Electrical installations in hazardous areas:

New brazilian directives

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Since the Brazilian Technical Standards Association (ABNT – Associaçáo Brasileira de Normas Técnicas) adopted IEC as basis for electrical standards and changed the main code NBR 5410 – Electrical installations of buildings – Low voltage in 1980, Brazilian electrical installations designers of Oil and Gas Industry plants have continuously been working to harmonize the existing electrical installations (usually designed to NEC requirements (US-American standards) with the IEC requirements. The Brazilian Oil and Gas Sector is expected to invest approximately US $ 80 billion in the next eight years [1], and as a consequence, many new installations will be built using these new directives. As an additional characteristic, Brazilian regulations also require compulsory National Conformity Certification for explosion protected equipment, that will be also presented here.

Figure 1: Control station in IEC technique for motor control

History

The IEC types of protection were introduced in Brazil in the late 1970's, when Brazil´s State Oil Company contracted its first seven offshore jacketed platforms, similar to European ones operating in the North Sea. The electrical distribution system designed for those platforms, used armored cables, cable trays and cable glands for direct entry in Ex d metallic enclosures.

In 1980, ABNT adopted IEC as basis and since then, it is issuing all IEC hazardous locations standards (60079-XX series) and adopting them (after public voting) as National Standards.

Classifying locations

Since the issuing of Brazilian government directive ‚Labor and Employment Ministry´s Regulatory Rule for Electrical Installations and Services (NR-10)', which made mandatory the use of IEC standards in the absence of corresponding Brazilian ones, area classification analysis are using the Zone system.

This new directive changed the way that area classification analysis used to be developed: the classical method with figures related to each process unit.

Examples of classic area classification given by different standards [2] are shown in Figure 2:

The use of ‚risk assessment', given by the area classification standard IEC 60079-10, introduced for Brazilian technicians a new approach, which requires to know each source of release and the characteristics of release at that point. This new task is harder than the old approach, but it allows to customize the evaluation for each plant being analysed, seeking for the optimal extent of its hazardous areas [3].

The basic elements for establishing which Zone to apply, includes the knowledge of the sources of release and the degree of ventilation (natural or forced). The area classification study can influence the design of any plant or facility to minimize explosion risks.

Due to the quantitative approach given by IEC 60079-10, we can expect that soon it will be possible to use special software to define the extent of hazardous areas.

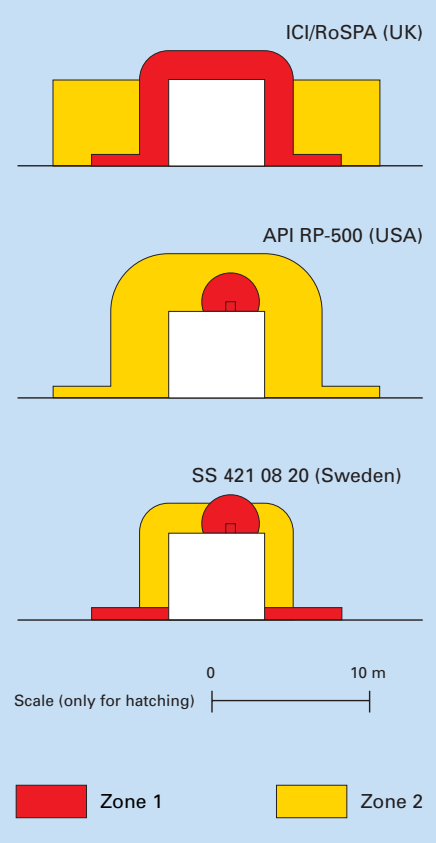

Figure 2: Zone extent for fixed roof tanks given by different standards

Installation Details

Some new installations possibilities given in the ‚NBR 5418 – Electrical installations in explosive gas atmospheres – Procedure' – a Brazilian IEC 60079-14 based standard – are:

Wiring Methods

- **Power Cables:** Armored and non-armored cables can be actually used, since the jacket material is suitable to resist the environment conditions and mechanical damage risks. As a dimensional requirement, the minimum allowed section for solid or concentric stranded conductors is 1,5 mm².

- **Enclosures Entries:** Direct entry of cables into flameproof enclosures allowed. For Ex d- enclosures, metallic certified Ex d cable glands must be selected according to the cable type and its internal and external diameter. For Ex e (metallic or plastic) enclosures, plastic Ex e cable glands can be used with non-armored cables; with armored ones, Ex d cable glands can be used.

Conduit System

Metallic conduits can be used, threaded, complying with the constructional requirements given by Brazilian standard ‚NBR 5597 – Carbon steel rigid conduit and with fitting protective coating'. Mixed systems (i.e. electrical equipment originally designed to be used with conduits but receiving cable glands instead, or the opposite) are allowed, as also direct and indirect entry methods. Indirect entry method has the advantage to allow connections without opening of the flameproof enclosure, but is still used rarely in Brazilian plants.

Considering that metal may become corroded, especially on offshore or shoreline locations (which if unchecked, can affect explosion protection integrity), cable trays of non-metallic materials (e.g.: glass fiber polyester reinforced) are being extensively used. These possibilities provide easier ways to build up processing units in the oil and gas industry, because cable trays and cable glands are less labor-intensive during the initial installation and in follow-up maintenance, than the threaded conduit system.

