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ATEX Fan Guide – EN14986

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ATEX Fans – EN14986

Introduction

ATEX fans are fans designed for use in potentially explosive atmospheres and are governed by EU Directive 2014/34/EU. This Directive is intended to increase safety by using a logical risk identification and mitigation method for design manufacture and use.

With so many fans in operation in potentially hazardous areas, and the real and perceived risk of such fans causing a possible ignition, in addition to the general mechanical standards (ISO/IEC 80079-36 & 80079-37), a specific EN (Euro Norm) standard exists. **EN14986:2017** ***Design of fans working in potentially explosive atmospheres*** details design and documentation requirements for ATEX fans.

As fans are essentially mechanical devices there is no legal requirement for third party certification, issuing of ATEX certification is left to the person or body placing such equipment on the market. However for an end user, having such a certificate is not the full picture, there is still a degree of due diligence required to ensure the equipment is suitable. Whilst an end user could not reasonably be expected to carry out a clause by clause verification for a given fan, there are a few fundamentals that should be checked.

This document aims to give a guide to engineers on the main features of such fans and to help in verifying there suitability for a given application.

Zones and Categories of Equipment.

Historically electrical equipment was designed for operation in "zones". The zoning of an area within an industrial facility is usually a result of a HAZOP study at the early stage of development. The important thing is that this is an "end user" responsibility, it is not the responsibility of a machinery supplier to specify the applicable zone for a hazardous area.

The recognised zones are;

Gas	Dust	Definition[1]
Zone 0	Zone 20	Hazard present in normal operation of for long periods (typically >1000 hr/year)
Zone 1	Zone 21	Hazard is likely to occur in normal operation (typically >10 but <1000 hr/year)
Zone 2	Zone 22	Hazard not likely to occur in normal operation and, if it occurs, will only exist for a short time. (typically <10 hr/year)

Having established the relevant zone for a given area, the ATEX directives then categorise equipment by its suitability for use in a given zone. The category of equipment can be considered a "degree of protection". Three categories of equipment are available, category 1 given the highest degree of protection and category 3 the lowest. Categories are further denoted by either G (Gas) or D (Dust) depending on the nature of the hazard.

Zone 0		Zone 1		Zone 2	
Gas	Dust	Gas	Dust	Gas	Dust
1G	1D	2G	2D	3G	3D

Again as with zoning the selection of category of equipment is the responsibility of the end user, though generally this is taken direct from the table above. However in some circumstances a higher category of equipment may be chosen, ie category 2G equipment in a Zone 2 Gas hazard. An example maybe where the consequence of ignition is deemed so severe, regardless of the possibility, that equipment with a higher degree of protection is selected.
It follows that any fan supplied needs the correct level of protection, or in other words is manufactured to the correct category. This should be clearly shown on both the label (see below for explanation of labelling) and any documentation.
If the category of equipment is not clear on both documentation and labelling then it may not be the correct fan.
Industrial fans can be roughly split into two sectors

1) Standard designs – for ATEX units these will carry the manufactures certification, including ATEX Category. In this case the user can ensure it is suitable for their application
2) Configured or bespoke design – for ATEX units these will be deigned to meet the category specified. Here the user needs to tell the manufacturer the required category.

<u>Maximum Surface Temperature.</u>
An important part of the concept for ATEX fans is control of temperature, in both normal and possible upset/fault conditions.
By keeping temperatures below a critical value ignition can be controlled. Different gasses and dusts have different critical temperatures. These are often called the “auto ignition temperature” meaning the temperature where, even without an additional ignition source the gas/dust will ignite.
The end user is responsible for products used/produced in their facility and it follows therefore, as with zones and categories, that specifying the maximum allowable temperature is their responsibility.
Gasses are generally grouped in one of 6 temperature groups T1 to T6.

Gas temp class	Max allowable surface temp	Gas temp class	Max allowable surface temp
T1	450^{O}C	T4	135^{O}C
T2	300^{O}C	T5	100^{O}C
T3	200^{O}C	T6	85^{O}C

For dusts the actual maximum surface temperature is given eg T135^{O}C
For dual certified equipment, that that is suitable for both a gas and dust hazard both the gas and dust temperature must be given eg T4 T135^{O}C
Similar to with the categories if a standard pre certified fan is being selected then the suppliers documentation should shows the maximum surface temperature to enable the user to ensure correct selection. For a bespoke unit temperature needs to be given to enable design to be carried out.

<u>Equipment Protection Level (EPL)</u>
This is a relatively new concept and is based on the Zoning of equipment and the ignition hazard assessment. Here possible faults/sources of ignition in the fan are assessed.

