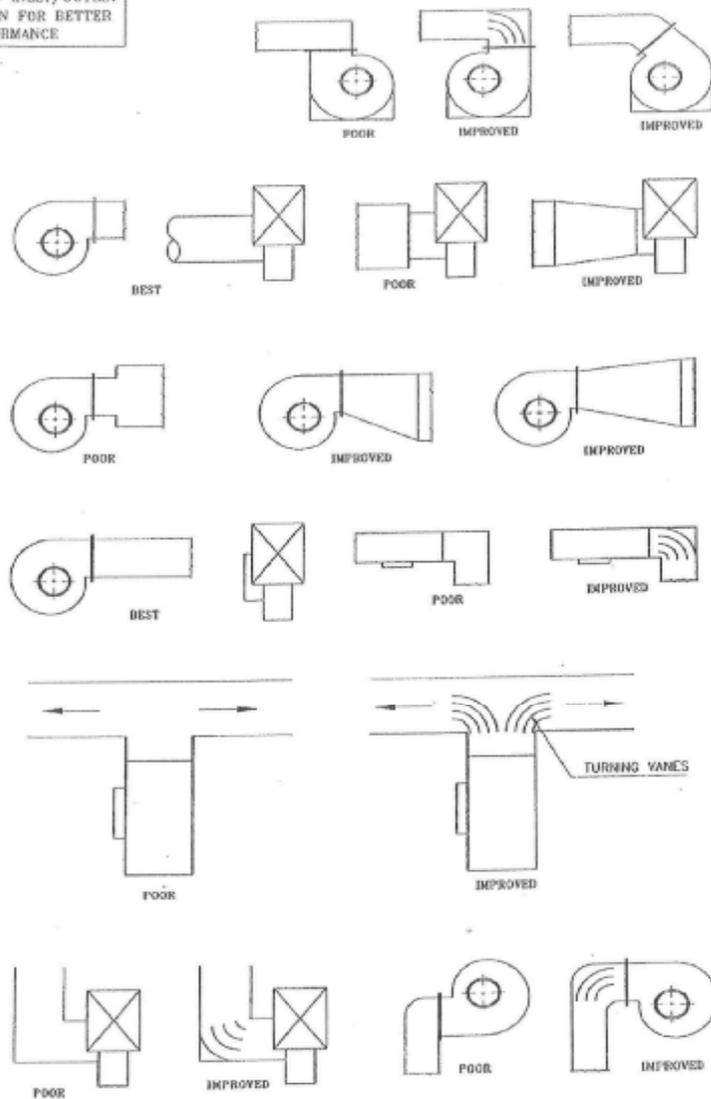
Abrupt changes in duct section should be avoided. In an abrupt contraction, the flow contracts due to the sharp edge and then expands again to fill the smaller duct with resulting loss. The shock loss in an abrupt enlargement is due to the widening jet of air into the larger duct. Gradual area changes offered by a cone transformation piece are preferred. The sketches illustrate poor and improved duct connections.

Flexible connections should be used to connect ducts to fan inlet and outlet. Unpainted canvas, rubber or other flexible connections must be used.

A fire resistant material should be used if a fire hazard exists. When fan is mounted on a floating base, flexible connections must be used.

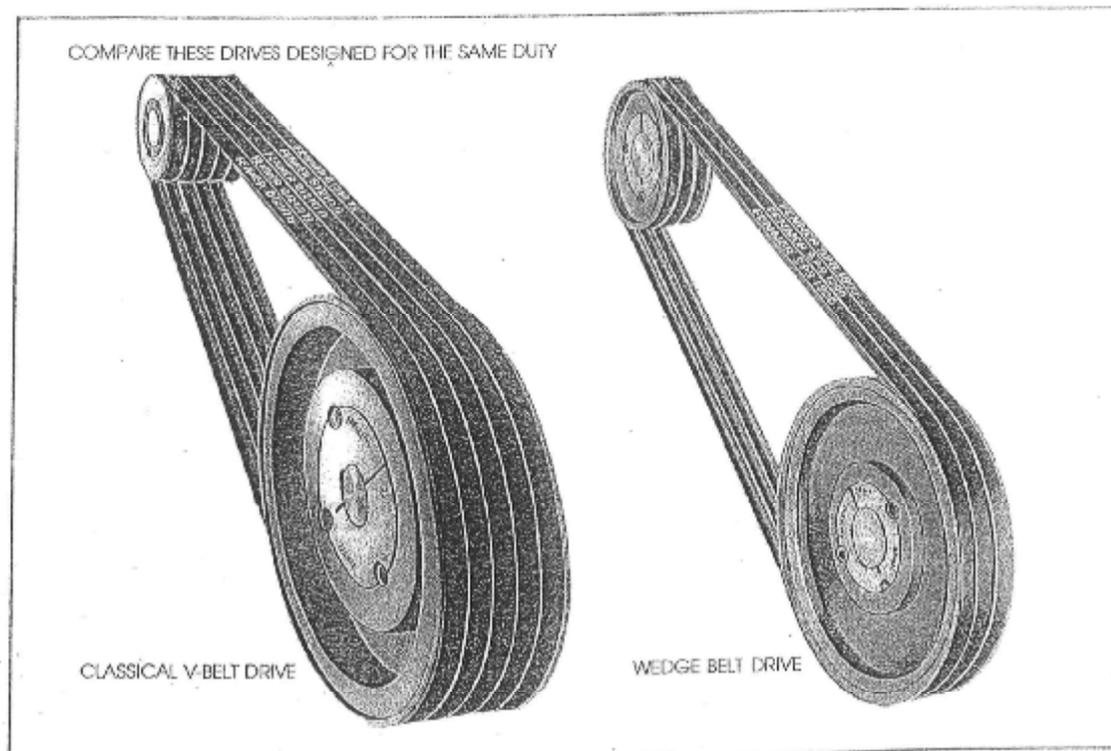
Access doors in duct connections should be provided for maintenance of the inlet bearing on arr. 3 fans and for inspection and maintenance of rotors.

SUGGESTED INLET/OUTLET CONNECTION FOR BETTER FAN PERFORMANCE



NADI Airtechnics Pvt. Ltd.
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 Azhngivakkam, Chennai-600 067.

Fenner Wedge Belt Drives



As manufacturers of both belts and pulleys, Fenner has experience unrivalled anywhere in the world in matching one to another as complete drives.

Continuous research work and efforts in development of V-Belts have been made to introduce the latest type of Spacesaver Wedge Belts. This line of Wedge Belt Drives is engineered to utilise to the full, all the performance capabilities of modern man-made fibres and synthetic rubbers. In combination with Dual-Duty Taper-Lock® Pulleys machined to close limits from high grade materials, these Wedge Belts result in drives which are extraordinarily compact. They are capable of handling even more than twice as much power in a given space as traditional V-Belt Drives.

