



ISO 9001



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FAN SYSTEMS
WITT

OPERATING and MAINTENANCE MANUAL

Jetfans and other Axial Fans

USER INFORMATION

FOR

TRANSPORT

INSTALLATION

OPERATION

MAINTENANCE

and

SAFETY

of

IGW - FANS and ACCESSORIES

12/03

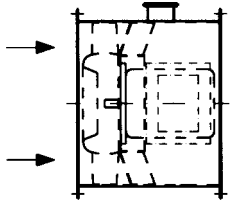
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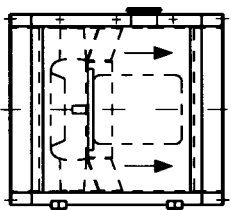
Commonly used designs of Axial Fans

A/G



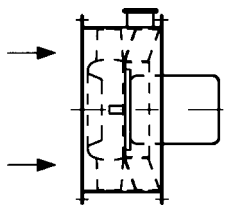
Long casing
 Flange motor
 Guide vanes
 Terminal box
 Service access
 (G = without service access)

B



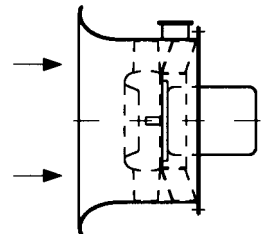
Long casing
 Large door
 Flange motor
 Guide vanes
 Terminal box

D



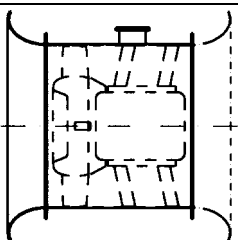
Short casing
 Flange motor
 Guide vanes
 Terminal box

DD



Casing with bellmouth
 Flange motor
 Guide vanes
 Terminal box

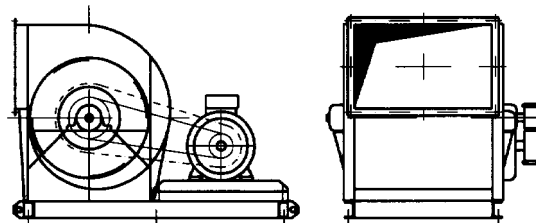
GD(R)



Long casing with bellmouth
 (R) =fully reversible with bellmouth at both ends

Double inlet
 Belt drive on base frame
 Rotor to be dismantled from both sides
 Shaft supported with two bearings
 Motor mounted on rails
 Belt protection

2/2



PREFACE

This is an operating and maintenance manual, not a system design guide. When designing systems using fans a multitude of factors must be considered which exceeds the possibilities of this publication. We must point to the relevant specialist literature, standards, guidelines, directives and courses as they are offered by universities, technical colleges and associations such as AMCA, BS, VDI, VDE and VDMA. If desired we can offer suggestions for required studies.

We have carefully manufactured a solid and reliable fan for you which corresponds to the state of the art. However, during operation fans are often exposed to large - often unexpected - stress. Even improbable accidents must be avoided, even in the case of two different failures occurring simultaneously. Fans must be regularly inspected and maintained by qualified staff in order to avoid damage and accidents.

Material damage and personal injuries can result from improper service. Damaged bearings and too high vibration levels can lead to failures and subsequent damage.

Fans include movable parts which are exposed to wear and tear. Special attention must be paid to the bearings. In spite of high safety standards and their normally long life expectancy, in the end every bearing wears out. Slight damage to the bearings may for example quickly worsen. Regular inspections must be carried out taking operating conditions into consideration. Destroyed bearings can lead to shaft failures and a total loss of the fan. Also V-belt drives and couplings are equipped with wearable parts and must be inspected regularly.

Vibrations are an enemy of all rotating machines, which - as is known - can lead to unpredictable fatigue failures. The best protection consists in minimizing the vibration energy. At the time of delivery from our works the fan has a high vibration quality. But because of bad inlet conditions, material build-up, wear, transport damage, fitting faults, bearing damage, overheating and other reasons, heavy vibrations can occur. Therefore, together with the inspection of the bearings, the vibration levels must be checked regularly.

Fans should not be installed near working or common areas. The fan must always be installed in such a way that no rotating parts can be touched. In case of free inlets or outlets protecting guards must be fitted. If the fan is connected to ducts, these must be supplied with protecting guards on the inlet and outlet side. Parts which can come loose from the impeller and foreign bodies must be contained safely inside the protection.

Before beginning any work on the fan, the electrical connections must be interrupted. The switching device must be marked and secured so that unintended operation cannot occur. The impeller must be mechanically blocked.

We refer to the „Fundamental Safety Instructions“ of Fan Systems Group, which are an integral part of this Operating and Maintenance Manual and which must be strictly adhered to (see sect. 21.)

The DIN EN 292 Parts 1 and 2 "Safety of machines" is the basis of all safety aspects.

Please, carefully follow the instructions set out below.

1. TRANSPORT see also section 7.

For lifting with cranes, attach hooks only to the lifting eyes provided for this purpose. Complete fans should only be lifted by means of the lifting eyes at the foundation, not at the lifting eyes of components such as the casing or motor. When using fork-lifts the fork is to be only applied to the base frame. Lowering is to be done with the lowest possible speed onto a soft support. Shocks, shaking and dropping might lead to imbalances and deformation or even destruction, especially of the bearings.

During every transport and during storage ensure that no water (e.g. by rain) can get into the motor, the bearings or other sensitive components. Axial fans (including jet fans) must, in case of short transport and temporary storage in the open, be stored in a horizontal position, if possible under a canvas cover so that no water can penetrate along the shaft into the motor. We would recommend only closed transport and storage in closed rooms without large temperature variations.

Safety advice: Inspect safe connection between fan and hoisting device, pay attention to the centre of gravity, do not cant or tilt, do not step under the load!

2. INSTALLATION OF AXIAL AND CENTRIFUGAL FANS - GENERAL

When installing fans the instructions according to DIN 4024 (machine foundations.) parts 1 and 2 must be observed.

Fans are only to be installed in the mounting position for which they were ordered and supplied (horizontal/vertical). Installation must be done on a level foundation. Care must be taken that the fans are not mechanically deformed or submitted to unwanted forces in order to prevent jamming or grinding of the impeller.

When using vibration insulators, they must be placed so that an uniform compression is obtained. It may be necessary to insert shims. When the fan is installed the insulators must not be canted, dragged over the floor or stressed on one side only. In that case the rubber or the springs could be damaged.

Flexible connections must be installed to allow some fan movement, especially during the start-up. Equally, they must not be collapsed too far or misaligned so there are folds which could unduly impede the air flow, **see also 13. Installation instructions for flexible connections.** In case of high pressure and danger of abrasion, guide rings (ducts) must be provided.

The connection of the fan to the motor must be done according to the connection diagram in the terminal box and according to the instructions of the motor maker. All motors are to be protected by means of motor protection devices. The connection must be carried out by licensed expert staff taking into consideration the protection and safety instructions.

3. DISMOUNTING - REFITTING

Under certain circumstances, large fans must be dismantled into separate components, in order to enable transport through narrow access doors. Pages 16 shows detailed diagrams of standard fans to ease dismantling-refitting. This work should only be carried out by expert staff. Installation support devices should be available. All parts fitting together must be marked before being dismantled. Special attention must be paid to the relationship between the parts. The interchange of parts can cause installation difficulties. The dismantling and installation of the impeller can either be done by the use of an extraction disc or a clamping bush (see section 11.+12.).

In case of a divided casing, remove screws of inlet grill and inlet bellmouth, take off the belt drive, and take off the upper part of the casing after having removed the flange screws. Fix impeller at crane by means of fixing devices, but do not yet lift. Remove fixing screws from bearings of the casing. Fix lifting devices at both ends of the shaft and connect to the crane. Carefully hoist the complete unit of impeller, shaft, bearing, inlet bellmouth out of the lower part of the casing. Further dismantling of the parts can be done after setting down the complete unit.

A difference must be made between fans with a large access door and all other designs. At first, the power supply must be visibly and safely interrupted. For design B with a large bolted access, the bolts and the access door are removed. Then the impeller can either be loosened by means of the extraction disc or the taper-lock bush (see section 11. and 12.). Then the motor bolts can be removed. Lifting devices are to be used.

For all other designs the fan must be separated from all connecting parts such as for example protective grills, silencers and, ducts, and must be placed on the floor with the impeller up. Then the impeller can be detached either with an extraction disc or taperlock bush. After that the motor can be unbolted. Lifting devices are to be used.

