Explosion Protected Electrical Apparatus in the Russian Federation

Adaptations of National Standards to International Standards, deviations and peculiarities

by Vitaly Lipavskiy

1. Status of application of explosion protected electrical apparatus in the Russian Federation

The industrial branches that are traditionally highly developed in Russia, such as those dealing with production, transport and processing of oil and gas, the petrochemical industry, and a number of other industries in which explosive atmospheres may occur, demand the use of explosion protected electrical equipment in certain areas.

Since these industrial branches are currently undergoing greater development and modernisation, there is a high demand for more modern, state-of-the-art designs owing to the fact that it is necessary to replace the technically outdated explosion protected apparatus in use. In order for explosion protected electrical apparatus to be used in Russian plants, such apparatus must have been approved by a recognised testing and certification authority of the Russian Federation confirming compliance with the requirements of Russian Standards.

This article outlines the fundamentals of Russian Standards in the sector of explosion protection of electrical apparatus and compares the Russian Standards with the corresponding IEC Standards. In addition, it explains essential national deviations from the International Standards in respect to the requirements applicable to explosion protected electrical apparatus, in particular with regard to marking and classification of the hazardous areas.

2. Harmonisation of Russian Standards with International Standards

A new series of Standards regulating construction of explosion protected electrical apparatus, classification of the hazardous areas and application of explosion protected apparatus of different protection levels in hazardous areas has been in force in Russia since January 1, 2001. One of the chief tasks when elaborating on these Standards was to harmonise them with the International Standards of Series IEC 60079. Table 1 provides an overview of the Standards currently in force in Russia together with the corresponding Standards of Series IEC 60079. Remarks further to Table 1:

- In the case of most Russian Standards, there are national deviations from International Standards. These deviations are discussed in Sections 3 and 4.
- Table 1, as from listing the new GOST R 51330 Standards, also lists the old Standard relating to installation ›Rules for electrical installations in hazardous areas‹, abbreviated to ›PUE‹ (ПУЭ –Правила устойства электроустановок). This document was the only applicable regulation until the Standards of Series GOST R 51330..-99 were introduced and stipulated classification of the hazardous areas into Zones and selection of the explosion protected equipment that may be used in the various Zones. This previous Standard has not yet been withdrawn and applies parallel to the new requirements pursuant to

GOST R 51330.9-99: ›Electrical apparatus for explosive gas atmospheres, Part 10: Classification of the hazardous areas‹. Section 5 explains where the requirements differ, when apparatus must be selected in accordance with the zone classification pursuant to GOST R 51330.9-99 and when devices must be selected on the basis of the zone classification pursuant to the old Installation Regulations.

3. The most significant deviations in Russian Standards from existing International Standards

GOST R 51330.0-99: General Requirements

The term ›explosion protection level of electrical apparatus‹ has been introduced – a grading of the explosion protection measures of the electrical apparatus under the conditions stipulated in the Standard. All explosion protected electrical equipment is split into three groups depending on the extent of the explosion protection level.

- **Protection Level 2**
  Electrical equipment ensuring a normal level of protection (the number 2 for apparatus of Group II and the combination of Cyrillic letters PB for Group I are added in the explosion protection marking). This relates to explosion protected electrical apparatus for which explosion protection is guaranteed under normal operating conditions.
  This explosion protection level can be guaranteed by the following types of protection: ia, ib, ic, px, pz, q, e, m, d, o, s
- **Protection Level 1**
  Explosion protected electrical equipment ensuring a high level of protection (The number 1 for electrical apparatus of Group II and the combination of Cyrillic letters РП for Group I are added in the explosion protection marking). The means of protection related to this equipment ensures the requisite level of protection, even in the event of frequently occurring disturbances or equipment faults which normally have to be taken into account. This explosion protection level may be guaranteed by the following types of protection: ia, ib, px, d, s
- **Protection Level 0**
  Special explosion protected electrical equipment with a very high level of protection (the number 0 for electrical apparatus of Group II and the combination of Cyrillic letters PO for Group I are stated in the explosion protection marking). This relates to explosion protected electrical apparatus on which additional protection measures are taken using a standardised type of protection. This explosion protection level may be guaranteed in the case of the following types of protection: ia, s.
  Alternatively, it is possible to use two independent explosion protection measures, e.g. confinement of the parts generating sparks in the event of a fault by encapsulation with a moulding compound, or by immersion in a liquid or bulk insulation material or by mounting in a flameproof enclosure or by a combination of a flameproof enclosure with the type of protection Pressurization ›p‹. ➔