Many V-Belts fail because the load-carrying cords do not retain their designed and correct position under tension. Cord movement also sets up internal friction and heat — a sure belt destroyer. Narrower belts can — not buckle so easily and there is increased support for the tension members in Wedge Belts. Special Polyester Cord Cables provide the strength and flexibility needed for the immense load carrying capacity of these small sections, and an exclusive process of banding the cables to the rubber element of the belt ensures that all parts of the belt act in unshakable union under conditions of the severest flexing.

Four sections of Wedge Belts: SPZ, SPA, SPB and SPC conforming to B.S. 3790 are available which can transmit upto 480 kW of power with our standard stock size Taper-Lock® Pulleys. Higher powers can be transmitted with specially made non-standard through-bored Pulleys.

The benefits of Wedge Belts go beyond compactness and low initial cost. Every Wedge Belt is highly resistant to heat, oil and exposure to weather and has adequate electrical conductivity to deal with normal static hazards.

The design engineer benefits from other spacesaving opportunities — guards will be smaller, narrower pulleys will reduce overhung, thus bearing life is improved.

For some of the heavier drives, even if designed with Fenner PB V-Belts, it is not always possible to fit the pulleys directly on the driving/driven shaft because of considerable amount of overhung and as such a Jackshaft arrangement is invariably required, which means extra space and expenditure. A Wedge Belt Drive will overcome these difficulties in most of the cases.

Installation and Operation of Belt Drives

BELT MATCHING AND LENGTH CODING

On those applications, where coded belts are being fitted, it is important to ensure that the belts are used in matched sets. The code number, which is printed on the belt close to the label, indicates the actual length related to the nominal length. Each 2 mm variation from nominal length is represented by one unit above or below the number 50. For example, C4013 Belts with code number 53 have an actual pitch length of $(4013+6) = 4019 \text{ mm} \pm 1 \text{ mm}$.

Care should be taken to ensure that matched sets fall within the following limits.

Belt Pitch Length	Code Spread
upto 1250 mm	2 mm
1251-1760 mm	4 mm
1761-2500 mm	6 mm
2501-3730 mm	8 mm
3731-6860 mm	10 mm
6861-9140 mm	12 mm
9141 mm and over	14 mm

The above allowances correspond to those in B.S.S.1440 : 1971.

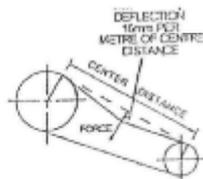
INSTALLATION

In assembling a drive, the motor or prime mover should be moved toward the driven unit so that the V-Belts may be placed in their respective grooves by hand. The allowances below should be available for adjustment of the centre distance.

Under no circumstances should V-Belts be forced on to pulleys with crowbars, wedges, screwdrivers, or any other type of implement. Such procedure would tend to cause the outside jacket or inside cords, or both, to rupture. It is possible for the inside load carrying cords to be broken by forcing over the grooves, without this being evident from the outside appearance of the V-Belt. Such V-Belts fail completely during the first few hours running.

When the V-Belts have been placed in the pulley grooves, the motor or prime mover should then be moved away from the driven unit to apply uniform tension to the V-Belts.

TENSIONING



- (1) Measure the centre distance.
- (2) At the centre, apply a force at right angles to the belt to deflect one belt 16 mm for every metre of centre distance.
- (3) Compare this force with values in the table below.

V-Belt Section	Force required to deflect V-Belt 16 mm per metre of centre distance	
	Kilogramforce(kgf)	Newton (N)
A	1.0 to 1.5	10 to 15
B	2.0 to 3.1	20 to 30
C	4.1 to 6.1	40 to 60
D	7.1 to 10.7	70 to 105
E	12.7 to 18.3	120 to 180

If the measured force falls within the values given the drive tension should be satisfactory. A measured force below the lower value indicates undertensioning. If the force is higher than the upper value the drive is overtensioned; however, a new drive should be tensioned to near the higher value to allow for the normal drop in tension during the running-in period. After the drive has been running for a few days the V-Belts will have seated in the grooves and the drive tension should be re-checked.

Make adequate provision for tensioning the belts during their life.

VENTILATION

Where guards are necessary it is desirable to use the wire screen type rather than air-tight covers so as to permit free circulation of air.

STORAGE

V-Belts should be stored in a dry stock room and contact with hot pipes and direct sunlight carefully avoided.

Where possible, hang the belts loosely in single (or triple) coils. Always avoid tying them tightly with thin string.

TROUBLE SHOOTING

Small Cracks on V-Belt side and base

Generally caused by excessive heat and chemical fumes. The heat may be generated by a shortage of belt tension.

V-Belt swelling or softening

Caused by excessive contamination by oil, certain cutting fluids or rubber-solvent.

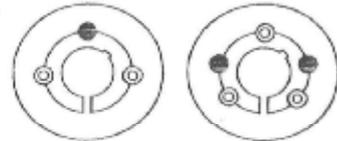
Whipping during running

Usually caused by incorrect tensioning, principally on long centre drives. If a slightly higher (or lower) tension does not cure the problem there may be a critical vibration frequency in the system which requires re-design or a banded belt. Consult Fenner.

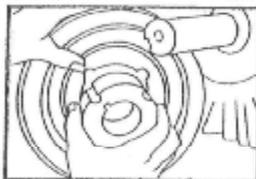
ALIGNMENT

Good alignment of pulleys is important otherwise the belt flanks will wear quickly.

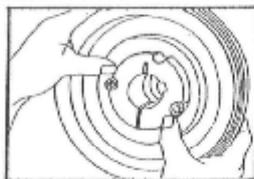
Fenner Taper-Lock[®] Bushes



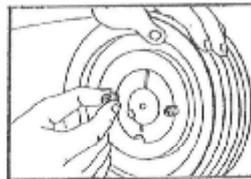
Installation Instructions



INSERT BUSH INTO PULLEY OR COUPLING



INSERT SCREWS AND LOCATE ON SHAFT



TIGHTEN SCREWS FINGER-TIGHT



TIGHTEN SCREWS ALTERNATELY

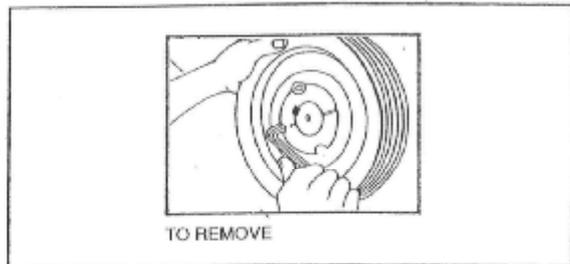
▲ To Install

- Remove the protective coating from the bore, outside of bush and bore of hub. After ensuring that the mating tapered surfaces are completely clean and free from oil and dirt, insert bush in hub, so that the holes line up.
- 1. Oil thread and point of grub screws, or thread and under-head of cap screws. Place screws loosely in holes threaded in hub, shown thus ⊙ in diagram.
- 2. Clean shaft and fit hub and bush to shaft as one unit. Locate in position desired, remembering that the bush will grip the shaft first and then the hub will be slightly drawn on to the bush.
- Using a hexagon wrench tighten screws gradually and alternately until they are fully secured. Use a piece of pipe on wrench to increase leverage.

