Dust Explosion Protection Consistent with North American Practice

now to EN 61241-1 as an option

by Helmut Greiner

Figure 1: ADM Grain Mill in Kansas City, USA after the explosion on 10 April 1979
(source: R. W. Schoeff, Kansas State University)

The new European Standard EN 61241-1 [1] now provides an option referred to as ›Practice B‹ which has already been in use in North America for seven decades. This report provides some background information on how this Standard came into being and describes individual details of the design and testing requirements and acceptance criteria. Practice B may be of interest as an alternative to Practice A for

- manufacturers who wish to or have to supply this method of dust explosion protection to North America and
- repair and servicing companies who are obliged to restore the original condition

on explosion protected apparatus.
Beyond this, users will be interested in the real meaning of the letters ›A‹ and ›B‹ for example, within the framework of a project.

1 How this Standard came into being

Explosions caused by grain dust (Figure 1) were relatively frequent in the USA, as shown by the statistics for the years 1980 tru 1990 (Figure 2). In the decade under consideration here there were around 200 serious incidents involving of a total of 54 persons and 256 injuries, and also causing damage to property amounting to approx. 165 million dollars.

Efforts to prevent such incidents, even as early as 1929, led to the first edition of Standard UL 674 (A) ›Electric motors and generators for use in hazardous locations, Class II, Groups E, F and G‹.

When IEC standardisation work in relation to dust explosion protection began (around 1980), North American experts were able to point out the 50 years of experience they already had at the time with UL Standard 674 (A). Consequently, it was necessary then to standardise two ›Practices‹ which had an equivalent technical-safety level but which differed fundamentally (Table 1) to the first edition of IEC 1241-1-1: 1993.

When IEC 1241-1-1 was adopted as EN 50281-1-1: 1998, it was possible to eliminate Practice B since the work was being conducted solely at the European CENELEC level.

The new Standards for type of protection ›tD‹ (IEC 61241-1 and EN 61241-1) were, however, elaborated on in parallel voting procedure between IEC and CENELEC and thus, once again contained a consensus with both Practices A and B. ➔

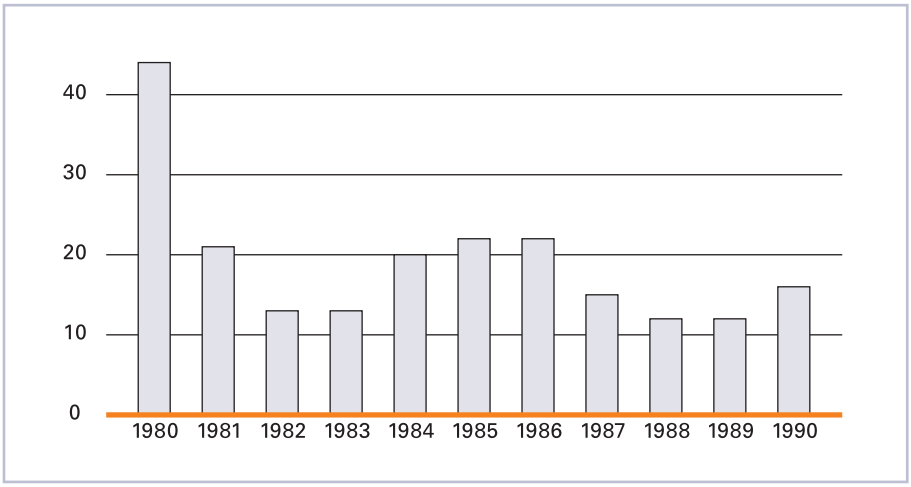


Figure 2: Number of explosions involving food and fodder dusts, recorded by the >Federal Grain Inspection Service< of the US Department of Agriculture

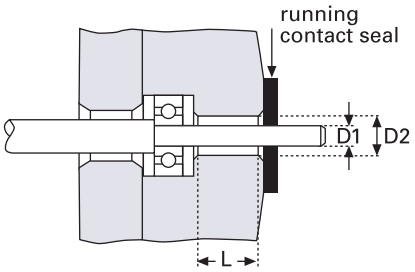
	Praxis A	**Praxis B**
Basic Standards	EN 1127 EN 60529	UL 674 CSA C 222 No. 145
Dust layer during temperature test	no	yes
Ignition temperature referred to dust layer thickness 5 mm	12.5 mm (1/2 Zoll)	
Criteria for thightness	IP6X/IP5X	Gap at sealing joint
Test dust particle size	< 75 µm	< 150 µm
Design requirements	no	special

Table 1: Comparison values for Practices A und B in accordance with IEC and EN 61241-1

2 Requirements applicable to joint dimensions

The joint seals in the case of Practice B are comparable with the design principle of Flameproof Enclosures without being targeted at or tested for avoidance of flame transmission (explosion propagation).

