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General consideration regarding fault – find, tests and maintenance in the installations in hazardous areas

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Abstract. The main topic of this paper is to analyse the approach to fault – finding, tests and maintenance regarding on what shall and shall not be done in an installation in hazardous area from the point of view of the explosion – protection safety. For a fault it is usual to be investigated by following a logical routine. This is one possible ways of proceeding developed from good engineering practice and experience in general terms. The test equipment for use in hazardous area will be either certified or uncertified. The maintenance is regarding in this paper from the point of view of SR EN 60079 – 17 starting from general requirements.

1 Introduction

The main objective of the paper is finding the best approach for discovering defects, performing the tests and the maintenance in the installations in hazardous areas.

This paper, is considered as a guide, a path to follow for what needs to be done or not from the point of view of explosion protection safety.

To find the defects the common practice is to use a logic scheme so that security issues are clearly identified. This is one possible way to find faults, which is not a recommendation of any standard, but it is the result of good engineering practices and a rich practical experience.

In terms of testing there is a wide variety of test equipment on the market. For use in potentially explosive atmospheres these must be in compliance with the requirements of ATEX Directive 2014/34/EU and specific explosion protection standards [1-2].

The paper also addresses to establishing the frequency of inspections and maintenance in order to prevent and / or detection the faults.

The logic scheme used to find a fault is presented in Figure 1.

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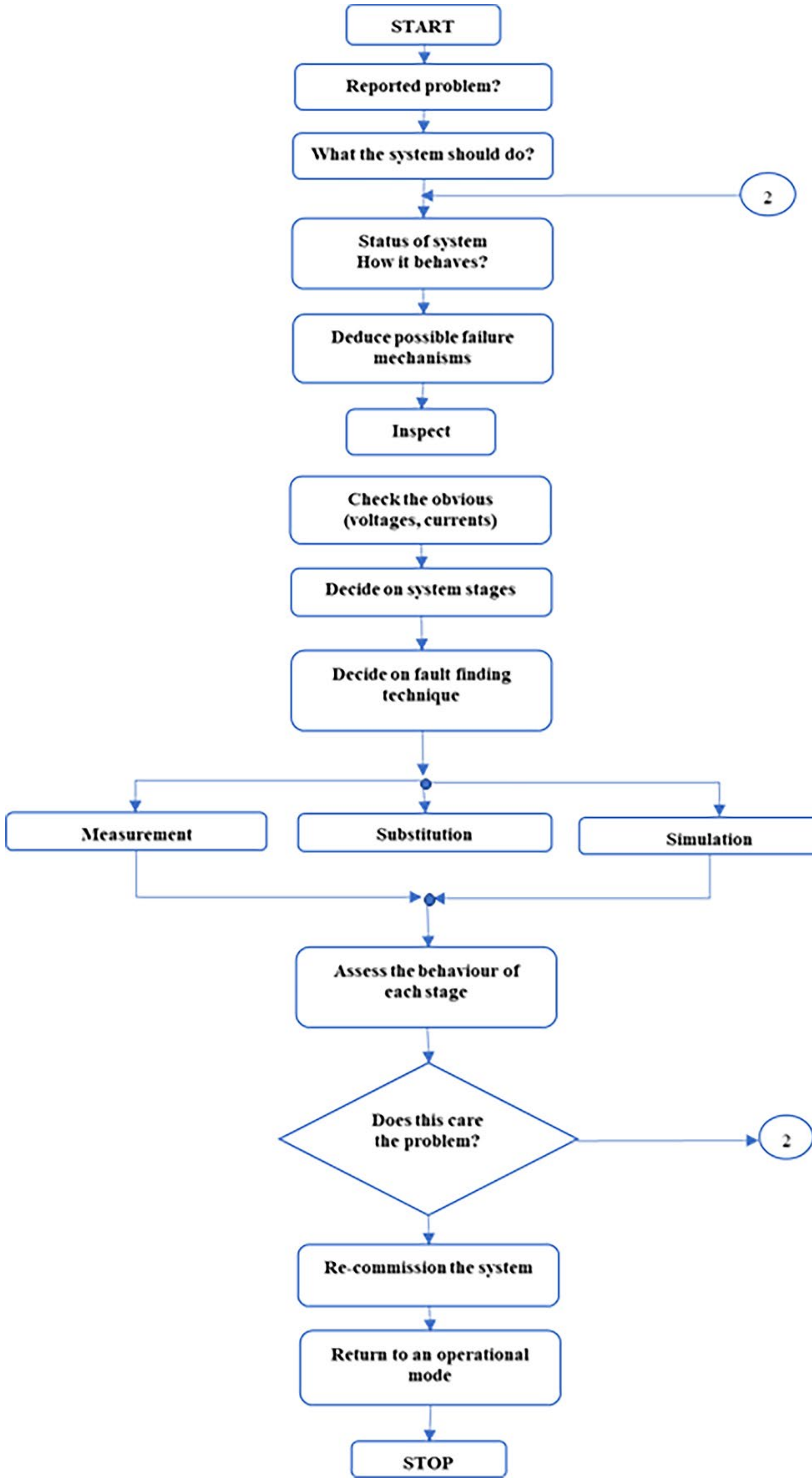