РВ
рудничное взрывобезопасное
(Mining Explosion Safety)

РП
рудничное повышенной надежности против взрыва
(Increased Mining Explosion Safety)

РО
рудничное собовзрывобезопасное
(Special Mining Explosion Safety)

Cons. No.	State Standard of the Russian Federation GOST R (ГОСТ Р – ГОСУДАРСТВЕННЫЙ СТАНДАРТ РОССИЙСКОЙ ФЕДЕРАЦИИ)	IEC-Standard
1	GOST R 51330.0-99: Electrical apparatus for explosive gas atmospheres Part 0: General requirements	IEC 60079-0-98
2	GOST R 51330.1-99: Electrical apparatus for explosive gas atmospheres Part 1: Flameproof enclosures ›d‹ – Ex d	IEC 60079-1-98
3	GOST R 51330.3-99: Electrical apparatus for explosive gas atmospheres Part 2: Pressurized enclosures ›p‹ - Ex px, Ex py, Ex pz	IEC 60079-2-98
4	GOST R 51330.5-99: Electrical apparatus for explosive gas atmospheres Part 4: Method of test for ignition temperature	IEC 60079-4-75
5	GOST R 51330.6-99: Electrical apparatus for explosive gas atmospheres Part 5: Powder filling ›q‹ – Ex q	IEC 60079-5-97
6	GOST R 51330.7-99: Electrical apparatus for explosive gas atmospheres Part 6: Oil-immersion ›o‹ – Ex o	IEC 60079-6-95
7	GOST R 51330.8-99: Electrical apparatus for explosive gas atmospheres Part 7: Increased safety ›e‹ – Ex e	IEC 60079-7-90
8	GOST R 51330.9-99: Electrical apparatus for explosive gas atmospheres Teil 10: Classification of the hazardous areas	IEC 60079-10-95
9	GOST R 51330.10-99: Electrical apparatus for explosive gas atmospheres Teil 11: Intrinsic safety ›i‹ – Ex ia, Ex ib, Ex ic	IEC 60079-11-99
10	GOST R 51330.11-99: Electrical apparatus for explosive gas atmospheres Part 12: Classification of mixtures of gas and vapurs with air according to their maximum experimental safe gaps (MESG) and minimum ignition currents (MIC)	IEC 60079-12-78
11	GOST R 51330.12-99: Electrical apparatus for explosive gas atmospheres Part 13: Construction and use of rooms or buildings protected by pressurization	IEC 60079-13-82
12	GOST R 51330.13-99: Electrical apparatus for explosive gas atmospheres Part 14: Electrical installations in hazardous areas (other then mines)	IEC 60079-14-96
13	GOST R 51330.14-99: Electrical apparatus for explosive gas atmospheres Part 15: Type of protection ›n‹ – Ex n	IEC 60079-15

Table 1: Explosion Protection Standards of the Russian Federation by comparision with the IEC Standards