With IEC equipment, Brazilian designers are able to use new installation options, where commonly only metallic conduits were used before. This brings easier-to-maintain installations, as shown in figure 3 and 4.

The Brazilian Ex conformity assessment system

The Brazilian government can dictate compulsory conformity certification, if the equipment can affect safety or health of users. The National Institute of Metrology, Industrial Quality and Normalization (INMETRO - Instituto Nacional de Metrologia, Normalizaçáo e Qualidade Industrial) issued in 1991, the Edict 164/91 which stipulated that all electrical and electronic equipment (Brazilian and imported), for use in potentially explosive atmospheres, must obtain a compulsory certification to be put on the market. The conformity certificates must be issued by an INMETRO Accredited Certification Body for Products (OCP - Organismo Certificador de Produtos), following the Rule of Procedure for explosion protected equipment, which is applied to Brazilian and imported equipment.

The Rule of Procedure for Brazilian Equipment

Regarding the valid INMETRO (Instituto Nacional de Metrologia, Normalizacao e Qualidade Industrial) Edict 176/00 [4], we will present two models of conformity certification applied to Brazilian explosion protected equipment for use in hazardous areas :

- **Brazilian Conformity Mark:**
  This model consists of type tests of prototypes, based on corresponding type of protection to IEC standards, plus the evalu- →

ation of the manufacturer's Quality Management System, made by audits based on ISO 9002 standard (at least one per year). These audits are taken into consideration to define the expiration date of the certificate. It is not mandatory for the OCP to hold the Register of the manufacturer´s Quality Management System. This model also expects tests on samples collected from the manufacturer and resellers, and it is mainly applied to equipment in current production.

- **Batch Certification**

  This second model has no evaluation of the manufacturer´s Quality Management System based on ISO standards. Beyond the approval of shop tests for all lot units, 6% of the produced units (at minimum one piece) must be approved in type tests. The certification is valid to all lot units, and each one shall be individually identified. This model is actually applied to big motors produced for special applications.

Under the first model, which is the most common, the OCP can be responsible for the manufacturer´s Quality Management System evaluation too. The constructional evaluation can be performed by the experts from the OCP or by the experts from the laboratory station contracted to perform the tests.

The results of the tests and constructional evaluation are formatted in an Evaluation and Test Report. This report and the audit report are submitted to the OCP´s Certification Commission; after approval by this commission, the Conformity Certificate can be issued and the manufacturer facility receives annually at least one audit on its Quality Management System. Samples can be collected from the production line or in the market, and then submitted to an accredited testing lab, according to the program contracted between the OCP and the applicant.

Figure 3: Non-metallic Ex ed control box of plastic material (left side) replacing Ex d old ones

Figure 4: Control station made of glass-fibre reinforced material, type of protection Increased safety ‚e' and Flameproof enclosure ‚d' replacing the Ex d old ones, retaining the existing conduit installation

The Procedure for Imported Equipment

There are some special situations that the compulsory Brazilian certification does not apply:

- **Import of small Quantity**

  When importing quantities below 25 units of the same explosion protected item, it will be necessary for the supplier to present to OCP the following documentation:

  · Ex type conformity certificate,
  · ISO 9002 Manufacturer´s Facility Quality Management System Certificate,
  · Proforma invoice.

This will allow the OCP to issue (within thirty days), a Declaration of Documentation Analysis (DAD), saying that the imported explosion protected equipment (as identified in proforma invoice) has safety characteristics similar to those required by Brazilian (IEC based) standards.

- **Skid Mounted Equipment**

To ‚skid-mounted devices' (e.g.: gas compressor units), the documentation described in the previous item, regarding all electrical and electronic explosion protected equipment installed on each skid (e.g: electric motors, pressure transmitters, luminaires, cable glands, etc.), has to be presented to OCP by the supplier. This will allow the OCP to issue a DAD (Declaraçáo de Análise de Documentaçáo), but usually takes more than thirty days, due to higher quantity of documents.

Training Necessities

The wider the range of types of protection and the explosion protected apparatus used, the more knowledge regarding installation techniques has to be acquired to perform safe installations. Brazilian Oil & Gas companies are increasing the offering of IEC techniques training courses to their employees, to build up installations in hazardous areas without non-conformities, which could affect the safety of working places [5]. Courses specifically directed at craftsman and electrical inspectors are also be expected.

Conclusions

In respect of zone classification analysis, one key point is to recognize that the area classification procedure needs to be carried out by a group formally constituted from experienced professionals, including the process engineer, the mechanical engineer, the safety officer and the electrical engineer, with the necessary seniority to ensure the credibility of the study. This approach is a broader, more expensive analysis method, it will involve sound research and coordinated efforts from maintenance, design, process and safety representatives to acquire sources of release data. As we can see, changing from NEC technology with classification into Divisions to the Zone area classification system is not an easy task.

The IEC system can bring advantages [6] due to wider choice of electrical equipment types, broader selection of materials in highly corrosive areas, flexibility, less weight and easier maintenance. But it is worth saying that despite the import duties, (usually involved because there is no Brazilian manufacturer for equipment type of protection Increased safety ‚e' yet), users are increasing the use of equipment designed in IEC technology, specially in a combination of type of protection Increased safety ‚e' and Flameproof enclosure ‚d'.

The growing participation of imported items in the Brazilian market, brings as consequence that more training regarding Ex IEC installations and maintenance requirements, is needed.

Literature

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