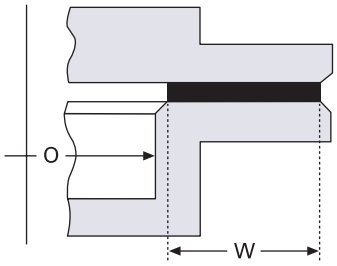
Certain values are outlined in extract form below and – where possible – compared with the requirements, as in the case of Flameproof Enclosures (Figures 3 to 6), using the original diagrams of the Standard from US sources.



3. Path for power shafts

Path for power shaft in the case of Practice B in accordance with IEC and EN 61241-1 Diagram by analogy with the original in the Standard

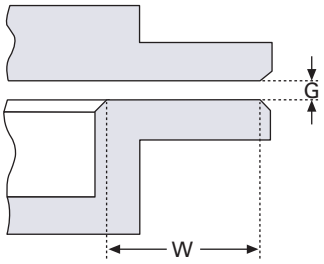
	EEx d	Practice B
Length of path L	12.5 mm	38.5 mm
D. clearance D2 - D1	0.26 mm	0.57 mm



4. Gasketed joint

Flanged joint at a contact face with gasket

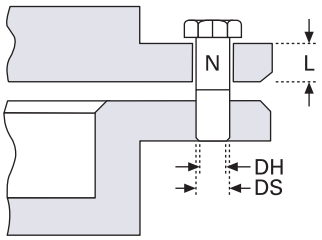
Maximum opening width O	Minimum sealing width W
305 mm	3 mm
915 mm	4.8 mm



5. Plaine joint

Plaine joint at a contact surface

	EEx d	Verfahren B
Width of joint	5 mm	22 mm
Max. clearence G	0.05 mm	0.22 mm



6. Clearance of a bolt

Maximum permitted diametrical clearance between the unthreaded shank of the bolt N and the clearance hole in the enclosure

Length of path L	12.5 mm
Max. permitted clearance DS - DH	0.26 mm

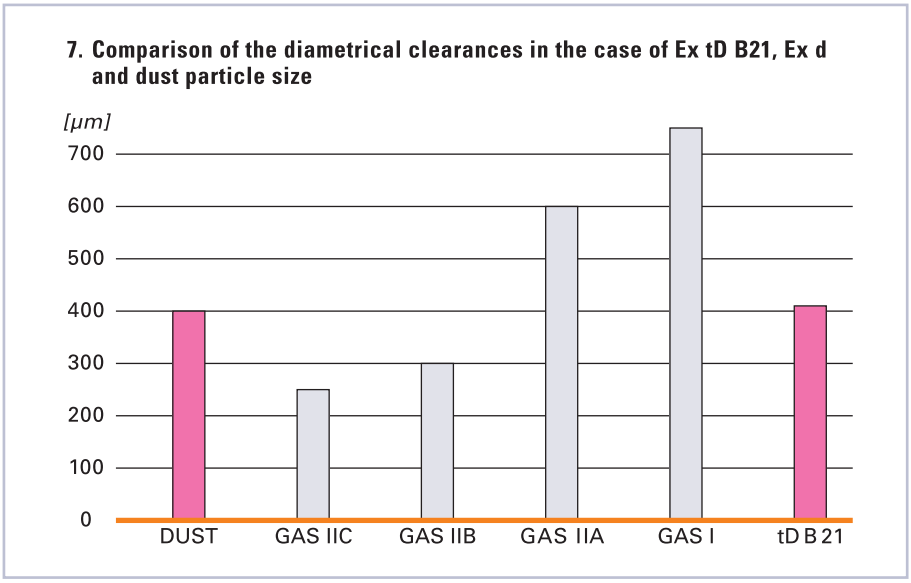


Figure 7: Comparison of the permitted diametrical clearances in the case of joint width 25 mm for Explosion Groups I, IIA, IIB and IIC in the case of type of protection EEx d (Flameproof Enclosures) with the particle sizes of ignitable dusts and with the gap in accordance with IEC and EN 61241-1 Practice B (tD B 21 in the case of Zones 21 and 22)

3 Testing dust-tightness

›Breathing‹ of a housing as the result of the heating cycle is simulated in the IP test in accordance with EN 60529 [2], applied in the case of Practice A, by generating an artificial partial vacuum in the housing that may be up to twice the natural partial vacuum [3]. In the case of Practice B, the partial vacuum is produced by heating during operation at rated power and then cooling.