► To Remove

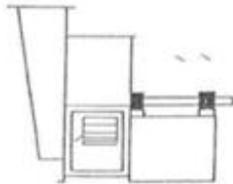
- Slacken all screws by several turns. Remove one or two according to number of jacking-off holes, shown thus ⊙ in diagram. Insert screws in jacking off holes after oiling thread and point of grub screws or thread and under-head of cap screws.
- Tighten screws alternately until bush is loosened in the hub and assembly is free on the shaft.
- Remove assembly from shaft.

5. For normal drives a key is unnecessary. But when a key is not used hammer against large end of bush using a block or sleeve to prevent damage. (This will ensure that the bush is seated squarely in the bore). Screws will now turn a little more. Repeat this alternate hammering and screw tightening once or twice until correct tightening torque is obtained.
6. If a key is to be fitted, place it in the shaft keyway before fitting the bush. It is essential that only a side-fitting parallel key with TOP CLEARANCE be used.
7. After drive has been running under load for a short time stop and check tightness of screws.
8. Fill empty holes with grease to exclude dirt.

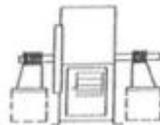


Bush		1008 1108	1310	1210 1215	1610 1615	2012	2517 2525	3020 3030	3525 3535	4040	4545	5050
Screw tightening torque (Nm.)		56	20	20	20	31	48	90	113	170	192	271
Screw Details	Qty.	2	2	2	2	2	2	2	3	3	3	3
	Size (BSW)	1/4"	3/8"	3/8"	3/8"	7/16"	1/2"	5/8"	1/2"	5/8"	3/4"	7/8"

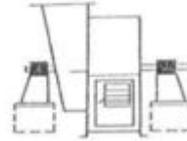
SW - Single Width DW - Double Width
 SI - Single Inlet DI - Double Inlet



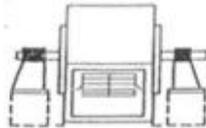
ARR. 1 SWSI WITH INLET BOX For belt drive or direct connection. Impeller overhung, two bearings on base. Inlet box may be self-supporting.



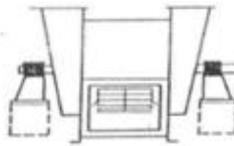
ARR. 3 SWSI WITH INDEPENDENT PEDESTAL For belt drive or direct connection fan. Housing is self-supporting. One bearing on each side supported by independent pedestals.



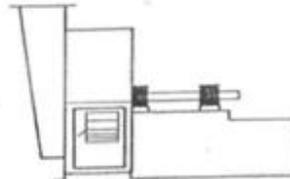
ARR. 3 SWSI WITH INLET BOX AND INDEPENDENT PEDESTALS For belt drive or direct connection fan. Housing is self-supporting. One bearing on each side supported by independent pedestals with shaft extending through inlet box.



ARR. 3 DWDI WITH INDEPENDENT PEDESTAL For belt drive or direct connection fan. Housing is self-supporting. One bearing on each side supported by independent pedestals.



ARR. 3 DWDI WITH INLET BOX AND INDEPENDENT PEDESTALS For belt drive or direct connection fan. Housing is self-supporting. One bearing on each side supported by independent pedestals with shaft extending through inlet box.



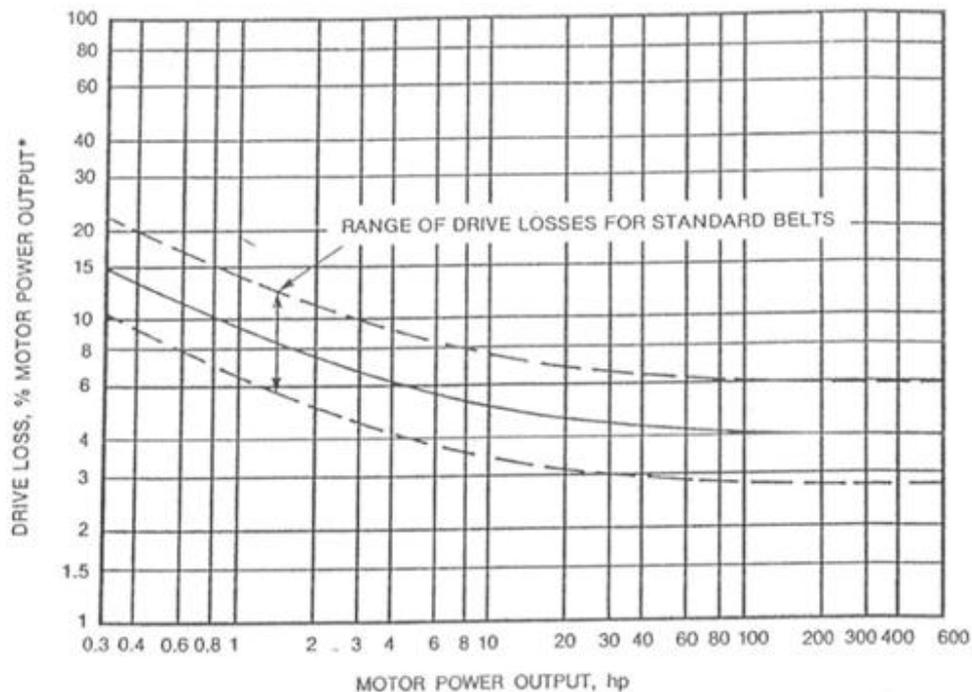
ARR. 8 SWSI WITH INLET BOX For belt drive or direct connection. Impeller overhung, two bearings on base plus extended base for prime mover. Inlet box may be self-supporting.

AMERICAN CONFERENCE
 OF GOVERNMENTAL
 INDUSTRIAL HYGIENISTS

DRIVE ARRANGEMENTS
 FOR CENTRIFUGAL
 FANS

DATE 5-92

FIGURE 6-5b



HIGHER BELT SPEEDS TEND TO HAVE HIGHER LOSSES
THAN LOWER BELT SPEEDS AT THE SAME HORSEPOWER

*Drive losses are based on the conventional V-belt which has been the "work horse" of the drive industry for several decades.