4. START-UP

General Safety Instructions:

Before engaging the fan, the casing and duct pipes must be investigated for foreign particles. Loose parts can be carried by the air flow and can lead to injuries. Attention must be paid to the installation of protection grills, belt protection and other safety features. No one may ever stand in the air flow! The air pressure might be so strong that a human body and even heavy objects could be sucked into the fan or blown away.

The safety instructions for electrical equipment and of the electricity supply company must be observed at all times.

The rotational direction of the fan is indicated by an arrow on the fan casing, the fan protection or the motor. This should be checked by briefly starting the motor and observing the rotating parts. If it is wrong, the electrical leads must be reconnected. The amperage must be measured and compared to the nominal current of the motor. Centrifugal fans must be throttled appropriately, otherwise the motor can be overloaded. The reverse is true for axial fans. With free outlet they absorb less power than when throttled.

Before the rotational direction is reversed, the impeller must come to a complete standstill. The high moment of inertia can otherwise lead to damage.

Mechanical Safety

Safety features must be installed to prevent moving parts being touched. If not an integral part of the fan they must be provided by the installation company. This is especially the case for inlets, outlet and access doors which must be secured on site.

Systems with dampers

Dampers that can interrupt the airflow completely must be connected in such a manner that the fan is automatically stopped immediately after closing of the damper. Otherwise an excessive heating of the fan and excessive vibrations can occur.

Fans operating in parallel

When fans are operating in parallel ensure that the non-operating fans are not rotating in the opposite direction of their intended rotational direction. The start-up of a fan rotating in the wrong direction can otherwise lead to overloading of the power supply and motor. Damage to the impeller can also occur. Special care must be taken when carrying out maintenance work. The impeller has to be mechanically blocked before starting the maintenance work.

Maximum Speed, different speeds and speed control.

The fan may not be operated at higher speeds than stated in the data sheet.

A speed reduction is only permissible after checking with Fan Systems Group. This is to ensure that the fan is not going to operate at a resonance frequency which can damage the fan or associated components.

When using variable speed control, resonance frequencies of the various fan components may be reached. At the corresponding speeds no permanent operation may occur. When starting up the system the variable speed control must be programmed so that these resonance speeds are bypassed quickly. Please note section 8.4

Starting couplings

To avoid excessive heating and overloading of the coupling, a maximum 4 starts per hour is permissible. Between any 2 starts a cooling period of at least 10 minutes is required.

Explosion-proof fans (please also refer to section 8.3)

Very special care must be taken. In addition to other instructions the following must be noted: **The build-up of electrostatic charges must be avoided by grounding all relevant parts. Special care must be taken to ensure adequate distance between rotating and non-rotating parts. The motor may at no point become overloaded or overheated.**

5. MAINTENANCE

The safety instructions for initial operation of the fans are also valid for maintenance. The maintenance frequency depends largely on the operating conditions, surrounding conditions and required availability. The frequency must be set by the system designer taking into consideration the instructions of the fan supplier. Sufficient spare parts must be available.

All impellers have been carefully balanced prior to leaving the factory. Imbalance can occur due to dust, wear, abrasion and accumulation of material on the impeller, leading to vibrations and damage of bearings. Low levels of vibrations must always be maintained.

5.1 Vibration monitoring

Increased vibrations always constitute a danger signal (VDI 2056 and ISO 2372). Changes in the vibration level can best be monitored by measuring the mechanical vibrations on the bearings and/or the motor. By comparison over a prolonged period changes can best be detected. If significant changes are observed the cause must be established, for example dirt accumulation or wear on the impeller. Cleaning and/or rebalancing of the impeller may be necessary.

5.2 BEARINGS

5.2.1 Monitoring of bearings

Every bearing, both in fans proper or electric motors has to be checked regularly. Dirt particles or humidity must not enter the bearing as they may cause premature failure. When relubricating or replacing bearings, utmost cleanliness must be observed.

When monitoring bearings it is a great advantage to use shock pulse monitoring (SPM-method). Measurement should be made directly at the bearing unit. The separate instructions of the test equipment manufacturer must be adhered to. Not only the momentary values are of importance, but also the comparison of the data over a prolonged period since this best allows changes to become apparent. In rare cases SPM measurements can lead to wrong conclusions. Bearing noise and temperature development should also be recorded, especially for essential fans. Increasing values are always a sign of danger.

The relubrication intervals are valid for stationary machines under normal conditions for non-ageing lithium soap lubricants as prescribed in section 5.4.3, as long as the temperature on the external bearing ring remains below 70°C. For temperatures exceeding 70°C every increase by 15°C will halve the greasing interval. The maximum temperature limit of the grease is not to be exceeded.

The life expectancy of bearings is largely dependent on the operating conditions and the conditions at site. We strongly recommend regular bearing checks. The intervals depends on the importance of the fan. For machines of essential importance we recommend annual bearing replacement even in the absence of increased vibrations, after relatively fan running hours. Bearings for less important machines should be replaced less often or when a breakdown is imminent.

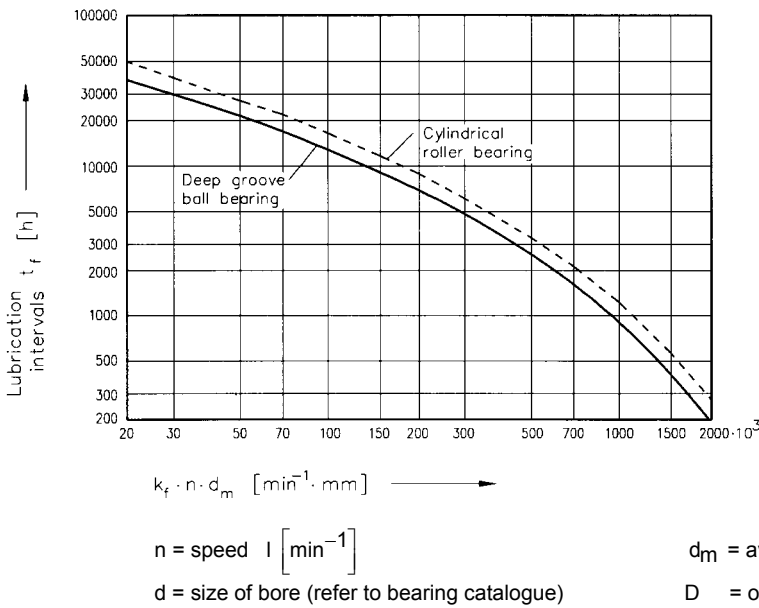
5.2.2. Grease quality and lubrication intervals

Except for special cases - where this is clearly indicated - the motor bearings are greased with lithium soap grease. The different brands are mutually compatible. The brand is selected by the motor supplier, see name plate.

Current Lithium soap grease brands:	SKF - LGM 2/3	FAG - Arcanol L 71	Blaser - Blasolube 462
	Shell - Alvania R3	Esso - Beacon 3	
	Mobil Oil - Mobilux 3	Aral - Aral HL3	

Fan bearings are normally greased with the same grease as the motor bearings. The grease data are given on a label.

certified acc. to DIN ISO 9001



Lubrication intervals at normal conditions acc. to DIN 51 825 -10 bis +70°C room temperature with the above mentioned grease types

Bearing type	k_f
Deep-groove ball bearing single-row	1.1
Cylindrical roller bearing single row	3.5

$k_f \cdot n \cdot d_m$ [min⁻¹ · mm] →

n = speed [min⁻¹]

d = size of bore (refer to bearing catalogue)

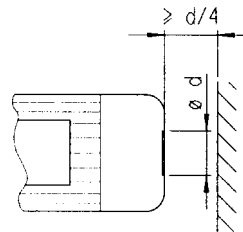
d_m = average bearing diameter [mm] = $(d+D)/2$

D = outer diameter (refer to bearing catalogue)

In two cases other grease types are used. For bearings with exceptionally heavy loads Optimol Longtime PD2 made by Optimol Ölwerke Munich is used, which gives longer bearing life. Please note the label regarding special grease type.

If bearings have to operate at high temperatures, we use Staburags N12MF made by Klüber, Munich. This grease type is suitable for -

The cooling air of the motor **must not be obstructed** and the exhaust air - also from other machines - must not be reused.