Zone	ATEX Equip category	Ignition source present during.			EPL Gas/Dust
		Normal operation	Expected Malfunction	Rare Malfunction	
0	1	yes**	yes**	yes	Ga/Da*
1	2	no	yes	yes	Gb/Db
2	3	no	no	yes	Gc/Dc

Notes * EN 14986 does not cover manufacture of Zone 0 cat1 Da fans.

** For Zone 0 cat 1 Ga fans two measures required to prevent ignition source second of which is an "explosion proof" case and flame arrestors.

Flame arrestors cannot be used for Da protection as these would blind up due to conveyed dust hence exclusion of Da EPL.

What does this table tell us?

For fans used in Zone 0 where hazardous gas is normally or frequently present INSIDE the fan case highest level of protection "**a**" required. Fan is designed so there are two separate mitigations to prevent ignition in normal operation and during an expected malfunction. Fan is also safe in event of a rare malfunction which could be two simultaneous expected malfunctions. Such zone 0 fans are very specialised and are subject to third party testing and certification.

For Fans used in Zone 1 a medium level of protection "**b**" is used to give protection in normal operation and during "expected malfunction"

For Fans used in Zone 2 the lowest level of protection, "**c**" is used giving protection during normal operation.

Fans present a couple of anomalies.

1) The use of "material pairings" (see Detailed fan design – material pairings below) is still required for Zone 2 fans in many cases
2) The possible different zones, categories and protection levels inside and outside the fan casing. This often requires dual labelling. Generally to take into account that few fans are truly "gas tight" only one category difference is allowed between the internal and external of a ducted fan.

<u>Protection Concept</u>

This is a relatively new concept but is a guide to how the EPL has been achieved.

Readers may be familiar with the Exd marking of electrical equipment where the d indicates explosion protection – any explosion is prevented from propagating beyond the motor housing.

For mechanical equipment the available options are ;

Protection Concept	Flameproof	Pressurised	Enclosure	Construction	Control of ignition	Liquid immersion
Code	Exd	Exp	Ext	Exh	Exh	Exh

En 14986 covers "constructional safety" so fans complying to it should be marked Exh.

<u>Labelling</u>

Correct labelling is important. It gives a quick easy way to check the suitability of a given fan. Clearly displayed on the nameplate should be something in the format shown below.

		Internal		External
CE Ex	**II**	**2GD**	**/**	**3G2D**
1 2 3		4		4
Gas		**Exh IIB T4 Gb**	**/**	**IIB T4 Gc**
		5 6 7 8		6 7 8
Dust		**Exh IIIB T175°C Db**	**/**	**IIIB T175°C Db**
		5 6 9 8		6 9 8

Ket

1 CE mark

2 Ex mark showing equipment is ATEX certified suitable for potentially explosive atmosphere

3 II Roman numeral 2 denotes equipment group I is for mining equipment II surface equipment. EN 14986 covers only group II equipment.

4 2GD 3G2D Equipment category 1,2 or 3. G for Gas, D for Dust & GD combined gas & dust

5 Exh Protection concept. Applies to internal and external zoning of fan.

6 IIB This specifies the gas group. Gas groups are IIA typically propane, IIB ethylene and IIC hydrogen.

IIIB This specifies the dust group. Dust groups are IIIA combustible flyings, IIIB non-conductive dust, IIIC conductive dust.

7 T4 max surface temp gas. T1= 450°C, T2= 300°C, T3= 200°C, T4= 135°C, T5= 100°C & T6= 80°C

8 Gb Gc & Db Equipment protection level for gas and dust both inside and outside fan case

9 T175°C max surface temp dust. Common values 110, 135 145°C

/ separation between internal and external of enclosed fan case. It should be clear if the fan is certified the same internally and externally or if these are different.

If you can't see this information on your fan nameplate you may not have the correct certified fan, or even not an ATEX fan at all.

Unlike electrical equipment there is no notified body number as equipment is self-certified. As mentioned in the introduction this is acceptable for mechanical equipment but there is a degree of due diligence required from the user that correct equipment has been selected.

If your fan is marked Exd be careful that somebody has not just transferred the motor marking to the fan case, it happens. Fans complying with EN14986, where this standard is taken as the overarching design document cannot be marked E xd!

Detailed Fan Design

EN 14986 sets out a number of minimum design rules to which hazardous area fans should comply. It is legally possible to produce a fan that does not comply and complies with ISO/IEC 80079-36 & 80079-37 but there would have to be a very good reason why – such special cases where they do exist are beyond the scope of this paper.