EXAMPLE

- Motor power output, H_{mo} , is determined to be 13.3 hp
- The belts are the standard type and just warm to the touch immediately after shutdown
- From chart, drive loss = 5.1%
- Drive loss, H_L = 0.051×13.3
= 0.7 hp
- Fan power input, H = $13.3 - 0.7$
= 12.6 hp.

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*ESTIMATED BELT
DRIVE LOSS*

DATE 5-92

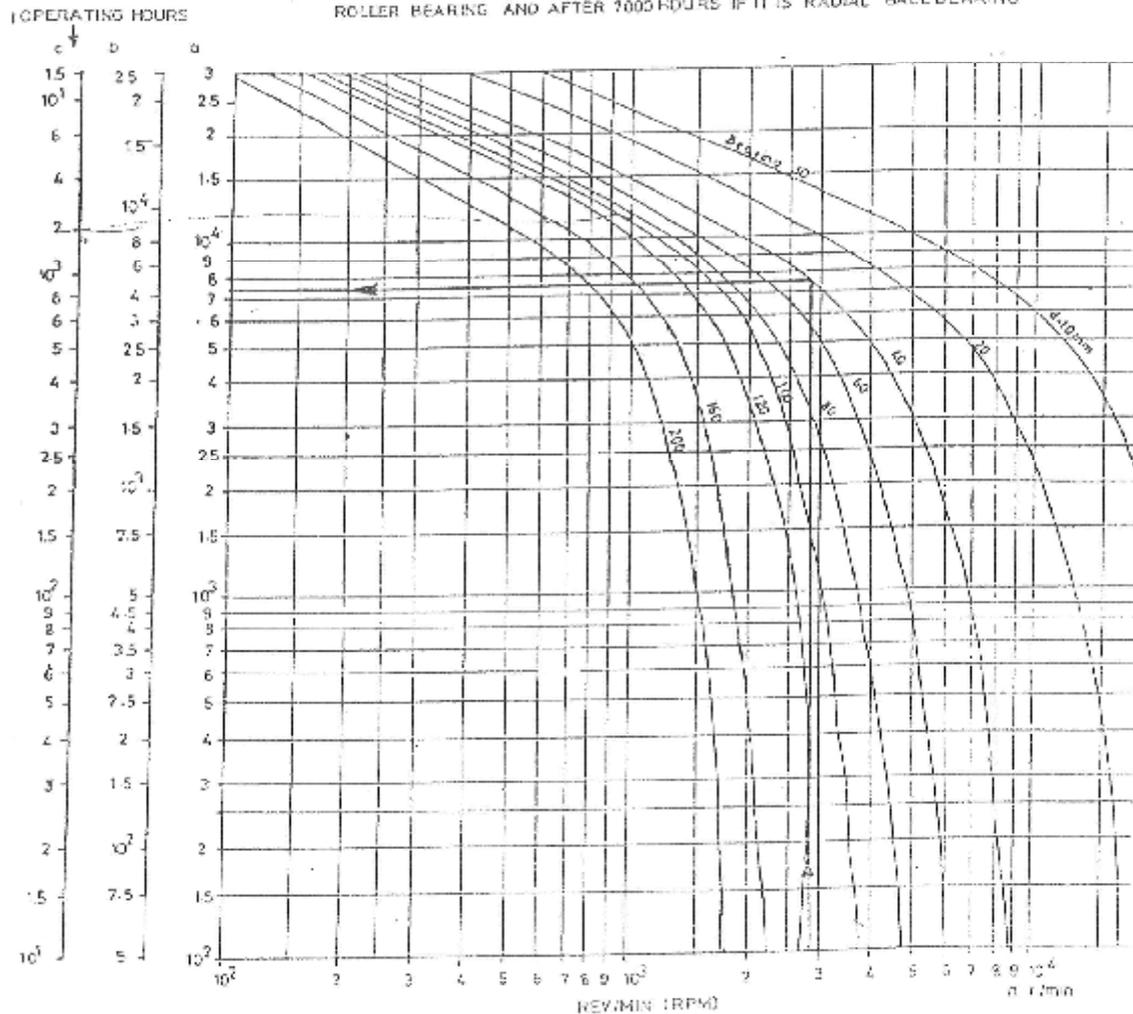
FIGURE 6-6

RELUBRICATING INTERVAL FOR BEARINGS

(FOR IDEAL CONDITION IT IS ADVISABLE TO REMOVE THE ENTIRE QUANTITY
OF GREASE AND REFILL WITH NEW GREASE DURING LUBRICATION)

EXAMPLE:

A BEARING WITH INSIDE DIAMETER OF 40MM AND RUNNING AT 2900 RPM
WILL REQUIRE TO BE RELUBRICATED AFTER 800 HOURS IF IT IS SPHERICAL
ROLLER BEARING AND AFTER 7000 HOURS IF IT IS RADIAL BALL BEARING



Scale a: radial ball bearings

Scale b: cylindrical roller bearings, needle roller bearings

Scale c: spherical roller bearings, taper roller bearings, thrust ball bearings

full complement cylindrical roller bearings (0.2 H)

crossed cylindrical roller bearings with cage (0.3 H)

cylindrical roller thrust bearings, needle roller thrust bearings, spherical roller thrust bearings (0.5 H)



INITIAL GREASE CHARGE FOR SPLIT BEARING BLOCKS

The approximate Initial Grease Charge (GMS) for split Bearing Blocks is in the Table given below. The Recommended Initial Grease Charge is one - third to one - half the volume of the free space in the Bearing Block Base. This recommendation is for moderate speeds and normal or light bearing loads ($C/P \geq 8.3$). The table gives the Grease mass for a charge of one - third of the base free space volume.