20 to 160°C continuous operation, short term for up to 180°C. Please note the label regarding special grease type.

5.3 Impeller inspection

If abrasion, corrosion or dirt deposits on the impeller are likely, regular inspections, cleaning and repeated balancing must be carried out at least once a year, in extreme cases even at intervals of one or two weeks. Wearing plates on the impellers should only be installed by a qualified workshop. Buying a second impeller is recommended for alternate maintenance. Frequent impeller inspections using the penetrant paint method are recommended for fans operated with speed control, to check against starting fatigue.

5.4 DISMOUNTING - REFITTING of impellers see section 11. and 12.

6. ELECTRIC MOTORS

The guidelines and safety instructions of the motor manufacturer must be strictly adhered to.

By nature the fan is a machine with a high inertia. This is especially the case for large impellers with low speed, i. e. a motor with a relatively low power and a small torque. Therefore the time should be checked at least for all fans having a lower number of rotations than the motor and for all motors above 10 kW. The short relay times generally in use today will in many cases make it necessary to use relays for extra heavy starts of centrifugal couplings.

Special attention is necessary when single phase motors are employed, as these motors generally have an extremely unfavourable torque curve.

Electrical connections

All work may only be carried out by **qualified** personnel on **stopped** machines with the power supply **cut off** and visibly secured **against restart**. This also applies to auxiliary power supplies (e. g. space heaters).

Check that the voltage is switched off!

Surpassing the tolerance laid down in EN 60034-1/DIN VDE 0530, part 1, i. e. voltage $\pm 5 \%$, frequency $\pm 2 \%$, correct curve shape and lack of symmetry increase the heating up of the motor and affect the electro magnetic compatibility.

Please note the performance data on the motor plate and the connecting diagram in the motor terminal box.

The electrical connection must be **permanently secured** (no dangling leads); prepared cable ends must be used. Make **safe earth connections**.

The minimum air gap between non-isolated, voltage carrying parts and the grounding may not be less than: 8 mm for $U_N \leq 550$ V, 10 mm for $U_N \leq 725$ V, 14 mm for $U_N \leq 1000$ V. The terminal box must be free of foreign matter such as dirt, humidity etc. Cable gland holes not in use and the terminal box itself must be closed to ensure they are free from **dust** and **humidity**. For testing without a load on the shaft the shaft key must be secured. For machines with brakes, the correct operation of the brakes must be tested before starting the motor.

Operation

Normally vibration levels of $v_{\text{eff}} \leq 3,5$ mm/s ($P_N \leq 15$ kW) and 4,5 mm/s ($P_N > 15$ kW) respectively are safe, but in some cases higher levels must be accepted, see ISO 14 694 (Draft). If changes occur compared to the normal operation - e. g. **increased temperature, noise or vibration levels** - the cause must be established, if necessary after referring to the motor manufacturer. Safety protection devices must not be disconnected even during trial operation. **When in doubt** turn off the fan.

In dirty locations the motor must be cleaned regularly.

Bearings with relubrication should be greased while the motor is **running**. Use the correct grease type. In case of overflow, grease valves with stop caps (IP 54 shaft side; IP 23 shaft and cooling side), remove these before operating the motor and close again afterwards. Bearings should be exchanged after approx. 10.000 h for bearings with permanent lubrication (1Z-bearings) for 2 pole motors, and approximately 20.000 hours for motors having higher pole numbers, unless otherwise stated by the manufacturer.

General

All electrical machines have dangerous parts that are under **electrical tension, are rotating** and which may have **hot** surfaces. All work transporting, connecting, operating and maintaining is only to be carried out by **qualified and reliable personnel** (prEN50110-1/VDE 0105, IEC 364 should be adhered to). Inexpert handling can lead to serious **damage to people and property**.

Appropriate use

Low voltage machines are made according to the standards **EN 60034 (VDE 0530)**. The use in **explosion areas is strictly prohibited**, unless **specifically** designed for this purpose (see marking on the name plate). Protection classes less than \leq IP 23 **should not be used** outside. Machines with air cooling are designed for an site temperature of **-20°C to +40°C** and a height above sea level of less than **1000 m**. Different instructions on the name plates have to be **strictly** followed. The conditions at site must match all instructions on the name plate.

Low voltage motors are **components** for installation into end products according to the machine directive 89/392/EWG. **Start-up** is not permissible until the conformity of the end product with the machine directive has been established (note e. g. EN 60204-1).

Transport and storage

Damages to the motor that are noticed must **immediately** be repaired. **Start-up** may have to be **delayed**. Tighten the inserted transport bolts before lifting. The bolts are designed for carrying the weight of the motor, **not** any additional loads. Remove **transportation securing devices** before putting into operation. Reuse for renewed transport. If storing low voltage machines ensure a **dust free, dry and vibration free** ($v_{\text{eff}} \leq 0,2$ mm/s) site. Measure the insulation resistance before putting the motor into operation. If the measured values are $\leq 1\text{k}\Omega$ for every Volt of the measuring voltage, the windings must be dried out. Follow the "storage instructions" from the motor manufacturer.

Mounting

Ensure an even support with good flange and/or foot connection and exact alignment if directly coupled. Avoid resonance frequencies in surrounding equipment. Turn the rotor **by hand** and listen to unusual grinding noises. **Control the direction of rotation**.

Pulleys and couplings are **only** to be mounted/dismounted using appropriate tools (heated). Safety guards etc. are to be fitted. Avoid unsuitable belt tension (chapter 5.2). The balancing condition of the low voltage machine is marked on the name plate (H = half shaft key, F = full shaft key). If the motor has a half shaft key (H), the corresponding coupling must also be balanced with a half shaft key. Protruding **parts of the shaft key** must be removed.

If required a special protective screen is to be mounted at site to avoid foreign bodies falling into the fan.

Under certain operating conditions the motor casing can be subject to condensation. This can be avoided by the use of a space heater or applying a low voltage to the windings. Drainage openings on the motor must be regularly opened and checked.

The end user must protect the motor against overload under special conditions, e. g. when the fan handles hot gases or if the motor cannot operate under standard temperature and pressure at site. For start-up of centrifugal fans sometimes the absorbed power must be reduced, e. g. by partial closing of dampers in the duct, reduction of rotational speed or partial closing of an inlet vane.

The normally used asynchronous motors with squirrel cage rotor conform, when used properly and operated at a power supply according to EN 50 160, with the requirements of the EU-directive concerning electromagnetic compatibility.

When being fed by a frequency converter, electromagnetic disturbances may be emitted depending on the design of the converter. To avoid surpassing the limits set in EN 50 081-1 for the converter/motor system, the EMV-instructions of the converter manufacturer must be adhered to. For motors with built-in sensors (e. g. thermistors) the sensor leads can cause interference. The requirements to the motor acc. to EN 50 082-2 are generally complied with.

For motors with built-in sensors (e. g. thermistors) the end user must ensure the appropriate selection of the sensor leads and the measuring instruments to ensure proper operation.

7. INSTRUCTIONS FOR STORAGE AND PROLONGED STANDSTILL (refer also to section 1. TRANSPORT)

Care must be taken that the fan and the motor are protected against humidity and dust. Large temperature changes should be avoided. Otherwise damage to electric motors, cable boxes, bearings, painted surfaces and seals might result. It is to be considered that not all paints are weather resistant, corrosion might occur for example under a primer.

Prolonged standstill may reduce the lubrication properties of grease or oil. Corrosion can occur on the bearings and they might fall dry and belts might become brittle. Ball bearings can develop pits. In order to avoid this, the **fan should be operated for about 10 minutes every month**. If this is impossible at least the impeller should be turned by hand. The grease is to be exchanged every 3 years.

7.1 Precautions against unintentional start-up

The user must take appropriate measures and provide appropriate equipment to avoid unwanted power supply to the fan and associated equipment. This has special relevance during service and maintenance operations. Beside the electrical power supply also other potential energy sources such as hydraulic, pneumatic, potential energy, spring loads and draft in the duct system must be considered. Separation, switching, grounding and interlocking gear must be installed by the user. Safety devices against unwanted switching must be clearly visible. The user must comply with EN 1037 „Safety of machines - Avoidance of unwanted start-up“.