The following section looks at some of the more important design requirements of EN14986.

Maximum Surface Temperature.

From the section on marking it can be seen that the maximum expected surface temperature inside / outside the fan case should be displayed. This is the highest of either

1) Maximum temperature in operation due to heating eg bearings, seal friction etc

2) Max temperature at fan outlet. This is as a result of the “work done” on the gas as it passes through the fan. The standard applies a 20% margin on the calculated/measured outlet gas temperature in degrees C

Note it is NOT possible to ATEX certify a fan for are given temperature, for example T4 when the maximum design temperature of the gas already exceeds this. This may seem obvious but the auther has seen countless examples of this especially on ID fans in the oil/gas & petrochemical industries.

Material Pairings

Although the protection concept is ‘exh’ i.e. by design the standard identifies that in the event of expected malfunction or rare malfunction there is a high possibility of contact between stationary and rotating parts. This would be the impeller inlet and inlet cone on a centrifugal fan and blade tips and casing on an axial fan.

The material parings have been selected to reduce risk of sparks and hot spots due to frictional rubbing in the event of movement between stationary and rotating parts.

In general the common pairings are given in table below

A full list of all pairings with notes is given in EN 14986 clause 4.7.2 table 1

Common pairings found in industrial fans

Material 1	Material 2	Category 3	Category 1 & 2	Notes
Carbon & Stainless Steel Aluminium alloy	Navel Brass CuZn39Sn	yes	yes	Most common method used 3
Aluminium alloy	Aluminium alloy Navel Brass	yes	yes	1
Steel alloy Stainless steel Nickel alloy	Steel alloy Stainless steel Nickel alloy	yes	yes	2,3
Steel alloy	Brass CuZn37	yes	No	2 Brass should be the stationary part
Plastic	Plastic Aluminium Steel alloy Stainless Steel	yes	yes	4
Rubber coated material	Rubber coated material Steel alloy	yes	yes	5,3

Notes

1 Aluminium should contain approx. 12% silicone. This gives a brittle structure which will fracture rather than deform under prolonged contact

2 These pairings will cause sparks and therefore are restricted to; motor power 5.5 kW, relative rubbing speed 40 m/sec AND where the specified clearance between parts can be assured on installation and during use. Manufactures instructions should include details on how to measure and maintain clearance in use.

Outside of these parameters, for example where fan is handling corrosive chemicals, other forms of protection are necessary.
3 Stainless steel should be Austenitic non magnetic
4 The use of plastic should be carefully considered due to, low thermal conductivity leading to hot spots, low mechanical strength and possibility of static discharge. For category 1 & 2 fans plastic should withstand short term exposure to flames. Details should be given in technical documentation
5 For rubber lined impeller maximum tip speed 70 m/sec (223mm dia impeller at 3000 rpm, 446mm dia at 1500 rpm). Minimum clearances to be maintained in use.

What can we conclude from the above?

a) For most common method of protection correct brass must be used. If "Navel Brass" is NOT used then restricted to category 3 (zone 2 machines) and <5.5 kW & 40 m/sec rubbing speed see c below
b) Historically aluminium has been used as a non-sparking material, however if aluminium on aluminium is used the requirement for minimum silicone content may result in material being unsuitable for impeller
c) If steel on steel or stainless on stainless is used this is limited to small fans (127mm contact diameter at 3000 rpm or 254mm at 1500 rpm). Also user must be able to confirm clearance when fitted – often this is unrealistic. IOM manual should contain instructions on required gap and how to measure it. User should measure this gap record it and check it as part of maintenance procedures.
d) Plastics need careful selection and IOM should contain details of plastic used with regard to thermal, electrostatic and flame retardant properties.

<u>Clearances between rotating elements and fan casing.</u>
En 14986 states "the clearances between rotating elements and fan casing is the most important safety feature of ignition minimising fans.
As such it is important that this is not only correctly set by the manufacturer but also maintained in operation. As we have seen above regarding material pairings there is a requirement for certain pairings that this is ensured on site.
The manufactures instructions should give details how this can be maintained on site. A fan supplied without this information is not an ATEX fan! Similarly if a fan is installed with for example a steel on steel material pairing and no records of the actual running clearance when installed exists then there is no certification. Bearing in mind the size restriction for such a pairing and the practical difficulties of measuring the clearance it is difficult to justify such a selection in the vast majority of applications.

If you have an ATEX fan with no information on the running clearances or how to check them you should ask why not?

<u>Fan Casing</u>
These should be rigid design, generally with fully welded seams and designed to minimise leakage. If fan is not gas tight or leakage rates are not known only one category difference between internal & external is allowed to take into consideration leakage.