BEARING BLOCK	GREASE CHARGE (GMS)	BEARING BLOCK	GREASE CHARGE (GMS)
505	11.5	520	310
506	28.5	522	395
507	37.0	524	440
509	51.0	526	610
510	58.5	530	795
511	76.5	532	895
513	120	534	1100
515	145	536	1150
516	180	538	1500
517	220	540	1850
		544	2250

BEARING RELUBRICATION CHART

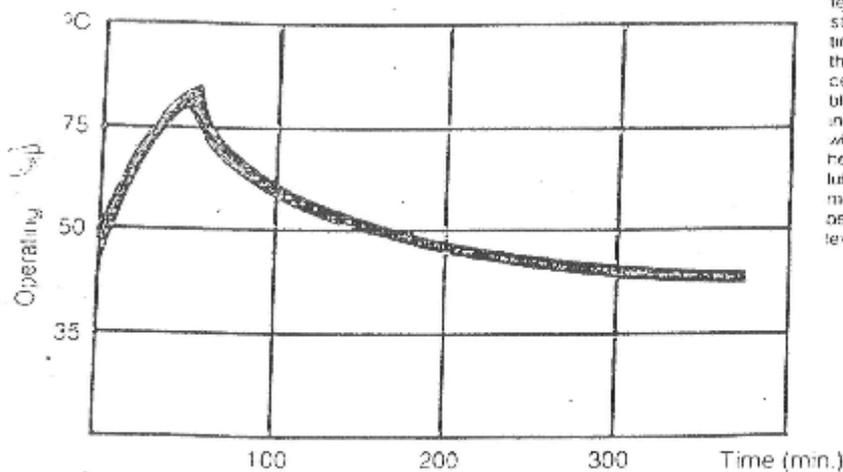
RECOMMENDED GREASE - SKF LGMT3



Sl No	Shaft Size	Bearing Housing	Regular Re-Lubrication Grease (Grms)	Relubrication Interval		
				Speed Upto 1000 RPM	Speed Upto 1000 - 3000 RPM	High Temperature Fans
1	25	SN506/MB306	10	720 Hrs	480 Hrs	336 Hrs
2	30	SN507/ MB307	15	720 Hrs	480 Hrs	336 Hrs
3	35	SN508/MB308	15	720 Hrs	480 Hrs	336 Hrs
4	40	SN509/MB309	20	720 Hrs	480 Hrs	336 Hrs
5	45	SN510/MB310	25	720 Hrs	480 Hrs	336 Hrs
6	50	SN511	25	720 Hrs	480 Hrs	336 Hrs
7	55	SN512	30	720 Hrs	480 Hrs	336 Hrs
8	60	SN513	30	720 Hrs	480 Hrs	336 Hrs
9	65	SN515	35	720 Hrs	480 Hrs	336 Hrs
10	70	SN516	40	720 Hrs	480 Hrs	336 Hrs
11	75	SN517	50	720 Hrs	480 Hrs	336 Hrs
12	80	SN518	50	720 Hrs	480 Hrs	336 Hrs
13	85	SN519	60	720 Hrs	480 Hrs	336 Hrs
14	90	SN520	70	720 Hrs	480 Hrs	336 Hrs
15	100	SN522	80	720 Hrs	480 Hrs	336 Hrs
16	110	SN524	100	720 Hrs	480 Hrs	336 Hrs
17	125	SN528	125	720 Hrs	480 Hrs	336 Hrs
18	135	SN530	150	720 Hrs	480 Hrs	336 Hrs
19	140	SN532	150	720 Hrs	480 Hrs	336 Hrs

Effect of Grease Quantity on Bearing Operating Temperature

(TEMPERATURE MONITORING CHARTS FOR GREASE LUBRICATION)

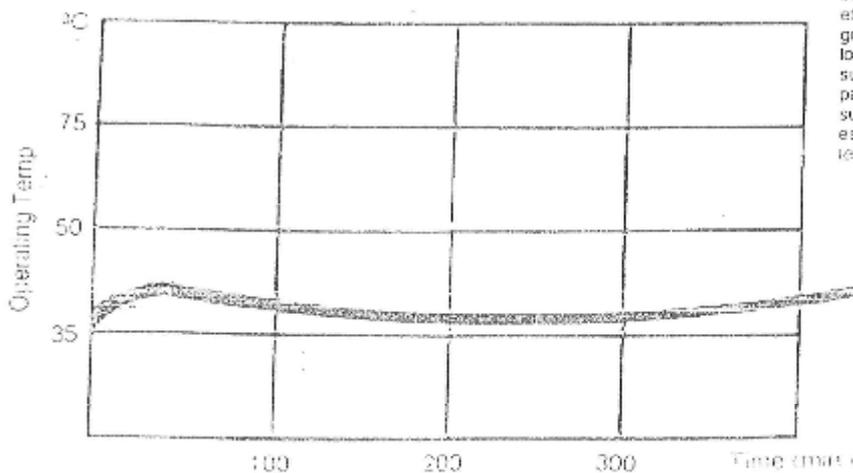


CORRECT LUBRICATION (Fig. a)

CORRECT LUBRICATION (Fig. a):

It can be noted that there is a temperature rise initially and the same stabilizes to a low level over a period of time. This characteristic is attributed to the mechanism of grease lubrication. A certain temperature is required for the oil to bleed out from the grease soap. Hence, initially, there is a metal to metal contact which leads to temperature rise. This rise helps the oil to bleed and form the lubricating film. When the film is formed the metallic contacts are separated and the bearing temperature stabilizes to a low level.

(b)

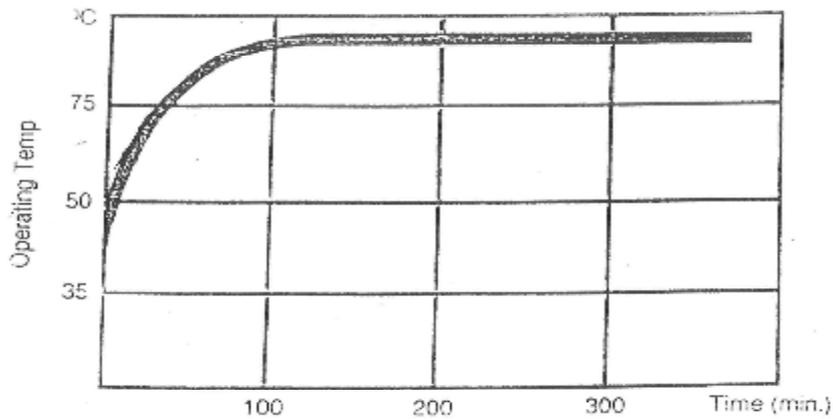


UNDER LUBRICATION (Fig. b):

Here the oil film formation takes place in a short time due to small quantity of grease available in the bearing housing. Hence, there is no appreciable rise in bearing temperature for some period of time. However, the heat generated due to interlayer friction in the oil film is not efficiently dissipated due to inadequate grease bank. The temperature rise leads to lowering of the viscosity of oil and the subsequent thinning of the oil film. After passage of time the film is not able to sustain itself and metallic contact is established. This explains the rapid rise in temperature as shown in the figure.

OVER LUBRICATION (Fig. c):

In this case the major cause of temperature rise is the churning of the grease filled in the housing. The bearing temperature stabilized at a very high level. This is a dangerous situation as high bearing temperature is normally considered to be an indication of inadequate quantity of grease and there is a tendency to pump more grease in the housing. Hence, it is advisable to remove grease from the housing when such temperature characteristics are observed.



OVER LUBRICATION (Fig. c)

NOTE:

The graph characteristics (shape of the curve) shown in the above figures are for an ambient temperature of 25 deg.C. The peak values will change depending on the ambient temperature. During monitoring it is the graph characteristics which are more relevant than the actual values.