8. SPECIAL INSTRUCTIONS

8.1 Operation at higher temperatures (> 70°C)

For fans designed for operation at higher temperatures, precautions against the touching of hot surfaces (e. g. safety guards, warning signs) must be taken. In the case of cold starts, the power consumption could possibly exceed the design value and the current consumption could increase to inadmissibly high values. This is especially the case when centrifugal fans are not started against closed dampers. Careful observation of the start-up is required.

Before the fan is switched off, it shall be operated for some time at low gas temperatures (<100°C), until impeller, shaft and housing have cooled off. This is to prevent heat from the fan impairing the bearings or grease at standstill. Also, the shaft shall be turned until it has cooled off, to prevent warping of the warm shaft.

When using cooling discs for higher temperatures, it should be noted, that adequate cooling is only achieved when the speed of rotation is sufficient. At high impeller temperatures and low speeds (e. g. when running on a frequency converter) or when stopped (e. g. due to emergency stoppage or power failure) the user must ensure that the cooling disc is externally cooled, e. g. with a separate fan with a special power supply.

Additional measures according to local or legal regulations, standards, directions or instructions must be observed. In case of imbalance and abnormal vibrations as well as after dismounting and remounting of the impeller, the fan must be inspected.

8.2 Explosion protection (refer also section 4. explosion-proof fans)

The regulations under VDMA 24 169 parts 1 and 2 as well as DIN EN 1127 are to be complied with. They should constitute the basis for the operation of all equipment in systems which have explosion risk.

Systems that have been designed to operate within a explosion risk zone must be equipped with safety netting on all inlet and outlet openings with a maximum mesh of 12 x 12 mm to keep unwanted particles out. To avoid unwanted objects dropping into the system some type of cover must be provided by the user. Openings must be located in accessible and easily controllable areas. All conductive parts must be earthed. To reduce the explosion risk when aluminium is present the possibility of rust and/or airborne rust must be excluded. Also, no iron oxide or metal based paints may be used. All additional local or regulatory standards, laws and regulations must be investigated and adhered to. The prescribed distance between the rotating and fixed parts has been adhered to while manufacturing the fan. Before starting the fan e. g. after installation or maintenance, ensure that the distance has not been altered e. g. due to wear on the bearing, transport damage, incorrect installation etc. If imbalance and/or abnormal vibrations occur the fan must be stopped immediately and the fault repaired. After maintenance work, such as dismounting and remounting of the impeller, the fan and the distances between rotating and static parts must be checked before restarting.

8.3 Frequency converter

The frequency converter must be set so that unnecessary loads on the fan due to high acceleration or deceleration are avoided. In general the start-up time for an impeller with the diameter of 1000 mm should be at least 30 seconds, between 1000 and 2000 mm at least 60 seconds and for larger diameters 120 seconds.

To avoid frequently repeated accelerations and decelerations which can lead to material fatigue, the process control should be made as slow as feasible.

The accelerations coming from the process control should not be larger than 0,45 rad/s², except when passing through resonance frequencies.

Material fatigue in the impeller and other parts of the fan is reported to have occurred in the past due to frequent speed changes. In order to avoid the impeller should be replaced after, at the most, 0,5 million speed changes (equal to 2 years at 4000 operating hours/year and one speed change per minute).

If resonance frequencies are passed through while doing the speed changes an even lower life expectancy may result.

Warning: After disconnecting the power supply to the frequency converter at least 10 minutes must pass before the leads or other components of the converter can be touched. There is serious risk of injury from stored energy in the capacitors. Also control boards can be at the voltage of the power supply. Before touching any components they should be grounded.

Before mounting and starting operation the special instructions from the manufacturer of the frequency converter must be noted and adhered to.

Some general comments on the use of frequency converters:

- To minimise magnetic fields the motor and converter should be placed as closely together as possible.
- The leads must have a mechanical protection and not be longer than specified by the manufacturer.
- Cable, cable shields, the frequency converter and the motor must be grounded.
- To avoid radio interference additional filters may be necessary.

8.4 Thermal safety

Fans of components that can become less than -10°C cold or more than 70°C warm must be protected on site, be provided with insulation and have warning signs (EN 563). It should be noted that bearings can become very hot, but should not be insulated, since heat accumulation could damage the bearings.

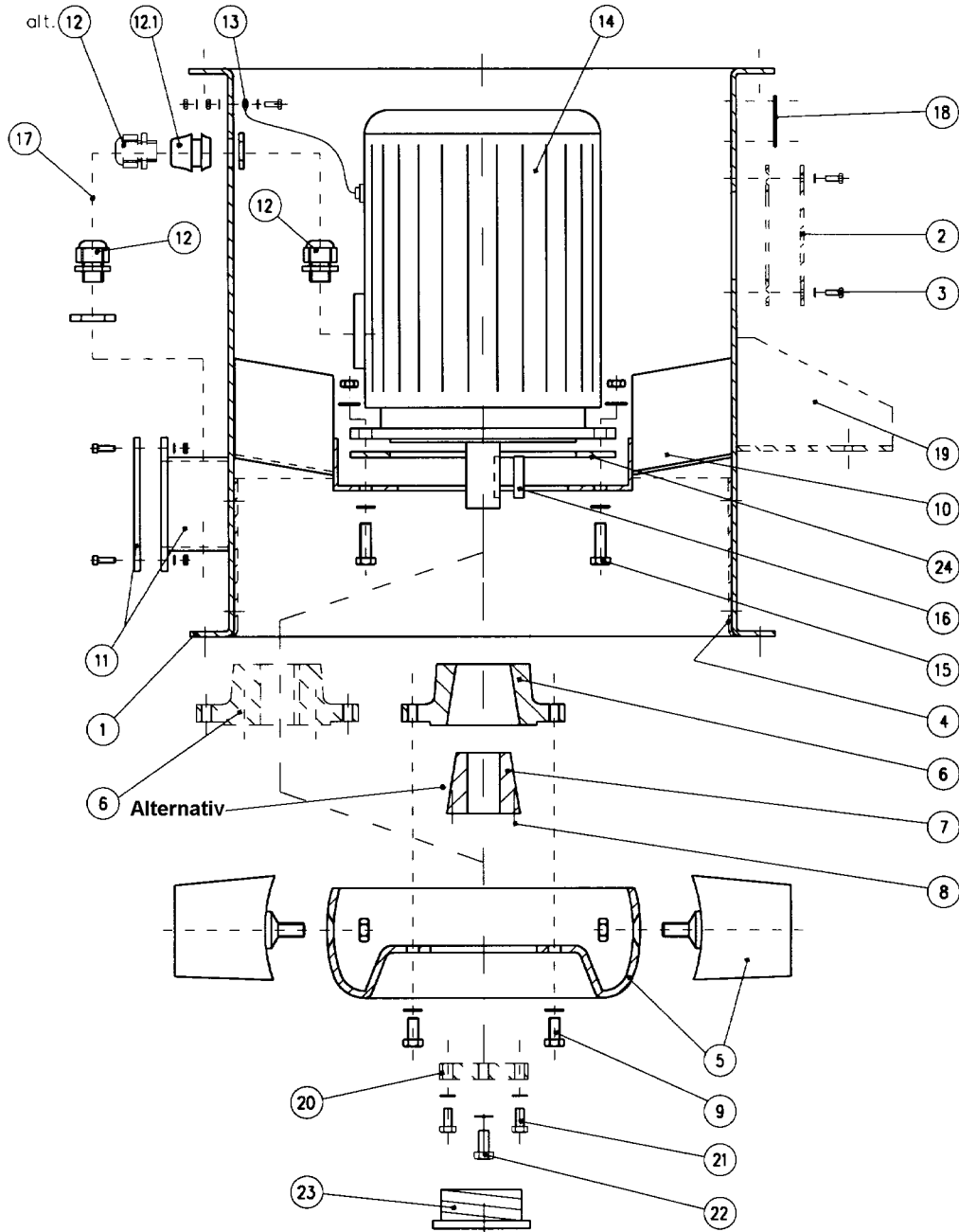
9. DOWN-TIME LIMITATION

Proper mode of operation, checks, regular maintenance and the availability of wear and spare parts are necessary for avoiding fan down-time. Wear parts are among others:

Roller bearings - V-flat belts and pulleys - elastic sleeves - vibration attenuators - sealings - sealing rings - couplings - impeller in the case of abrasive operation.

In order to monitor the fan status a written record is recommended which must be signed and dated by the inspector (see also section 20.)