Cons. No.	State Standard of the Russian Federation GOST R (ГОСТ Р – ГОСУДАРСТВЕННЫЙ СТАНДАРТ РОССИЙСКОЙ ФЕДЕРАЦИИ)	IEC-Standard
14	GOST R 51330.15-99: Electrical apparatus for explosive gas atmospheres Part 16: Artificial ventilation for the protection of analyser(s) houses	IEC 60079-16-90
15	GOST R 51330.16-99: Electrical apparatus for explosive gas atmospheres Part 17: Inspection and maintenance of electrical installations in hazardous areas (other than mines)	IEC 60079-17-96
16	GOST R 51330.17-99: Electrical apparatus for explosive atmospheres Part 18: Encapsulation ›m‹ – Ex m	IEC 60079-18-92
17	GOST R 51330.18-99: Electrical apparatus for explosive gas atmospheres Part 19: Repair and overhaul for apparatus used in explosive atmospheres (other than mines or explosives)	IEC 60079-19-93
18	GOST R 51330.19-99: Electrical apparatus for explosive gas atmospheres Part 20: Data for flammable gases and vapours, relating to the use of electrical apparatus	IEC 60079-20-96
19	GOST R 51330.20-99: Electrical apparatus for explosive gas atmospheres, Insulating properties (comparative tracking indices). Clearances and creepage distances, requirements and test methods	IEC 60079-7-90 IEC 60112-79
20	GOST R IEC 61241-1-1-99: Electrical apparatus for use in the presence of combustible dust Part 1: Electrical apparatus protected by enclosures and limitation of surface temperature. Construction and testing.	IEC 61241-1-1-99
21	GOST R IEC 61241-1-2-99: Electrical apparatus for use in the presence of combustible dust Part 1: Electrical apparatus protected by enclosures and limitation of surface temperature. Selection, installation and maintenance	IEC 61241-1-2-99
22	GOST R IEC 61241-1-3-99: Electrical apparatus for use in the presence of combustible dust Part 3: Classification of areas where combustible dusts are or may be present	IEC 61241-3-97
23	GOST R IEC 62086-1-2003: Electrical apparatus for explosive gas atmospheres. Electrical resistance trace heating Part 1: General and testing requirements	IEC 62086-1-2001
24	›Rules for electrical installations in hazardous areas‹, 6th revised and supplemented edition, bibliography (Правила устройства электроустановок)	

Editor's Note:
The term ›explosion protection level‹ basically corresponds to the stipulation regarding the Equipment Category in European Directive 94/9/EC but with different numbering, a different assignment of the types of protection, and a different grading in the underground sector. Neither is there a direct assignment of level of protection 0, 1 and 2 to Zone 0, 1 and 2. The GOST R 51330.13-99 Installation Regulations define the types of protection to be used in the particular Zone. This corresponds to the stipulation in IEC 60079-14.

The letters ›X‹ and ›U‹ are stated not after the certificate number but in the explosion protection marking. Materials containing light metal alloys are not to be used to produce housings or enclosures unless measures have been taken to prevent possible formation of friction or impact sparks . This can be achieved by a suitable protection coating.

Electrical interlocking of plugs and sockets must be designed to allow interruption of the power contacts only after the power supply is disconnected. For portable lamps and cap lamps of Group II, the cable must be protected against short-circuiting by means of a fusible link if the voltage source and light source are in separate housings or enclosures and they are connected by means of cables.

GOST R 51330.1-99
Flameproof Enclosures

Direct cable entries may be realised with the aid of flexible seal rings or seal materials, which do not influence the explosion protection properties of the enclosure. The using of flexible seal rings for direct entries is approved for electrical apparatus that does not spark or have hot components during normal operation, which could ignite any explosive mixture present.

Electrical apparatus of Group IIC which have only been tested for hydrogen-air mixture but not for the other substances of Group IIC may be marked with: 1ExdIIBT4/H2 or 1ExdIICT1/IIBT4. The temperature class of Group IIB is determined in this case by the maximum surface temperature of the electrical apparatus during operation. A general explanation of the marking scheme is provided in Section 4.

GOST R 51330.5-99
Ignition Temperature

(Winter)Diesel fuel is classified to Explosion Group II B und Temperature Class T3.