8.1.2 Centrifugal Flow Fan - Outlet Ducts. Centrifugal fans are sometimes installed with a less than optimum length of outlet duct. If it is not possible to use a full length outlet duct, a SEF must be added to the system resistance losses. System Effect Curves for centrifugal fans with less than optimum outlet duct length are shown in Figure 8-3.

8.2 OUTLET DIFFUSERS

The process which takes place in the outlet duct is often referred to as "static regain." The relatively high velocity airstream leaving the blast area of the fan gradually expands to fill the duct. The kinetic energy (velocity pressure) decreases and the potential energy (static pressure) increases.

In many systems it may be feasible to use an outlet duct which is considerably larger than the fan

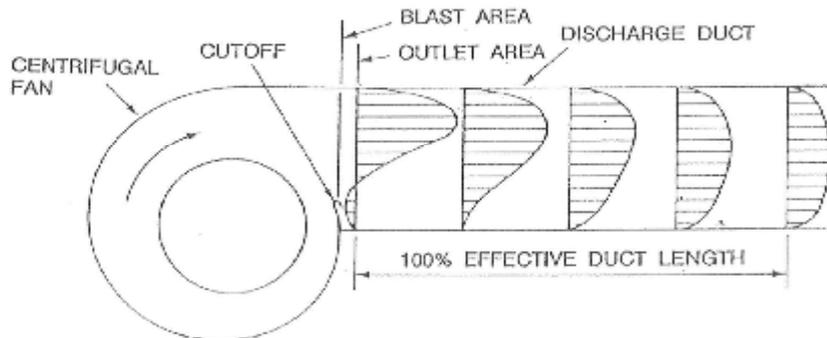
outlet. In these cases the static pressure available to overcome system resistance can be increased by converting some of the fan's outlet velocity pressure to static pressure.

To achieve this conversion efficiently it is necessary to use a connection piece between the fan outlet and the duct which allows the airstream to expand gradually. This is called a "diffuser" or evase.

The efficiency of conversion will depend upon the angle of expansion, the length of the diffuser section, and the blast area/outlet area ratio of the fan.

The fan manufacturer will, in most cases, be able to provide design information for an efficient diffuser.

See AMCA Publication 200 for an example showing the effect of a diffuser on a duct exit.



TO CALCULATE 100% EFFECTIVE DUCT LENGTH, ASSUME A MINIMUM OF 2-1/2 DUCT DIAMETERS FOR 2500 FPM OR LESS. ADD 1 DUCT DIAMETER FOR EACH ADDITIONAL 1000 FPM.

EXAMPLE: 5000 FPM = 5 EQUIVALENT DUCT DIAMETERS. IF THE DUCT IS RECTANGULAR WITH SIDE DIMENSIONS a AND b, THE EQUIVALENT DUCT DIAMETER IS EQUAL TO $(4ab/\pi)^{0.5}$

	No Duct	12% Effective Duct	25% Effective Duct	50% Effective Duct	100% Effective Duct
Pressure Recovery	0%	50%	80%	90%	100%
$\frac{\text{Blast Area}}{\text{Outlet Area}}$	System Effect Curves				
0.4	P	R-S	U	W	—
0.5	P	R-S	U	W	—
0.6	R-S	S-T	U-V	W-X	—
0.7	S	U	W-X	—	—
0.8	T-U	V-W	X	—	—
0.9	V-W	W-X	—	—	—
1.0	—	—	—	—	—

DETERMINE SEF BY USING FIGURE 7-1
Figure 8-3 System Effect Curves for Outlet Ducts - Centrifugal Fans

8.4 TURNING VANES

Turning vanes will usually reduce the pressure loss through an elbow, however, where a non-uniform approach velocity profile exists, such as at a fan outlet, the vanes may actually serve to continue the non-uniform profile beyond the elbow. This may result in increased losses in other system components downstream of the elbow.

8.5 VOLUME CONTROL DAMPERS

Volume control dampers are manufactured with either "opposed" blades or "parallel" blades. When partially closed, the parallel bladed damper diverts the airstream to the side of the duct. This results in a non-uniform velocity profile beyond the damper and flow to branch ducts close to the downstream side may be seriously affected.

The use of an opposed blade damper is recommended when volume control is required at the fan outlet and there are other system components, such as coils or branch takeoffs downstream of the fan. When the fan discharges into a large plenum or to

free space a parallel blade damper may be satisfactory.

For a centrifugal fan, best air performance will usually be achieved by installing the damper with its blades perpendicular to the fan shaft; however, other considerations, such as the need for thrust bearings, may require installation of the damper with its blades parallel to the fan shaft.

Dampers are often furnished as accessory equipment by the fan manufacturer (see Figure 8-6). In many systems a volume control damper will be located in the ductwork at or near the fan outlet.

Published pressure drops for wide open control dampers are based upon uniform approach velocity profiles. When a damper is installed close to the outlet of a fan the approach velocity profile is non-uniform and much higher pressure losses through the damper can result. Figure 8-7 lists multipliers which should be applied to the damper manufacturer's cataloged pressure drop when the damper is installed at the outlet of a centrifugal fan. These multipliers should be applied to all types of fan outlet dampers.