AXIAL FAN



Part	Description	Part	Description	Part	Description	Part	Description	Part	Description
1	Casing	6	Impeller hub	11	Terminal box IP54 (IP55) with cover and sealing	15	Motor fixation bolt	20	Puller plate w. u.
2	Service access OPT	7	Taperlock bush w. u.	12	Cable gland	16	Key	21	Bolt for puller plate w. u.
3	Bolt for service access OPT	8	Bolt for taperlock bush w. u.	12.1	Cable duct	17	Cable	22	Bolt for puller plate w. u.
4	Anti spark lining OPT	9	Bolt for impeller hub	13	Ground wire OPT	18	Name plate + direction arrow	23	Plastic cap w. u.
5	Impeller	10	Guide vane	14	Motor	19	Mounting brackets OPT	24	Distance ring w. u.

OPT = Optional

w. u. = when used

10. ROOF SUSPENDED-FANS - VERY HIGH SAFETY REQUIREMENTS

The following instructions - in addition to „General Instructions“ - are valid:

A) NECESSARY SAFETY CHECKS

As the fans operate close to persons and are liable to damages and collisions, the fan must be inspected for external damage at least every 6 months. All damaged parts must be exchanged immediately.

The vibration level acc. to VDI 2056 / ISO 2372 in horizontal radial, horizontal axial and vertical radial direction must be checked at measuring points which are marked during the first measurement. By comparing the measured values over a longer time period, changes become apparent. If the values experience major changes, the causes must be investigated, e.g. dirt on the impeller. Perhaps a rebalancing is necessary.

Increased vibration values can lead to destruction of the fan, represent an acute risk and lead to the loss of the maker's warranty. Vibrations may lead to the loosening of suspension bolts in the tunnel roof.

If there is an increased risk of the fan getting dirty, inspection and cleaning must be done more often than described below.

B) RECOMMENDED SAFETY CHECKS

B 1) VISUAL INSPECTION

At least every 6 months, in the beginning more often.

Conduct thorough inspection for damage and corrosion of silencers, impeller, inlet cone, motor, cable, connections, mounting frame and vibration attenuators. Damages, especially damage to the surface protection, must be repaired before they worsen.

B 2) NOISE CONTROL

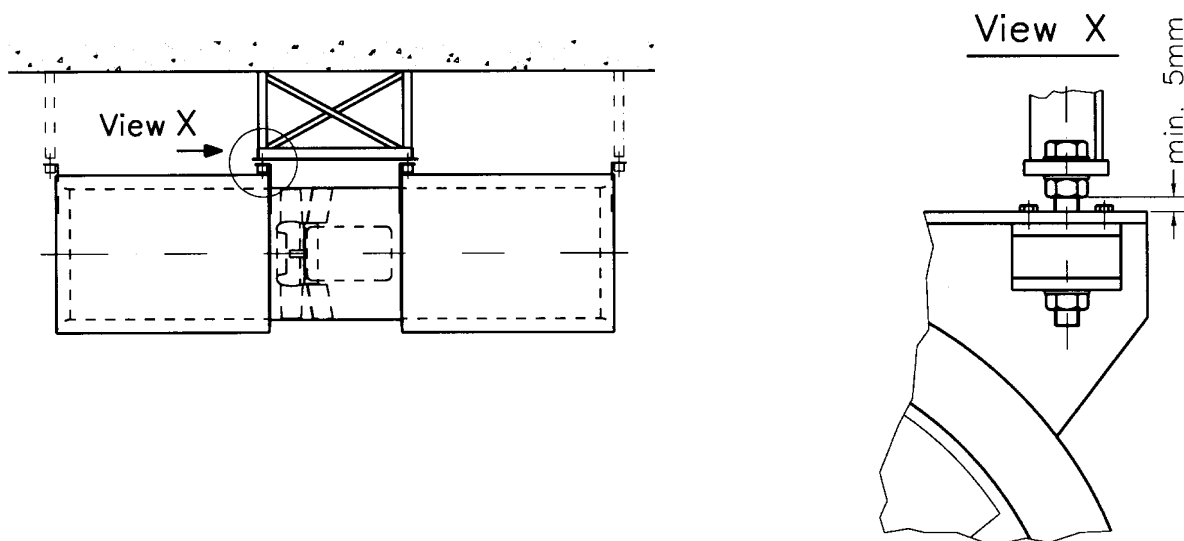
At least every 6 months, in the beginning more often.

The proper operation can be ascertained by checking the noise and temperature levels generated. For this purpose the noise at start and stop can be compared with that of similar fans.

B 3) INSPECTION OF MOUNTING

(every 6 months, in the beginning more often)

Carry out careful inspection of all supporting parts and screw connections. All nuts must be secured against loosening and fixed with the correct torque. Damaged surface protection at the screw connections should be remedied.



10.1 INSTALLATION PLAN FOR ROOF SUSPENDED FANS

1. Number and size of anchor bolts depends on the roof construction and is normally the responsibility of the civil engineer. If not otherwise specified, the following minimum dimensions should be used.

Anchor bolts per fan	:	4 x	anchor bolts M16 (M20/M24)	-	mounting structure
		2 x	anchor bolts M16	-	safety wires
		2 x	anchor bolts M10	-	security switch

2. The holes on the roof are marked using a template and drilled. The anchor bolts are to be fastened according to the maker's instructions. If required, test the bolts with the load specified by the manufacturer.

3. Install the mounting structure. Adjust connection angles (adjustment to tunnel radius $\pm 15^\circ$). Tighten screw connections.

4. Mount the complete jet fan to the mounting structure.

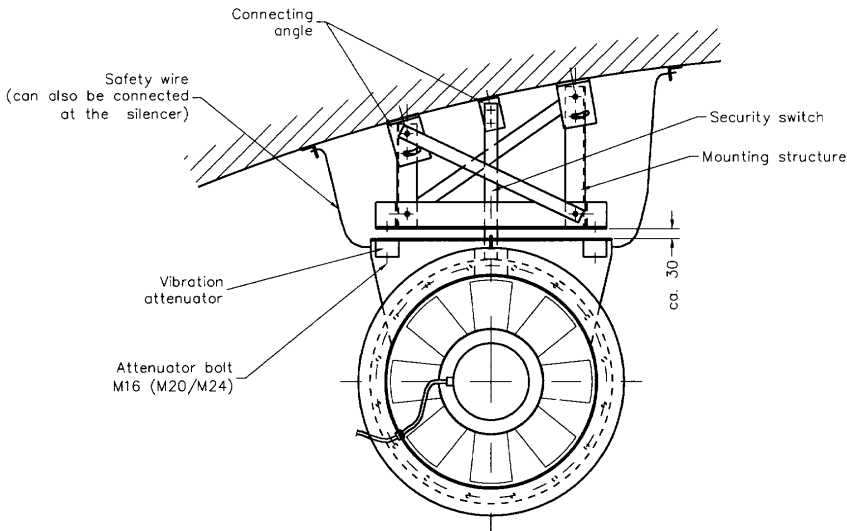
Torques:

Screws DIN 1.4301 or 1.4571 Property class 70	Torque [Nm]
M10	37
M12	65
M16	150
M20	300

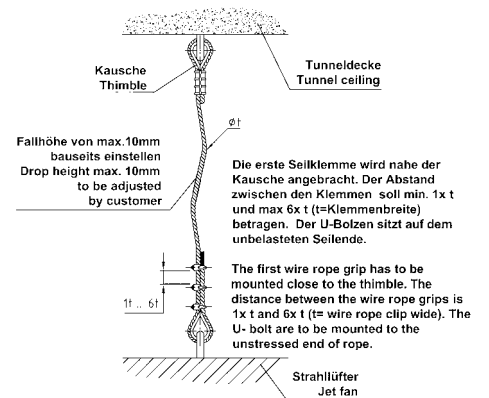
Ensure horizontal adjustment using the attenuator bolts M16 (M20).
 The distance between fan and mounting structure should be approx. 30 mm.

5. Fitting of security switch:
 Drill second screw connection after adjustment of connection angles. Adjust the security switch.
6. Connect the safety wires to the tunnel ceiling with connecting angles 40 x 6, thimbles and screw clamps (our supply). A slack of about 10 mm must be kept.
7. Establish the electrical connections.
8. Inspect surface protection. If necessary repair with the paint supplied with the fan.

