Technical paper : **01**

by Charles Halstead BEng., AMI MechE. Halifax Fan Limited

ATEX - Implications for manufacturers

1. With the introduction of the ATEX Directives in 2003, mechanical equipment for use in hazardous areas will be subject to similar certification as now applies to electrical equipment. This paper aims, by using the manufacture of industrial fans as an example, to highlight areas of interest and concern to manufacturers. As fans are used over a wide range of industries, and are often seen as a major "ignition source", CEN TC 305 have commissioned a specific standard "Design of fans working in potentially explosive atmospheres" and it is this standard which forms the basis of this paper. It is hoped however, that some of the principles will be applicable to other industrial products.

2. Current Standards

Whilst electrical equipment is presently covered by current Hazardous Area Certification (Exn, Exd, Eexde etc.,), no such certification exists for non electrical machinery, including fans. Where specified manufacturers may offer spark reducing features, that vary from brass rubbing strips to more sophisticated levels of security, the degrees of protection vary widely. Often, in more demanding applications, the final specification is arrived at by consultation between interested parties.

3. Information required from end user

The term "end user" can be taken literally; often on large projects a supply chain will be in existence ie. user - main contractor - major contractor - equipment manufacturer - equipment manufacturer. Whatever the supply chain, the equipment manufacturer will require additional information for equipment to be used in hazardous areas.

3.1 Zones and Categories

The familiar Zones 0, 1 and 2 are retained for gases and vapours and 20, 21 and 22 for dusts. The categories 1, 2 or 3 are introduced to give an indication as to the level of security. The category is a function of the zone - the likelihood of the presence of an explosive mixture - and the consequence of an explosion. Table 1 shows the normal relationship between category and zones.

Table 1 - Zones and categories for gas, vapour and dust

Directive 94/9/EC Group II fans classification	**Directive 1999/92/EC** Area classification gas, vapour, mist
category 1G	zone 0
category 2G	zone 1
category 3G	zone 2
Directive 94/9/EC Group II fans classification	**Directive 1999/92/EC** Area classification dust
category 1D	zone 20
category 2D	zone 21
category 3D	zone 22

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In some cases the category may be higher or lower than that shown. For example, a Zone 1 fan in a hospital laboratory might be built to Category 1. Alternatively a unit supplied on a remote plant might be manufactured to a lower category. In either of these cases, it is the responsibility of the user to specify to the manufacturer the Zone and category required.

3.2 Gas and Dust Groups

As with existing electrical equipment, the manufacturer must be informed of the nature of the explosive component. This could include gas group, auto ignition temperature and dust type.

3.3 Normal and Expected Operating Conditions

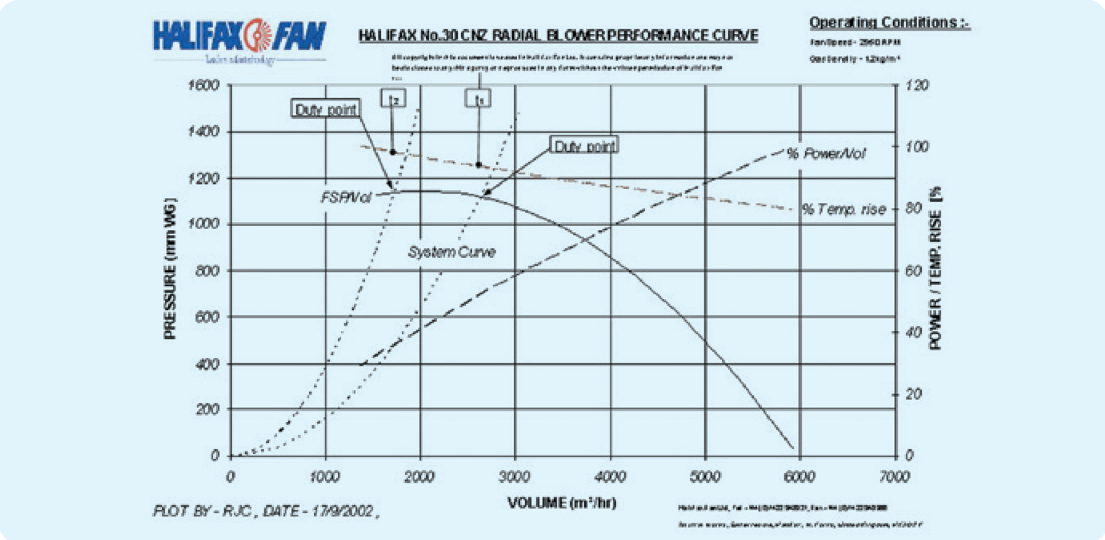
In order for the equipment manufacturer to carry out a full risk assessment, all normal and anticipated operating conditions must be considered. For the case of industrial fans, two specific examples are given.