GOST R 51330.6-99
Powder Filling

The housings or enclosures must be designed to prevent escape of the powder in operating position if the covers are removed. Only dry silica glass or hard glass particles with no metallic admixtures are approved as filling.

GOST R 51330.7-99
Oil Immersion

The openings for the level indicator (rod indicator type) must be arranged so that, at maximum possible angle of inclination with respect to the non-insulated electrical components, the rod complies with three times the value of the required phase-to-phase or phase-to-ground clearance.

GOST R 51330.10-99
Intrinsic Safety

The intrinsically safe circuit of Protection Level (Category) ic has been introduced. With voltages U_m and U_i applied, the intrinsically safe circuits in electrical apparatus of protection level ic shall not be capable of causing ignition of the explosive mixture when subject to the influence of heat in accordance with the stipulated test conditions and with a probability of less than 10^{-3} in normal operation, and with the application of those non-countable faults that give the most onerous conditions.
The terminals for connection of the outer intrinsically safe circuits must be covered with a lead-sealed cap or a cap which can be removed with special tools only. One exception to this rule relates to electrical apparatus installed in housings, enclosures or cabinets with interlocks.

Requirements applicable to Ex i circuits

- Intrinsically safe circuits and non-intrinsically safe circuits connected electrically to them must be electrically isolated from the circuits with a higher energy level than the general mains (e.g. for motors and lighting installations).
- When earthing intrinsically safe circuits, the connection to earth is to be made only at one point.
- The capacitance, the inductance and the resistance of the line must be taken into consideration in an intrinsically safe circuit routed via an external line
- The mains voltage must be considered allowing for the permitted mains voltage tolerance.
- Soldering points and welds inside an item of apparatus must be protected with insulating enamel.
- Fuses must be provided in mains systems with non-earthed neutral conductors: in two phases in three-phase systems, and in one phase in the case of single-phase systems with non-earthed neutral conductor: in two phases in three-phase systems an din one phase in the case of single-phase.
- Fuses must be provided in each conduc-