STANDARD MOUNTING DESIGN



SAFETY WIRES (OPTION)



Seil- ϕ ; Anziehmoment Rope- ϕ ; Torque figure t	[Nm]	Anzahl der Seilklemmen Units of wire rope grips
5	2	2
6,5	3,5	3
8	6	4
10	9	4
13	33	4
16	49	4

11. DISMANTLING AND REFITTING OF IMPELLERS HAVING AN EXTRACTION DEVICE

Accessibility: At first the impeller must be made accessible. In the case of radial fans this includes:

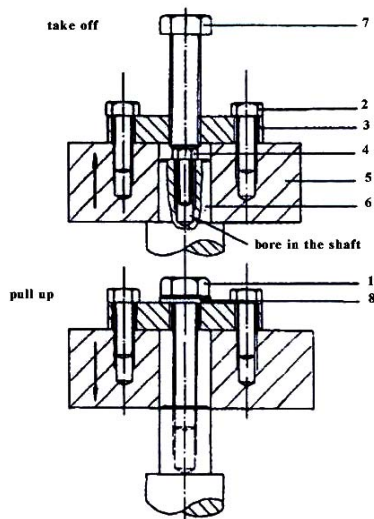
1. Take off duct system at inlet side of the fan.
2. Remove screws at the inlet cone of the casing (includes inlet spigot, protection grill, inlet cone and/or inlet duct).
3. Carefully take off inlet cone **Attention:** Do not damage the sealing.
4. **ATTENTION:** Measure the distance between impeller back disc and inlet cone and maintain it when refitting. Differences in the distance lead to capacity reduction!

For axial fans the fan in general must be dismantled and placed on a level surface with the impeller pointing upwards. Exceptions are swing out type axial fans where the impeller is accessible after opening the door and fans inside jet cowls.

DESCRIPTION OF FUNCTION

For impellers fitted directly on the shaft, the screw (7) is screwed into the fan shaft (6), so that the disc (3) presses against the shaft end. The impeller hub (5) is connected to the disc (3) by means of 2 screws (2).

DISMANTLING OF IMPELLER



No	Part	Indication	Quantity
8	8	washer	1
7	7	dismounting screw	1
6	6	shaft journal	1
5	5	impeller hub	1
4	4	forcing screw	1
3	3	extraction disc	1
2	2	fixing screw, extraction disc	2
1	1	set bolt	1

- a) In case of corrosion a rust dissolving oil must be employed. The use of hammers, crowbars, or other violent methods is not allowed.
- b) Remove the three screws (7) and (2) and lift off disc (3).
- c) Put on screw (4) or small plate into fan shaft bore.
- d) Fit disc (3) again with the screws (2).
- e) Put screw (1) into the thread of the disc (3), as can be seen from above diagrams. Turn to the right until the impeller comes loose.
- f) Then lift out the impeller.
- g) Remove screw (4) or plate.

FITTING OF IMPELLER

- A Fit the disc (3) by means of the two bolts (2) to the impeller hub (5).
- B Clean and grease shaft and impeller bore.
- C Lift impeller onto the fan shaft and press slightly.
- D Put screw (7) with washer into the bore of the disc (3) and screw it as deeply as possible into the motor shaft.

Tightening torque for draw-up screw (7) and fixing screw(2)

Screw	Starting torque [Nm]
M6	10
M8	25
M10	49
M12	86
M16	210
M20	410
M24	710

Fan assembly

Carry out points 1 - 3 in reverse order. Check distances measured under 4. Turn the impeller by hand and check that it is turning freely.

12. DISMANTLING and REFITTING of IMPELLERS HAVING TAPERLOCK BUSHES

Accessibility: At first the impeller must be made accessible. In the case of radial fans this includes:

1. Take off duct system at inlet side of the fan.
2. Remove screws at the inlet cone of the casing (includes inlet spigot, protection grill, inlet cone and/or inlet duct).
3. Carefully take off inlet cone **Attention:** Do not damage the sealing.
4. **Attention:** Measure the distance between impeller back disc and inlet cone and maintain it when refitting. Differences in the distance lead to capacity reduction!

For axial fans the fan in general must be dismantled and placed on a level surface with the impeller pointing upwards. Exceptions are swing out type axial fans where the impeller is accessible after opening the door and fans inside jet cowls.

Description of function:

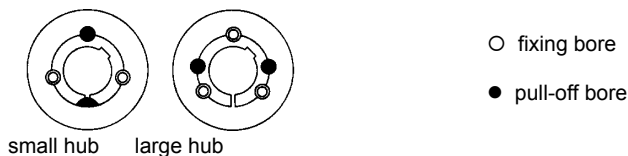
The hub has a conical inner bore. A conical bush, which is cylindrical inside is inserted. When tightening the fixing screws, the bush between shaft and hub is expanded and locked in place.

DISMOUNTING OF IMPELLER

- a) If corroded use rust dissolving oil. Do not use hammers, crowbars or other use of force.
- b) Detach all screws. Depending on size of the bush, unscrew one or two screws, oil them and screw them into the set bores.
- c) Tighten screw(s) uniformly, until the bush comes out of the hub, so that the bush can move freely on the shaft.
- d) Remove impeller with the bush from the shaft.

RECOUNTING OF THE IMPELLER

1. Clean and degrease all uncovered surfaces, such as the bore and the conical surface of the taperlock bush as well as the conical bore of the hub. Insert the taperlock bush into the hub and superimpose all connection bores (half-thread bores must always have half-plain bores on the opposite side).
2. Slightly oil and screw in threaded stud (Gr. 1008 - 3030) and/or cylindrical screws (Gr. 3535 - 5050). Don't fix screws tightly.
3. Clean and grease shaft. Push disc with taperlock bush onto the shaft until desired place is found.
4. When using a slot key, place it first into the slot. Between slot key and bore slot there must be a small gap.
5. Tighten thread studs and/or cylinder screws uniformly by using a screw driver, DIN 911, with the torques indicated in the table.
6. After a short time of operation (1/2 or 1 hour) check torque of the screws and correct if necessary.



Bush	Torque [Nm]	Screws		Bush	Torque- [Nm]	Screws		Bush	Torque [Nm]	Screws	
		Nb.	Size			Nb.	Size			Nb.	Size
1008 1108	5,6	2	1/4" BSW	2012	31	2	7/16" BSW	4040	170	3	5/8" BSW
1310 1315	20	2	3/8" BSW	2517	48	2	1/2" BSW	4545	192	3	3/4" BSW
1210 1215	20	2	3/8" BSW	3020 3030	90	2	5/8" BSW	5050	271	3	7/8" BSW
1610 1615	20	2	3/8" BSW	3535	112	3	1/2" BSW				

Fan assembly

Carry out points 1 - 3 in reverse order. Check distances measured under 4. Turn the impeller by hand and check that it is turning freely.

**13. OPERATING INSTRUCTIONS - User Information
VANE CONTROL WITH MANUAL AND REMOTE CONTROL**

SPECIAL SAFETY ASPECTS FOR RADIAL VANE CONTROLS

We have carefully built a solid and reliable component, which corresponds to the state of the art.

Material damages and personal injuries can result from insufficient maintenance. Increased vibrations may lead to breakage and subsequent damages.

Caution is necessary near moving parts. This applies to the guide vane blades and the driving and/or actuating mechanisms. When fixing the vanes in position the locking mechanism must be checked so that unwanted movement is avoided.

TRANSPORT

During transport by cranes the supporting devices must only be attached to the lifting eyes provided for this purpose.

When using a fork lift no movable parts may be touched nor damaged. Positioning on the floor should be done with the slowest lowering speed. Shocks, shakes and dropping might lead to deformations.

INSTALLATION

Ensure that the casing is not mechanically deformed or twisted in order to prevent jamming of the vane blades or damage to other parts. Guide vane controls may only be fitted so that they conform to the airflow direction for which they were ordered and designed. Please check that the guide vane control gives the air flow a rotational component in the same rotating direction as the rotation of the impeller. All moving parts must be protected against corrosion, dirt and icing.

The centrifugal vane control must be installed in the inlet of the fan. If a duct or flexible connection is not connected to the inlet, an inlet screen or protection grill must be installed. When using a flexible connection the fan and the pedestal should be placed on vibration attenuators. Ducts in front of the inlet should not have bends at a length of at least 2.5 times the inlet diameter in order to avoid uneven flow and turbulence.

Obstructions to the airflow in front of or behind the vane control should be avoided. If this is not possible, the manufacturer must be notified in writing when ordering.