Testing with heat cycle

1) The apparatus shall be mounted in a test chamber of sufficient size in order to permit free circulation of the dust-air mixture around the sample (Figure 8) during the test period. A mixture of suitable dust and air shall be circulated by auxiliary equipment and introduced continuously into the test chamber during the entire test period. The particle size of the dust shall be such that it passes through a No. 100 ASTM sieve (approx. mesh width 0.15 mm) with approx. 22 % passes through a No.200 ASTM sieve (mesh width approx. 0.075 mm).
2) Quote from EN 61241-1: »For the test specified above, the apparatus shall be operated at rated load until maximum temperatures are reached and then disconnected from the supply until it has cooled to approximately room temperature. The number of cycles of heating and cooling shall be at least six and shall last for a minimum of 30 hours«.

Acceptance criteria

The dust is gently removed by sweeping after the test. Under no circumstances shall the dust be removed by an air blast or vacuum cleaning . The housing is then opened and checked thoroughly for any dust which has penetrated. No visible dust may have penetrated the housing. Dust in joints may not be assessed as a fault.

Restricted sealing effectiveness of gaps or diametrical clearances

Practical experience to the effect that gaps or diametrical clearances without additional sealants have only a restricted ➔

Figure 8: Testing dust-tightness by six heating/cooling cycles in accordance with Practice B in IEC and EN 60241-1 (Source: Danfoss Bauer on the occasion of a previous UL acceptance testing procedure)

sealing effectiveness (Figures 9 and 10) was confirmed in a fundamental series of tests. The complete series of tests can be found in [3]. Figure 3 and the acceptance testing conditions confirm that even Standard UL 674 does not fully rely on the sealing effectiveness of gaps or diametrical clearances.

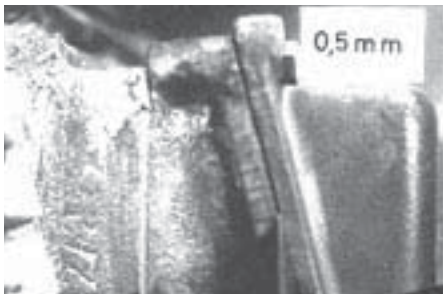


Figure 9: Adjustment of a gap (e.g. 0.5 mm) between the metallically bare faces of terminal box and cover

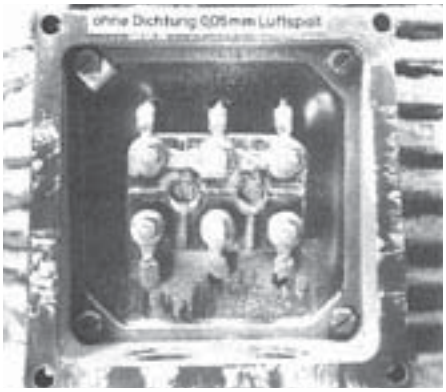


Figure 10: Test result with the gap reduced to 0.05 mm, test period approx. 200 minutes

4 Thermal tests

The basic conditions for the temperature rise test are defined in IEC and EN 61241-0 for the two Practices A and B: these have been adopted from EN 60079-0 for gas explosion protected apparatus. However, in the case of Practice B, there is an additional requirement to the effect that the apparatus must be covered with the maximum dust quantity remaining on it. Alternatively, a 12.5 mm thick layer of dust paste may be applied to the top of the apparatus in order to simulate the dust layer. This paste should consist of the following percentages-by-weight: 45 % dust (e.g. wheatmeal flour) and 55 % water. The temperature value should be measured after the paste has dried (Figure 11).

Figure 11: Testing temperature rise with dust covering on the upper side in the case of Practice B (dust blanket test) in accordance with IEC and EN 61241-1 (source: Danfoss Bauer on the occasion of an earlier UL acceptance test)

5 Marking

The two examples of marking below in the case of Practices A and B are based on Section 9 of IEC and EN 61241-1. The difference between the Practices results from the letters prefixed for the Zone in this case Zone 21.

Unfortunately, the specifically European stipulations were not allowed for in the Standards which originated on the basis of a parallel voting procedure. These result from EU Directive ATEX 94/9/EC.

CENELEC TC 31, responsible for the essential regulations for marking, unfortunately dealt with uniform definitions only at a very late point.

ABC company Type RST
Serial-No. 987654
N.A. 01/99999
Ex tD A21 T120 °C
V A Hz
kW r/min

ABC company Type KLM
Serial-No. 123456
N.A. 01/99999
Ex tD B21 T170 °C
V A Hz
kW r/min

Figure 12: Markings

Bibliography

1 EN 60241-1: Electrical apparatus for use in the presence of combustible dust, Part 1: Protection by enclosures >tD<

2 EN 60529/: Degrees of protection by enclosures (IP Code)

3 Greiner, H.: IP degrees of protection Publication SD 101E by Danfoss Bauer Gmbh