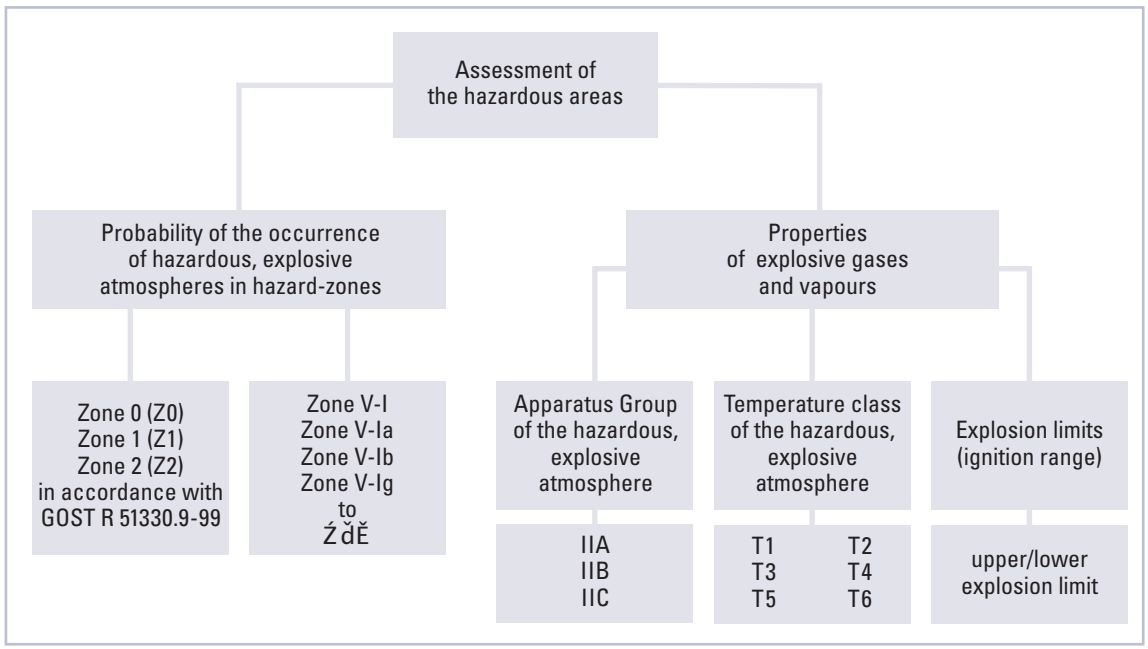

Figure 1: Assessment of hazardous areas in the Russian Federation

tors in mains systems with earthed neutral conductor. However, if measures to safely prevent an interturn fault of the transformer are taken in single-phase systems, one fuse in the non-earthed line will suffice.

GOST R 51330.11-99
Classification of the Flammable Substances into Explosion Groups

Substances which may form an explosive atmosphere and which are used frequently in industrial production in the Russian Federation, including (winter) diesel fuel, Group IIB, have been adopted in the listing (Annex A).

GOST R 51330.12-99
Pressurised Enclosures

Electrical apparatus which remains electrically live if the protective gas supply fails must be designed as explosion protected and must comply with the requirements of the area's hazard-zone.

Before commissioning the electrical apparatus, a check of the safety-related parameters and systems must be conducted, including: inert gas parameters, minimum over pressure, purging, function of the switch-off devices and signalling devices.

GOST R 51330.13-99
Electrical Installations

The Operating Instructions for the electrical equipment must precisely specify the explosion protection measures and the measures taken to maintain this level of explosion protection during installation, operation and repair.

Rotary electrical machines with type of protection Increased Safety ›e‹ may only be used if no heavy starting, frequent starts or changes of direction occur.

GOST R 51330.17-99
Encapsulation

The documentation of the electrical apparatus must state the maximum permissible continuous operating temperature of the encapsulation compound.
The maximum temperature occurring if a fusible link blows may exceed the permissible continuous operating temperature of the compound providing the type of protection Encapsulation ›m‹ is not impaired.

4. Marking the explosion protected electrical apparatus

The explosion protected electrical apparatus is marked in accordance with Standard GOST R 51330.0-99 and the Standards for the individual types of protection.
The explosion protection marking contains

- the explosion protection level
- the Ex symbol
- the symbols of the types of protection that are in use
- the groups (I, II oder IIA, IIB, IIC)
- the temperature class
- the letter X if special conditions in relation to safe use must be complied with or U if the product is an Ex-component

Examples of explosion protection markings:
1 Ex d II B T4, 0 Ex ia II C T6, PB Exd[ib] I,
1 Ex d II B T4/H_2, for ›associated electrical apparatus‹: [Exib]II C.