START-UP

Before starting the fan, fan casing and ducts must be inspected for foreign particles. The turning direction is indicated on the fan casing by an arrow. The correct turning direction can be checked by shortly switching on the fan and observing the direction of rotation. The absorbed current must be measured and compared with the nominal value of the motor.

During the starting phase the angle of the vane blades should be changed slowly in order to find the natural resonance frequencies of the guide vane control. Vane angles where the vibration speed exceeds ≥ 7 mm/s must be passed through quickly during operation, if they can not be blocked. Longterm throttling, ≥ 10 min, should be avoided with blade angles of more than 75° ($\dot{V}_{\min} \leq 0,25 \dot{V}_{\text{nominal}}$).

FUNCTION

The guide vane control is designed for the flow indicated on the data sheet of the fan +max.20 %. By means of the guide vane control, operating points below the characteristic curve of the fan can be reached. The control range is dependent on the characteristic curve of the fan, the operating point of the system and the fan.

The power consumption for each working point changes with the setting angle of the guide vane. It is always smaller than the power consumption of the characteristic curve of the fan.

The guide vane can be operated manually or through remote control drives. By means of a guide vane control up to 35% of energy loss can be saved. The guide vane control changes the characteristic curve of the fan, while a throttling control creates additional resistances and thus changes the resistance curve of the system.

Attention: Vane control always causes considerable turbulence - except with fully open vanes. When the turbulence hits the impeller, this may cause very high vibrations. In order to limit these, especially when the motor power is high, the control range should be fine as possible adjusted.

MAINTENANCE

The smooth movement of the various parts of the guide vane control and the device for locking the manual lever must be checked. This should be done at least every six months. The bearing has self-lubricating sleeves so that no additional lubrication is required. During painting care must be taken that the paint does not impair the mobility of the blades and the control devices. For all other bearings the indicated lubrication intervals must be observed. Note that every bearing only has a limited life expectancy.

Ensure the smooth movement of ball leads and tie rods and check for damage or deformations. Defective blade bearings, tie rods or roller bearings of the control ring may lead to increased vibrations and thus to fatigue. Mechanical, electrical or pneumatic control drives must also be checked.

14. FIRE DAMPERS

14.1 SAFETY ASPECTS

We have carefully manufactured a solid and reliable product according to the state of the art. Product damage and personal harm can result from insufficient maintenance. Excessive vibration may cause fractures leading to serious damage.

Caution is necessary near moving parts. This applies to the damper blades and the driving and/or actuating mechanisms. A malfunction of the damper blade lock might cause the blade to move unexpectedly due to its own weight, wind or air flow.

14.2 TRANSPORT

During transport only the specially provided lifting eyes are to be used as attachment points. When using forklift trucks the forks must not be allowed to damage the product. The lowering of the product should be carried out at the minimum lowering speed. Impact shocks, jerking and dropping can lead to deformations.

14.3 MOUNTING

Ensure that the casing is not mechanically deformed or distorted in order to prevent a jamming of the damper blade or damage to other components. Fire dampers can only be used in the installation position for which they were ordered and designed (horizontal or vertical). All movable parts and all control and operating levers must be protected from corrosion, dirt and icing.

14.4 INITIAL OPERATION

In case of fire the damper is closed mechanically either manually by a spring mounted fusible link, by disconnecting the pressurized air supply or the power supply. The purpose is to avoid the spreading of smoke and/or fire along the ducts. Normally the triggering temperature is set to 70°C. Before the initial operation the casing is to be checked for foreign particles. The rotational direction is shown on the casing. The correct direction can be verified through observation of the rotating parts.

14.5 MAINTENANCE - General

Fire dampers fulfil an essential function and must therefore be inspected and serviced regularly. The bearings are made of a stainless steel shaft (DIN 1.4571), with a loose fit inside a bushing of the same material. Lubrication is not required. However, every 6 months an operational check should be done, during which the release mechanism should be tested a number of times so that a quick and faultless closing can be verified.

The bearings must be inspected and cleaned if dirt or salt deposits from sea water spray are observed, e. g. using pressurised air or clean water. When painting, care must be taken to avoid paint restricting the free movement of the damper blade(s) and actuator(s). After a fire the functional capability of all parts must be inspected. Ensure that deformations due to heat have not impaired the tightness or the free movement of the damper. The release mechanism needs special attention during the inspection to ensure its operability.

14.6 MAINTENANCE - Special instructions

14.6.1 Manually operated fire damper

Check the ease of movement of the damper blade and the pin used to lock the manual lever. The manual operation can be a stand alone feature or an addition to an automatic release mechanism. In the second case the manual lever has a special shape allowing the manual closing of the damper irrespective of the automatic release mechanism.

14.6.2 Fire damper with fusible link / thermo switch

In the event of a fire, when the temperature rises above approx. 70 degrees C, the soft solder melts and the fire damper releases automatically. The plunger pin of the catch on the adjusting element is freed, the damper blade falls in the closing direction and is locked into the "CLOSED" position by the locking pin.

A check is carried out by pushing the red button which simulates a thermal release. To check the soft solder melting piece, the inspection flap must be removed and the soft solder melting piece taken out of the release device. Ensure that no outer damage is visible, then reload the spring and replace the soft solder melting piece.

If the fire damper is to be put into service again after a release, a new soft solder melting piece must first be installed into the air shaft. Subsequently one must pull the locking pin out and move the hand lever to the "OPEN" position. To lock it into this position the plunger pin is again pushed into the catch.

14.6.3 Fire dampers with pneumatic cylinder

The fire damper is closed in the pressureless condition by a spring which is built into the compressed air cylinder. The closing procedure can be triggered by one of the following actions:

1. The temperature in the air shaft reaches the pre-set temperature and the temperature valve is actuated.
2. Actuation of the hand valve on the fire damper.
3. Interruption of the power supply to the solenoid valve i. e.: through the electrical temperature switch on the fire damper, halon release, emergency stop switch or failure in the electrical supply.
4. Actuation of the main valve on the control system.
5. Leak in the compressed air supply.

The damper is closed by a spring built into the pneumatic cylinder. The system pressure should be checked. It should be between 2 and 10 bar. The pneumatic cylinder rod must be cleaned regularly and be lubricated with a thin film of acid free lubrication oil. The seals in the pneumatic cylinder are self lubricating. The filter in the pneumatic air system should be checked and if necessary renewed. The filter housing should be cleaned and the accumulated water drained.

14.6.4 Fire damper with electric motor

Check whether the spring built into the electric positioning motor closes if the power supply is interrupted. This can occur if:

1. The temperature in the duct reaches the pre-set temperature
2. The power supply is switched off
3. There is a fault in the power supply

**15. STORAGE INSTRUCTIONS for
SPARE PARTS**

All parts should be stored in a room at 15 - 25°C with a relative humidity of maximum 70 %. Variation in the temperature should be limited to maximum 1°C per hour.

Roller bearings are delivered in the original packing. The maximum storage time is two years. After one year the bearings have to be exchanged. A renewed conservation would be too expensive.

Rubber or rubber coated spare parts such as radial packing rings, O-ring seals, flexible connectors, dampers and V-belts have to be protected against light and have to be sealed in plastic wrapping. The parts should be checked as to their elasticity and brittleness every year. The maximum storage is five years or less according to the manufacturers instructions.

Parts made of metal such as impellers, shafts, bushes, pulleys and bearing housings have to be checked every year. Surface protecting coats have to be preserved, if necessary. Bright finished metal treated parts have to be greased.

16. FUNDAMENTAL SAFETY INSTRUCTIONS for products and components of Fan Systems Group

**21.1 Principle:
designated use**

The machine/installation has been built acc. to the technical state of the art and the recognized technical regulations. Nevertheless, its use may constitute a risk to life and limb of the user or third parties or cause damage to the machine and other material property.

Use machine only in technically faultless conditions as well as according to its designation, adhere to safety regulations and pay attention to dangers, strictly observing the working instructions! Attend to defects impairing safety immediately.

Pay careful attention to the operating instructions as well as the instructions concerning inspection and maintenance.

21.2 Organizational Measures

In addition to working instructions, note general legal and other binding directions concerning prevention of accidents and environmental protection!

Operating instructions are to be complemented by duties regarding operating particulars such as: organization of work, sequence of work, employed staff.