3.3.1 Changes in Duty Point

In the case of, say, a centrifugal fan operating a solvent extract system, figure 1 shows the usual fan performance curves - volume-pressure and volume-power, with an additional line showing temperature rise across the fan.

With a design duty point as shown, the temperature rise across the fan is t_1°C. If due to, say, a number of extract legs being shut down, the system curve steepens, the fan will now operate at duty point 2, with a corresponding temperature rise of t_2°C. Whilst the fan standard covers some deviation from the normal operating point, as can be seen, major changes from design duty point could cause increased heating within the fan. Should such changes be envisaged by the end user, these must be brought to the attention of the manufacturer.

Figure 1
Effect of change in duty point on temperature rise across a typical centrifugal fan



3.3.2 Inverter Drives

With the increase in use of inverter drives, another potential hazard is increased temperature generation within a motor. It is a common mis-conception that all fans follow a variable square torque characteristic with varying speed. Whilst this is true for a fixed system, i.e., an extract fan, for other duties this is not the case. A typical example may be an induced draught fan on an incinerator. In many cases these are used to give a constant negative pressure in the combustion chamber at varying flow rates and flue gas temperatures. Often the motor may be required to run at 50% speed and produce well in excess of the 25% full load torque that would be available from a conventional variable torque rated motor. Table 2 gives a typical range of duties required from a 762mm diameter fan used to generate a constant negative pressure of 5 KPa.

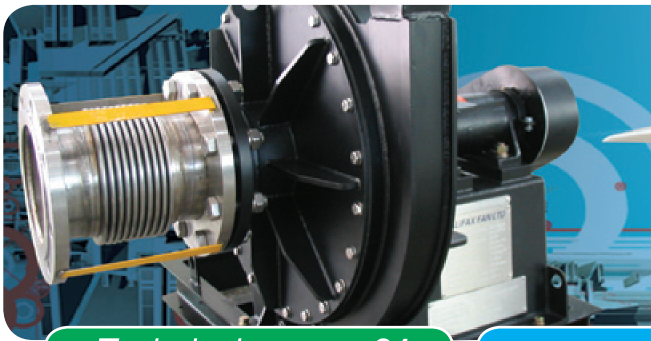


Table 2
762mm diameter fan duties to give constant negative pressure of 5 KPa over range of operating temperatures

Speed (RPM)	Temperature (degC)	Fan Absorbed Power (kW)	Torque (Nm)
2950	315	31	100
2450	140	24	93.5
2100	20	20	90

From the above table it can be seen that the required torque is almost constant. Clearly the manufacturer would need to ensure that the motor is capable of providing the required torque over the speed range. In the event that the motor was outside the scope of supply the relevant information would need to be passed to the motor supplier.

4.0 MANUFACTURERS RESPONSIBILITY

4.1 Risk Assessment

This is required to identify significant hazards and possible hazardous events that may occur. In the standard for industrial fans, this has been carried out as part of the standard. It is however, the manufactureris responsibility to ensure that ALL significant risks have been covered for the particular machine in question. The risk assessment also includes measures to prevent an ignition source from becoming effective. See appendix for typical example of risk assessment.

4.2 Design Specification

It may be that some industrial equipment will require very little in the way of design changes. However, in the case of industrial fans this is not the case. In order to certify units ATEX compliant, and dependant on the category supplied, previous industry standards will not be applicable. Whilst it is not the purpose of this paper to list the required design details, some of the more far reaching changes are worthy of comment i.e.