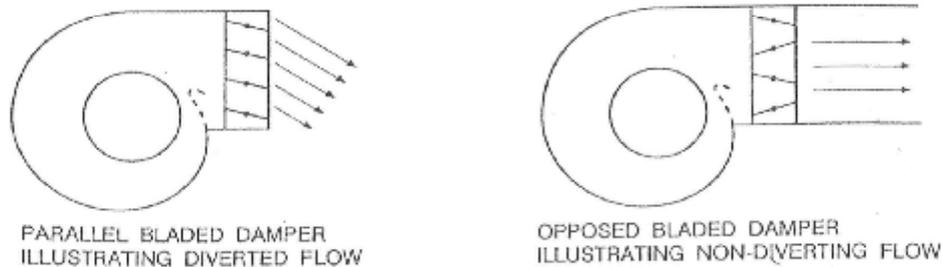


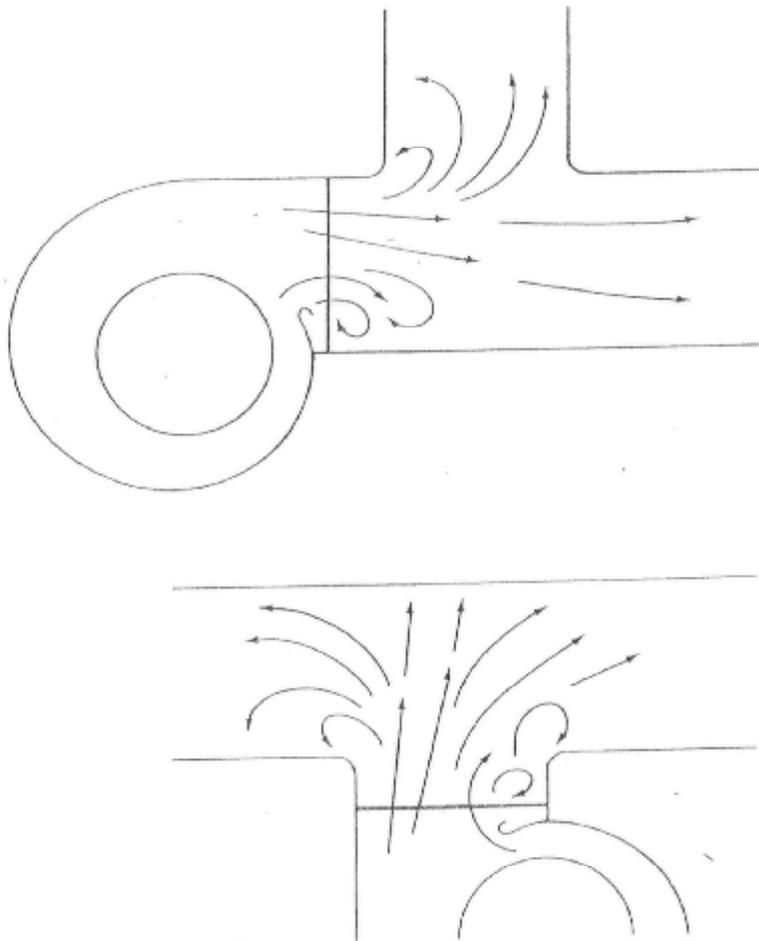
Figure 8-6 Parallel Blade vs. Opposed Blade Dampers

AMCA Publication 201-90

8.6 DUCT BRANCHES

Standard procedures for the design of duct systems are all based on the assumption of uniform flow profiles in the system.

In Figure 8-8 branch takeoffs or splits are located close to the fan outlet. Non-uniform flow conditions will exist and pressure loss and air flow may vary widely from the design intent. Wherever possible a length of straight duct should be installed between the fan outlet and any split or branch takeoff.



AVOID LOCATION OF SPLIT OR DUCT BRANCH CLOSE TO FAN DISCHARGE.
PROVIDE A STRAIGHT SECTION OF DUCT TO ALLOW FOR AIR DIFFUSION.

Figure 8-8 Branches Located Too Close to Fan

9.2.2 Centrifugal Fans - Inlet Duct Elbows. Non-uniform flow into a fan inlet, Figure 9-3a, is the most common cause of deficient fan performance. The *System Effect Curves* for mitered 90° round section elbows of given radius/diameter ratios are listed on Figure 9-5, and the system effect curves for various square duct elbows of given radius/diameter ratios are listed on Figure 9-6. The SEF for a particular elbow is found in Figure 7-1 at the intersection of the average fan inlet velocity and the tabulated *System Effect Curve*.

This pressure loss should be added to the friction and dynamic losses already determined for the particular elbow. Note that when duct turning vanes and/or a suitable length of duct is used (three to eight diameters long, depending on velocities) between the fan inlet and the elbow, the SEF is not as great. These improvements help maintain uniform flow into the fan inlet and thereby approach the flow conditions of the laboratory test setup.

Sometimes, where space is at a premium, the inlet duct will be mounted directly to the fan inlet as shown on Figure 9-3b. The reduction in capacity and pressure for this type of inlet condition is impossible to tabulate. The many possible variations in width and depth of the duct influence the reduction in performance to varying degrees; therefore, this inlet should be avoided.

Capacity losses as high as 45% have been observed in poorly designed inlets such as in Figure 9-3b.

Existing installations can be improved with guide vanes or the conversion to square or mitered elbows with guide vane, but a better alternative would be a special designed inlet box similar to that shown on Figure 9-4.

9.2.3 Inlet Boxes. Inlet boxes are added to centrifugal and axial fans instead of elbows in order to provide predictable inlet conditions and maintain stable fan performance. They may be used to protect fan bearings from high temperature or corrosive and erosive gases. The fan manufacturer should include the effect of any inlet box on the fan performance, and when evaluating a proposal it should be established that an appropriate loss has been incorporated in the fan rating. Should this information not be available from the manufacturer, refer to Section 10.4 for an approximate *System Effect*.

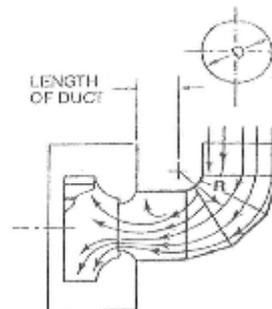


Figure 9-3a Non-Uniform Flow Into a Fan Inlet Induced by a 90°, 3-Piece Section Elbow--No Turning Vanes

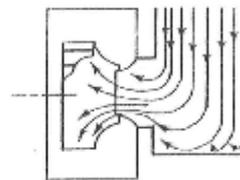


Figure 9-3b Non-Uniform Flow Induced Into Fan Inlet by a Rectangular Inlet Duct

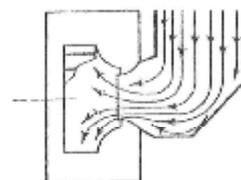
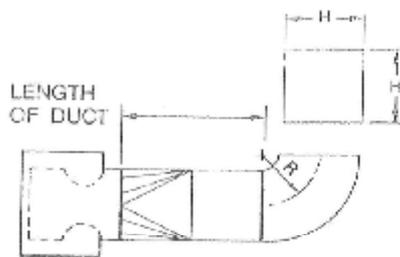


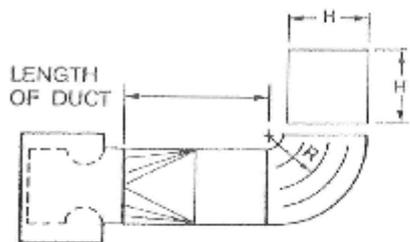
Figure 9-4 Improved Inlet Flow Conditions with a Special Designed Inlet Box



SYSTEM EFFECT CURVES

R/D	NO DUCT	2D DUCT	5D DUCT
0.5	O	Q	S
0.75	P	R	S-T
1.0	R	S-T	U-V
1.0	S	T-U	V

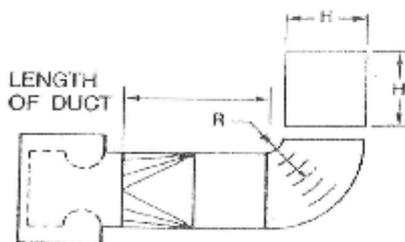
Figure 9-6a SQUARE ELBOW WITH INLET TRANSITION--NO TURNING VANES



SYSTEM EFFECT CURVES

R/D	NO DUCT	2D DUCT	5D DUCT
0.5	S	T-U	V
1.0	T	U-V	W
2.0	V	V-W	W-X

Figure 9-6b SQUARE ELBOW WITH INLET TRANSITION--3 LONG TURNING VANES



SYSTEM EFFECT CURVES

R/D	NO DUCT	2D DUCT	5D DUCT
0.5	S	T-U	V
1.0	T	U-V	W
2.0	V	V-W	W-X

Figure 9-6c SQUARE ELBOW WITH INLET TRANSITION--SHORT TURNING VANES

DETERMINE SEF BY USING FIGURE 7-1

D = Diameter of the inlet collar.