<u>Impeller Construction</u>
Impellers should be of rigid design, and either

a) Tested at 115% running speed

b) Designed such that primary stresses (tangential, radial and bending) are 2/3 material yield stress.

A welded construction, cast or moulded with appropriate thicknesses is deemed to satisfy the rigid design criteria without additional testing regarding rigidity. Conversely a lightweight design of say folded tabs or rivets would require some testing to ensure rigidity. Note rigidity and strength are easily confused, an impeller could be rigid (its resistance to deformation under an applied load) but fail due to strength (stress due to centrifugal loads under rotation), conversely a riveted impeller may pass the 2/3 stress criteria but deform under operation so as to reduce significantly the running clearances.

Whilst it is not reasonable for an end user to check a suppliers calculations there should be in the fan documentation some indication that either an over speed test has been carried out or reference to impeller stress calculations.

Testing

EN 14986 does not specify a particular test procedure, but it does state that vibration levels should be to ISO 14696:2003. The easiest practical way to do this is to run test the fan. Fan documentation should refer to run test and show residual vibration levels. In the case of large units where a factory run test is not practical this may be done for instance on site with prior agreement.

There should be some reference to a run test and vibration readings in the fan documentation, if not has this been done?

Technical File

Each ATEX fan should have a technical file. This is a comprehensive document identifying the fan, and showing compliance with the detailed requirements of EN 14986. The technical file is not necessarily provided to the end user. For Category 3 machines the manufacturer or importer (the organisation that places the fan "on the market") should keep the technical file for a minimum of 10 years after the product was last manufactured. For Category 2 & 1 equipment the technical file should be lodged with a notified body.

Note this does not mean the notified body has any role in checking the technical file, it is simply an independent "safe" storage of the technical file should it be required to be inspected (possibly as a result of an explosion).

The quoting of a notified bodies' reference for technical file storage on an ATEX certificate does not imply any form of approval/inspection/certification from that notified body. This is a common misconception giving purchasers and users the false impression of third-party verification.

Documentation

Reverence has been made in proceeding sections to the documentation provided with the fan. This is substantially more than just an ATEX certificate, though this is important.

The document package should include

a) Shipping and Storage instructions
b) Erection and Commissioning manual typically including
    I) General installation notes
    II) Checks prior to installation
    III) Erection procedure
    IV) Pre commissioning & commissioning checks
    V) Bolt tightening torques
    VI) Sub suppliers instructions (eg electric motor)

VII) Minimum and maximum airflow rates required to maintain maximum surface temperature

VIII) Specific information regarding maintaining clearance between rotating and stationary parts

The manual should include relevant forms to focus the installer towards key items. These should form the basis of a check sheet to record such things as clearance vibration levels and ideally be returned to manufacturer

c) Operating and maintenance manual
   I) Performance data
   II) Detailed description
   III) Health and safety
   IV) Operation of the fan
   V) Maintenance
   VI) Fault finding and rectification
   VII) Sub supplier's information
   VIII) Fan application category (BV1-BV5) according to ISO 14694
   IX) Specific information regarding maintaining clearance between rotating and stationary parts

d) Particle limitations with regard to ingress of foreign particles

e) Routine inspection and servicing.

This should make it clear that the ignition minimising properties of the fan and its accessories can only be retained if routine inspections and maintenance is carried out. It should address the following.

I) Inspection intervals taking into account operating conditions
II) Recommended spares
III) Wear of consumable components eg belts bearing seals flexible joints
IV) Inspection of rotating components
V) Seals and gaskets for fans having different categories internally and externally
VI) Any monitoring devices are regularly checked
VII) Additional cleaning requirements for category 2D & 3D internally fans where dust build up mare cause additional hazards

Clearly there are significant document requirements for all ATEX fans. If the fan documentation does not follow the above this should prompt further investigation.

<u>Conclusion</u>

We can conclude that in order to correctly install an ATEX fan there has to be a considerable interchange of information between User and Supplier.

If an ATEX fan is to be installed in either a new plant or exisiting then there has to be interchanges of at least the following information

Zone and category of fns both internally and externally
Gas/Dust group and maximum allowable surface temperature
Normal and expected operating conditions
Correct marking that captures the above items
Information pertenant to maintaining the explosion protection features of the fan
Certification showing compliance with relevant design code. (EN14986 in most cases)
Comprehensive documentation with regard to operating installation and maintenance

Whilst it is possible to buy fans that seem to have blanket certification making the purchasing easy the question has to be asked if the above flow of information is absent is it really an ATEX fan?