- Gas tight fan cases
- Impellers capable of overspeed testing
- Preferred materials for rotating - non rotating parts
- Bearing design
- Drive arrangement
- Impeller attachment

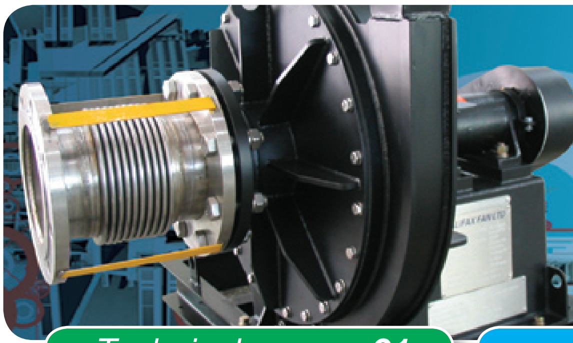
The final execution of the design lies with the manufacturer. Where, as is the case of fans, a specific standard exists, this can be used as basis for the design. For more specialised machinery, the design features are left to the manufacturer. In this latter case the manufacturer would need to work within the relevant general European Standards.

4.3 Testing and Certification

Coupled with the increased design specification are increased testing requirements. Where testing requirements are clearly defined it is the manufactureris responsibility to ensure these are carried out. In the absence of a specific standard, it is the responsibility of the manufacturer to ensure that suitable testing is carried out, the aim of which is to show that ignition sources are prevented from becoming effective during normal operating malfunction and rare malfunction. Clearly the degree of testing is open to some interpretation and in these cases liaison between concerned parties may well be necessary.

4.4 Third Party Certification

In some cases, typically Category 1 fans, a degree of third party certification is required. This should be carried out by the relevant notified body. Whilst type testing is acceptable and is well established for electric motors where large quantities of identical units are supplied, for other equipment i.e. fans, pumps, mills, filters etc., this is somewhat impractical. Often units are one-off designs, and as such each will require third party certification.



4.5 Documentation Requirements

Dependant on the degree of protection the following apply to industrial fans.

Category 3 -	Technical Documentation held by manufacturer
Category 2 -	Technical Documentation held in sealed envelope by notified body
Category 1 -	Notified body to ascertain by EC - type examination that relevant applicable safety provisions are met.

Unfortunately this does not specify :

a) How long a file should be held.

b) The degree of detail to be held by either the manufacturer or the certified body.

It may well be that these questions are not resolved until a failure occurs and are then addressed in court.

4.6 Marking and Labelling

It is a requirement that each machine is fitted with a clear nameplate giving the following information.

- name and address of the manufacturer;
- mandatory CE marking of the fan when being supplied to an EC country;
- year of construction;
- designation of series or type (if any);
- serial of identification number;
- rating information (casing pressure and temperature);
- conditions of use;
- reference to relevant standards;
- reference to instructions for installation, commissioning and maintenance;
- safety marking;

Additionally for category 1 and 2 fans the rating information shall be on the nameplate (see pr EN 14461). (Note this standard is not yet published).

4.6 Installation

There is a responsibility placed on the manufacturer that consideration is given to activities that may cause additional risks once the equipment has left the place of manufacture and testing. This could be damage in transit, erection, handling or incorrect installation. The ATEX standard advises that users request assistance from the supplier with the onsite installation of category 1 and 2 equipment. Whether this will become the norm remains to be seen but in any event, the manufacturer has a duty to provide full installation instructions.

4.8 Information for Use

This follows on from the above sub section. In addition to the information required above, manufacturers will need to supply.

- Shipping instructions.
- Storage instructions.
- Erection and commissioning manual.
- Operating and maintenance manual.