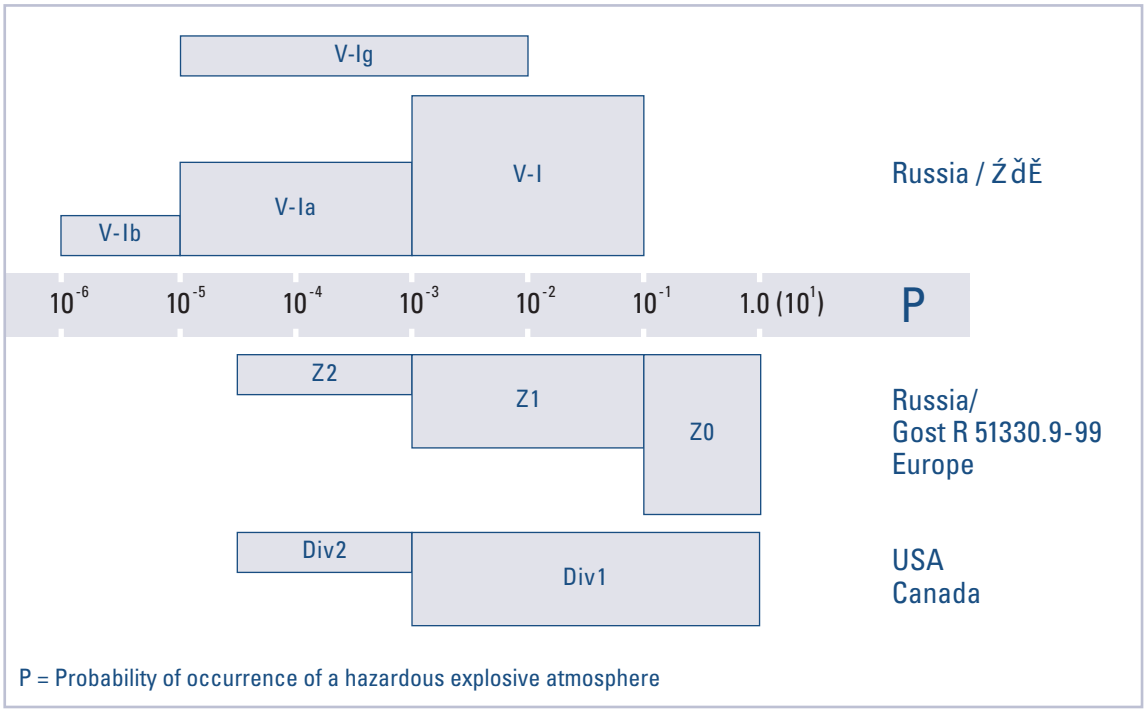

Figure 2: Classification of hazardous areas into Zones on the basis of the old and new Russian Standard.
(It must be pointed out that the illustration in Figure 2 is not a normative document but was simply elaborated on by the author on the basis of existing documents and a significant number of publications).

5. Hazardous areas

All hazardous areas in which explosive mixtures of gases, vapours and air or combustible dusts or fibres may occur in air are assessed in respect to their risk potential on the basis of two aspects:

- The likelihood of occurrence (frequency and duration) of an explosive atmosphere in the relevant area.
- Safety characteristics of the substances, gases, vapours or dusts used, in addition to the ignition soureces occurring.

Figure 1 shows the safety assessment parameters of hazardous areas currently conventional in Russia.

The safety parameters of the explosion protected apparatus must be matched to the characteristics of the possible, explosive atmosphere in this installation area when assessing the options for using explosion protected apparatus in an installation.
In this connection, it is necessary to classify the hazardous area into Zones on the basis of the likelihood of the existence of hazardous, explosive atmospheres.

Two classification options currently apply parallel to one another in Russia: the new classification pursuant to GOST R 51330-9-99 and the old classification in accordance to the old rules for electrical installation in hazardous areas . The reason for this relates to the many years of use of the classification of the Ex zones on the basis of the previously valid Standard. Thus, this classification applies not only in many currently existing plants but also to installations currently undergoing conversion. Figure 2 shows the relationships of the conditions in the Zones on the basis of both methods and, by way of comparison, with respect to the USA's NEC System.

6. Concluding remarks

A range of -20 °C ... +40 °C is specified as the normal ambient temperature range both in the Russian Standards and in the International Standards. On the other hand, temperatures down to -40 °C may occur in the wintertime in moderate latitudes in Russia, temperatures down to -50 °C may occur in the northern territories with temperatures as low as even -55 °C possibly occurring in these northern areas. Consequently, the test certificate for apparatus scheduled for use outdoors or use in unheated rooms must specify the ambient temperature range in which operation is possible.

The following Russian documents are required for use of electrical apparatus in hazardous areas:

- Certificate of Conformity, which confirms the compliance of the apparatus with Russian Explosion Protection Standards, and
- Approval of the Federal Technology Supervisory Authority for use of the explosion protected electrical apparatus in hazardous areas.