The inside area of the square duct (H X H) should be equal to the inside area of the fan inlet collar.

*The maximum permissible angle of any converging element of the transition is 15°, and for a diverging element 7°.

Figure 9-6 System Effect Curves for Various Square Duct Elbows

9. INLET SYSTEM EFFECT FACTORS

Fan inlet swirl and non-uniform inlet flow can often be corrected by inlet straightening vanes or guide vanes. Restricted fan inlets located too close to walls, obstructions or restrictions caused by a plenum or cabinet will decrease the useable performance of a fan. Cabinet clearance effect or plenum effect is considered a component part of the entire system; the pressure losses through the cabinet or plenum must be considered as a *System Effect* when determining system characteristics.

9.1 INLET DUCTS

Fans intended primarily for use as "exhausters" may be tested with an inlet duct in place, or with a special bell-mouthed inlet to simulate the effect of a duct. Figure 9-1 illustrates variations in inlet flow that will occur. The ducted inlet condition is shown as (a), and the effect of the bell-mouth inlet as (b).

Fans that do not have smooth entries (c), and are installed without ducts, exhibit flow characteristics similar to a sharp edged orifice in that a vena contracta is formed. The reduction in flow area caused by the vena contracta and the following rapid expansion causes a loss which should be considered as a *System Effect*.

If it is not practical to include such a smooth entry, a converging taper (d) will substantially diminish the loss of energy, or even a simple flat flange (e) on the end of the duct or fan will reduce the loss to about one half of the loss through an unflanged entry.

AMCA Standard 210 limits an inlet duct to a cross-sectional area not greater than 112-1/2% nor less than 92-1/2% of the fan inlet area. The slope of transition elements is limited to 15° converging and 7° diverging.

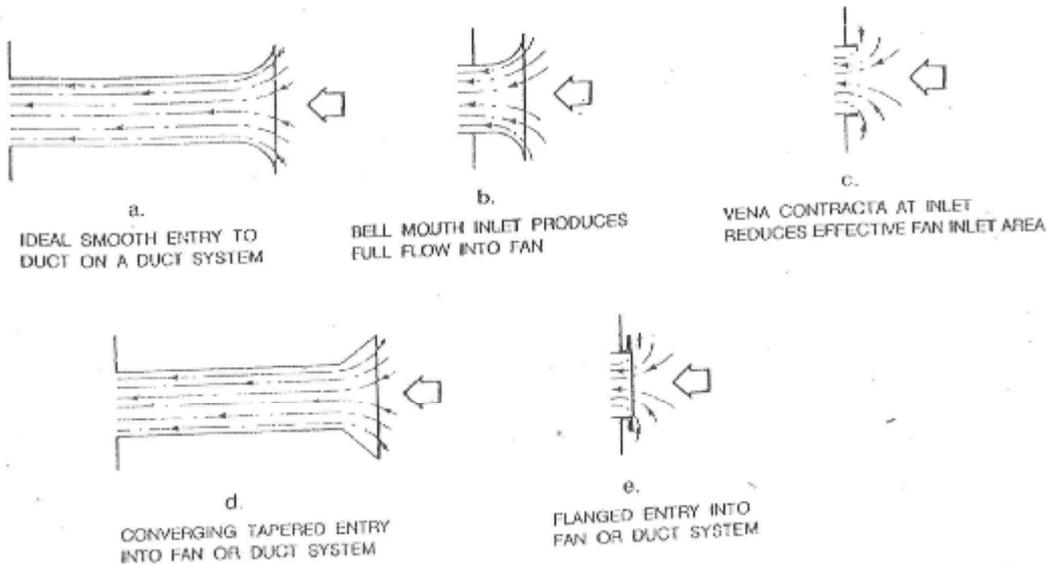


Figure 9-1 Typical Inlet Connections for Centrifugal and Axial Fans

9.3 INLET VORTEX (SPIN OR SWIRL)

Another major cause of reduced performance is an inlet duct condition that produces a vortex or spin in the airstream entering a fan inlet. An example of this condition is illustrated in Figure 9-7.

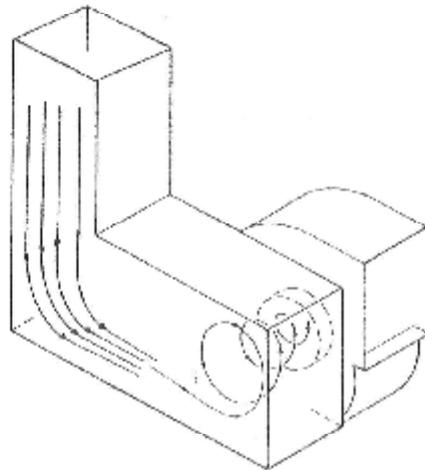
The ideal inlet condition is one which allows the air to enter axially and uniformly without spin in either direction. A spin in the same direction as the impeller rotation (pre-rotation) reduces the pressure-volume curve by an amount dependent upon the intensity of the vortex. The effect is similar to the change in the pressure-volume curve achieved by inlet vanes installed in a fan inlet; the vanes induce a controlled spin in the direction of impeller rotation reducing the volume flow rate.

A counter-rotating vortex at the inlet may result in a slight increase in the pressure-volume curve but

the horsepower will increase substantially.

There are occasions, with counter-rotating swirl, when the loss of performance is accompanied by a surging airflow. In these cases the surging may be more objectionable than the performance change.

Inlet spin may arise from a great variety of approach conditions and sometimes the cause is not obvious. Some common duct connections which cause inlet spin are illustrated in Figure 9-8. No SEFs are tabulated. It is recommended that these types of duct connections be avoided, but if this is not possible, inlet conditions can usually be improved by the use of turning vanes and splitter sheets to break the spinning vortex, (see Section 9.4).



COUNTER ROTATING SWIRL

Figure 9-7 Example of a Forced Inlet Vortex