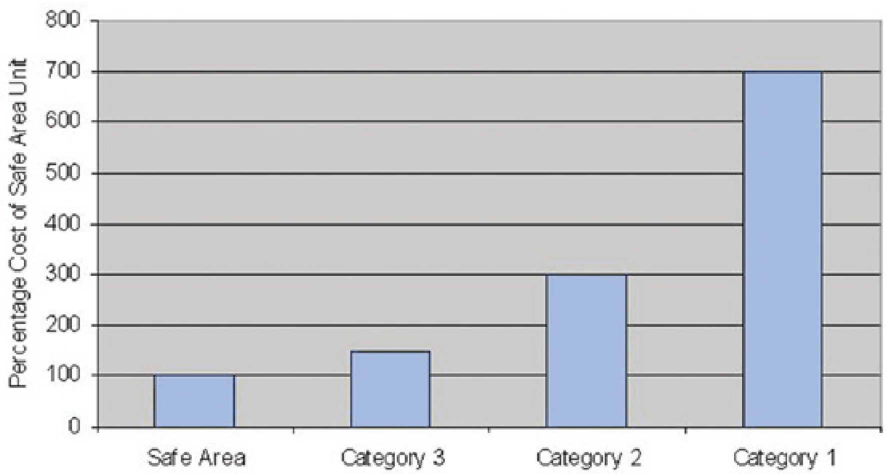
Again there is a responsibility on the supplier to take into account possible occurrences once the equipment has left the factory that may affect the integrity of the equipment. Whereas in the past such occurrences may have effected a claim under the manufacturerís warranty, there is now a much greater onus on the supplier to make the user aware of such pitfalls, and to some extent make provision for them during the design stage.

by Charles Halstead BEng., AMI MechE. Halifax Fan Limited

5.0 CONSEQUENCES OF CHOICE OF CATEGORY

Table 3

shows a simple cost analysis for a typical centrifugal fan.



This however, only gives part of the story. At present there are fewer than half a dozen manufacturers in Europe than can produce a Category 1 Fan. This type of fan probably represent less than 0.5% of total fan applications. Will this change? Zone 0 and Zone 20 are defined as areas with the permanent presence of explosive mixture. This could be interpreted such that many thousands of dust handling fans or extract fans would be classified into Category 1, with the expense, complexity and long lead time associated with this.

An example could be a fan handling air from a dryer. The air stream could contain both flammable gases and/or dust. Historically the fan would have been supplied with spark minimising features. This may have added approximately 5% to overall cost. If now ATEX is applied, and the view taken that in its normal operation the fan handles an explosive mixture, would this make it a Category 1 fan ? From a manufacturerís view point no clear guidance exists. There may be a tendency to adopt a ëbetter safe than sorryí attitude, but, even removing commercial considerations, there is probably not enough capacity in test houses alone to certify all the units that could fall in this category.

6.0 CONCLUSION

In order to satisfy the new ATEX directives manufacturers will require :

1) Full instruction from the user with regard to zone classification, equipment category operating conditions and any other details that may affect operation of the equipment and its ability to prevent it becoming a possible source of ignition.

They will then be required to :

1) Carry out a risk assessment regarding ignition sources and effective preventative measures
2) Carry out best practice design.
3) Carry out suitable testing.
4) To hold necessary design information for future inspection.
5) Provide detailed instructions for the installation commissioning and use of equipment within their scope of supply.

Taking industrial fans as an example, the new ATEX Directive will call for manufacturers to take extra responsibility for their products. The user will see additional expense, complexity and longer lead times.

Finally, in many uses there will be the need for increased dialogue between purchaser and supplier at the design stage to enable the correct specification to be arrived at.

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APPENDIX

Typical Risk Assessment for Industrial Fan for use in Potentially Explosive Atmosphere