The staff involved with a particular machine must have read the operating instructions before starting work, especially the chapter "Safety Instructions". Doing this during any work is too late. This especially applies to persons working only occasionally on a machine, e.g. during set-up or maintenance.

Check - at least from time to time - whether the staff is carrying out the work in compliance with the operating instructions and paying attention to risks and safety factors.

For reasons of security, long hair must be tied back or otherwise secured, garments must be closely fitting and no jewellery - such as rings - may be worn. Injury may result from being caught up on the machinery or from rings catching on moving parts.

Use protective equipment wherever required by the circumstances or by law!

Observe all safety instructions and warnings attached to the machine.

See to it that safety instructions and warnings attached to the machine are always complete and perfectly legible.

In the event of safety-relevant modifications or changes in the behaviour of the machine during operation, stop the machine immediately and report the malfunction to the relevant authority!

Never make any modifications, additions or conversions which might affect safety without the supplier's approval. This also applies to the installation and adjustment of safety devices and valves as well as to welding work on load-bearing elements.

Spare parts must comply with the technical requirements specified by the manufacturer. Spare parts from original equipment manufacturers can be relied upon to do so.

Never modify the software of programmable control systems!

Replace hydraulic hoses within stipulated and appropriate intervals even if no safety-relevant defects have been detected!

Adhere to prescribed intervals or those specified in the operating instructions for routine checks and inspections!

Specially adapted tools and workshop equipment are indispensable for maintenance work.

21.3 Selection and qualification of staff:

Basic responsibilities

Any work on and with the machine/installation must be executed by reliable persons only. Statutory minimum age limits must be observed. Only employ trained or instructed staff and set out clearly the responsibilities of the personnel for set-up, operation, maintenance and repair!

Make sure that only authorized personnel work on or with the machine!

Work on the electrical system and equipment of the machine must be carried out only by a skilled electrician or by instructed persons under the supervision and guidance of a skilled electrician and in accordance with electrical engineering rules and regulations!

Work on hydraulic systems must be carried out only by personnel with special knowledge and experience of hydraulic equipment!

21.4 Safety instructions governing specific operational phases

21.4.1 Standard operation

Avoid any operational mode that might be prejudicial to safety.

Take the necessary precautions to ensure that the machine is used only when in a safe and reliable state!

Operate machine only when all protective and safety devices, such as removable safety devices, emergency shut-off equipment, sound protections, exhaust installations are in place and fully functional!

Check the machine at least once per working shift for obvious damage and defects. Report any changes (incl. changes in the machine's working behaviour) to the relevant organization/person immediately. If necessary, stop the machine immediately and lock it.

In the event of malfunction, stop the machine immediately and lock it. Have any defects rectified immediately.

During start-up and shut-down procedures always watch the indicators in accordance with the operating instructions.

Before starting-up or setting the machine in motion, make sure that nobody is at risk!

Never switch off or remove suction and ventilation devices when the machine is in operation.

21.5 Special work in conjunction with utilization of the machine/installation and maintenance and repairs during operation; disposal of parts.

Observe the adjusting, maintenance and inspection activities and intervals set out in the operating instructions, including information on the replacement of parts and equipment. These activities may be executed by skilled personnel only.

Brief operating personnel before beginning special operations and maintenance work, and appoint a person to supervise the activities.

In any work concerning the operation, conversion or adjustment of the machine and its safety devices or any work related to maintenance, inspection and repair, always observe the start-up and shut-down procedures set out in the operating instructions and the information on maintenance work.

Ensure that the maintenance area is adequately secured!

If the machine is completely shut down for maintenance and repair - work, it must be secured against inadvertent start-up by:

- locking the principle control elements and removing the ignition key and/or
- attaching a warning sign to the main switch.

To avoid the risk of accidents, individual parts and large assembled units being moved for replacement purposes, should be carefully attached to lifting tackle and secured. Use only suitable and technically faultless lifting gear and suspension systems with adequate lifting capacity. Never work or stand under suspended loads.

The fastening of loads and the supervision of crane operators should be entrusted to experienced persons only. The supervisor giving the instructions must be within sight or sound of the operator.

Always use specially designed or other safety ladders and working platforms for carrying out overhead assembly work. Never use machine parts as a climbing aid. Wear a safety harness when carrying out maintenance work at greater heights. Keep all handles, steps, handrails, platforms, landings and ladders free from dirt, snow and ice.

Before cleaning the machine with water, steam jet (high-pressure cleaning) or detergents, cover or tape up all openings which - for safety and functional reasons - must be protected against water, steam or detergent penetration. Special care must be taken with electric motors and switchgear cabinets.

Ensure during cleaning of the machine that the temperature sensors of the fire-warning and fire-fighting systems do not come into contact with hot cleaning agents as this might activate the fire-fighting system.

After cleaning, remove all covers and tapes applied for that purpose!

After cleaning, examine all fuel, lubricant and hydraulic fluid lines for leaks, loose connections, chafe marks and damage. Any defects found must be rectified without delay!

Always tighten any screwed connections that have been loosened during maintenance and repair.

Any safety devices removed for set-up, maintenance or repair purposes must be refitted and checked immediately upon completion of the maintenance and repair work.

Ensure that all used materials and parts are disposed of safely and with minimum environmental impact.

21.6 Warning of special dangers

21.6.1 Electrical energy

Only use original fuses with the specified current rating. Switch off the machine immediately if trouble occurs in the electrical system.

Work on the electrical system or equipment may only be carried out by a skilled electrician or by specially instructed personnel under his/her control and supervision and in accordance with the applicable electrical engineering rules.

Disconnect the power supply, where applicable, to machines or parts thereof on which inspection, maintenance or repair work is to be carried out. Before starting any work, check the de-energized parts for the presence of power and ground or short-circuit them in addition to insulating adjacent live parts and elements.

The electrical equipment is to be inspected and checked at regular intervals. Defects such as loose connections or scorched cables must be rectified immediately.

Necessary work on live parts and elements must be carried out only in the presence of a second person who can cut off the power supply in case of danger by actuating the emergency shut-off or main power switch. Secure the working area with a red-and-white safety chain and a warning sign. Use insulated tools only.

Before starting work on high-voltage assemblies and after cutting off the power supply, the feeder cable must be grounded and components such as capacitors, short-circuited with a grounding rod.

21.6.2 Gas, dust, steam and smoke

Carry out welding, flame-cutting and grinding work on the machine only if this has been expressly authorized, as there may be a risk of explosion and fire.

Before carrying out welding, flame-cutting and grinding operations, clean the machine and its surroundings from dust and other inflammable substances and make sure that the premises are adequately ventilated (risk of explosion).

Observe any existing national regulations if work is to be carried out in narrow rooms.

21.6.3 Hydraulic and pneumatic equipment

Work on hydraulic equipment may be carried out only by persons having special knowledge and experience in hydraulic systems.

Check all lines, hoses and screwed connections regularly for leaks and obvious damage. Repair damage immediately. Splashed oil may cause injury and fire.

Depressurize all applicable system sections and pressure pipes (hydraulic system, compressed air system) before carrying out any repair work.

Hydraulic and compressed air lines must be laid and fitted properly. Ensure that no connections are interchanged. The fittings, lengths and quality of the hoses must comply with the technical requirements.

21.6.4 Noise

All sound protecting provisions of the machine must be closed during operation.

Always wear the prescribed ear protectors.

21.6.5 Oil, grease and other chemical substances

When handling oil, grease and other chemical substances, observe the product-related safety regulations!

Be careful when handling hot materials (risk of burning or scalding)!

21.7 Mobile machinery and equipment

(Machinery and equipment used at various sites)

For loading use only lifting gear and tackle of sufficient capacity!

Appoint a competent supervisor to assist in the lifting operations.

Lift machinery and equipment properly with suitable lifting gear and only in accordance with the operating instructions (fixing points for lifting tackle, etc.).

Only use suitable means of transport with adequate carrying capacity.!

Fasten the loads safely using the suitable fixing points!

Before or immediately after completion of the loading operations the machine must be secured by means of recommended/supplied devices against inadvertent shifting. A warning sign must be attached to the machine.

Before restarting the machine these devices must be properly removed.

Carefully refit and fasten all parts removed for transport purposes before restarting the machine.

Cut off the external power supply of the machine even if only minor changes of place are planned. Properly reconnect the machine to the supply mains before restarting.

Proceed in accordance with the operating instructions when restarting the machine.