Identification of hazards and required countermeasures

No.	Potential ignition source	Clause or annex	Measures applied to prevent the source becoming effective
1		All categories	
1.1	Transportation damage	6.4	Manufacturers instructions for transport
1.2	Storage damage	6.4	Manufacturers instructions for storage
1.3	General environmental influences	6.4	Manufactures instructions for erection concerning : a) Environmental temperatures *(comment: special requirements may apply for electric components if they can become exposed to temperatures in access of 40ºC)* b) Environmental humidity *(comment: Especially for electric components)* c) Environmental pollution d) Environmental corrosivity
2.7	Ignition due to contact between static and moving components caused by foreseeable misalignment and wear and tear	5.2.1.2 5.1.3.4.1	Minimum clearance Suitable material pairings
2.8	Ignition due to contact between static and moving components due to shafts sliding in bearings	5.2.1.4	Shaft fixation in bearing
2.9	Ignition due to bearing failure	5.2.1.4	Bearing specification
2.10	Ignition due to seal friction	5.2.1.3	Shaft seal specification
2.11	Ignition due weakening of materials and bridging of gaps due to corrosion	5.2.1.8	Corrosion protection
2.12	Ignition due to electrostatic dis-charges in connection with belts	5.2.1.7	Belt drive rules
2.13	Ignition due to contact between rotating and static fan parts caused by predictable loss of gap caused by creeping materials	5.1.3.4.1	Material pairings
2.14	Ignition due to contact between rotating and static components caused by thermal deformation	5.1.3.2 5.1.3.3 5.1.3.3	Suitable materials
2.15	Ignition due to mechanical faults and fatigue	5.1.3.5 5.2.1.1	Vibration control
2.16	Ignition due to contact with foreign particles	5.2.1.10 5.1.3.4.1	Protection against foreign particles Material pairings
2.17	Ignition caused by electrical components	5.1.3.8	Electric installation Electric equipment
2.18	Electrostatic ignition	5.1.3.7	Electrostatic discharges

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Note:
Clause or annex refers to relevant section of CEN/TC305/WG2/SG1

"Design of fans working in potentially explosive atmospheres"

No.	Potential ignition source	Clause or annex	Measures applied to prevent the source becoming effective
2.19	Burning of fan components and smoke poisoning	5.2.1.9	Fire resistance of plastic
3	Category 2G and 2D (Hazards and measures in addition to those already listed for all categories and for category 3G and 3D [item 1 and 2] in order to reach a high level of protection)		
3.1	Ignition caused by stray or unsymmetrical currents	no	See EN 1127-1:1997, chapter 6.7.4.4
3.2	Ignition caused by lighting	no	See EN 1127-1:1997, chapter 6.4.8
3.3	Ignition caused by radio frequency, electromagnetic waves	no	See EN 1127-1:1997, chapter 6.4.9 and 6.4.10
3.4	Ignition caused by ionising radiation	no	See EN 1127-1:1997, chapter 6.4.11
3.5	Ignition caused by ultrasonic	no	See EN 1127-1:1997, chapter 6.4.12
3.6	Ignition caused by adiabatic compression and chock waves	no	See EN 1127-1:1997, chapter 6.4.13
3.7	Ignition caused by exothermic reactions	no	See EN 1127-1:1997, chapter 6.4.14
3.8	Burning of fan components and smoke poisoning	5.2.1.9	Fire resistance of plastics
4	Category 1G (Hazards and measures in order to reach a very high level of protection. In addition to the hazards and methods referred to for all categories and categories 3G,3D,2G,2D [item 1,2 and 3]		
4.1	Internal fire or explosion due to rare and unlikely ignition process. Spreading of fire or an explosion inside the fan to the outside environment	A.4.3.6	Casing strong enough to contain an internal explosion. No elastic connection to ducts.
4.2	Spreading a fire or an explosion inside the fan along supply or exhaust ducts	5.2.3.2	Flame arresters as an integral part of the fan at both inlet and outlet side of the fan able to contain the fire or explosion
5	Category 1D (Hazards and measures in order to reach a very high degree of protection in addition to those listed for all categories and categories 3G,3D,2G,2D,1G [item 1,2,3 and 4]		
5.1	Spreading of an internal or external fire of explosion, inside the fan, along supply or exhaust ducts	5.2.4.2	Fast acting valve systems are an integral part of the fan at both inlet and outlet side. The ducts between fan/casing and the valves, if present, should be able to contain the fire or explosion as well

Halifax Fan Limited
Mistral Works, Unit 11,
Brookfoot Business Park,
Elland Road, Brighouse,
West Yorkshire HD6 2SD, UK
T: +44 (0)1484 475123
F: +44 (0)1484 475122
E: sales@halifax-fan.co.uk

Halifax-Fan (Shenzhen) Co Ltd
1 & 2F, No. 4 Building
Creative Industrial Park
Shang Xia Wei, ShaJing,
Shenzhen,
GuangDong Province, China
Tel No. 0086 755 8149 0059
Fax No. 0086 755 8149 0019