Fig. 1. Possible logic scheme for finding the fault of a system.

Where the steps are:

1. A problem is reported in the installation
   Who reported the defect?
   The interpretation of the defect is correct?
   What really happened?
   Is it really a defect?
2. A real understanding is necessary of what that part of the installation needs to do
3. An observation is required regarding the current state of the installation and how it behaves
4. What could be the reason (cause) of the observed effect?
   What's wrong? Which part of the installation caused the faulty?
   Can this be proven?
5. Is it the installation (system) protected to explosion?
   What measures are needed?
6. Visual inspection for verification of obvious faults
   Confirmation of types of protection
   What is the cause of the installation defect, obvious fault and visible mechanical problems?
7. Decision on the state of the system (of the installation)
   Understanding the fail (fault) of interconnected modules.
8. Decision on the fault – finding technique
   Measurement, Replacement, Simulation or combination thereof
9. Evaluation of the behaviour of the system (installation) after each stage
   Has the issue been resolved?
   If not, we return to the system state (step 3)
   If so, the system is finally repaired and documented
10. Restart the installation
    Return to operational mode

The concern for the steps 5 to 8 should be that the tests are performed safely so as not to compromise any security system. Each security system has both the role of operational security as well as explosion protection.

2 Evaluation of test security for finding faults and test equipment

On the market is a wide variety of equipment to perform testing, [3-4]. They may be intended for use in potentially explosive atmospheres or not.

If the test equipment is not intended for use in potentially explosive atmospheres, it can only be used in potentially explosive atmospheres if:

- it remains electrically isolated from any power supply;
- the temperature of any part of the equipment remains below the ignition temperature of the explosive atmosphere;
- no ignition source can become active in the presence of potentially explosive atmospheres;
- there is a low possibility of apparition of explosive atmosphere and this can be detected.

There is only a few (few) equipment for making test are certified in accordance with EN 60079-11, [5].

When necessary, simulation tests must be performed as close as possible to reality.

Older test equipment running on primary or secondary batteries, are certified for maximum subgroup IIB and possible Ex ib, so they cannot be connected in circuits in zone 0 [6].

3 Determining the frequency of maintenance inspections to detect faults

How industrial disasters happen? They are usually the result of multiple failures, that is, both of the installation (primary system) and the protection systems.

Ensuring that the protection system(s) is not faulty must be of the utmost importance. How often should we test the protection systems to ensure the required availability?

The correct determination of the frequency of inspection / testing activities, maintenance of protection systems is essential for the safety of any installation:

- too rarely, the installation is exposed to a major risk
- too often (frequently) the installation is subjected to an excessively planned downtime in excess and increased maintenance costs.

Maintenance to identify faults is a set of tasks designed to detect or predict faults in protection systems to reduce the likelihood of failure of protection systems and the installation to occur at the same time.

The maintenance frequency will be determined taking into account the following formula which will take into account all variables.

Thus:

$$FFI = (2 \times M_{TIVE} \times M_{TED}) / M_{MF} \quad (1)$$

(Fault find interval)

where:

- M_{TIVE} = MTBF of the protection device or system;
- M_{TED} = the average time between 2 defects of the protected function;
- M_{MF} = average time between 2 multiple faults.

We can consider as an example an installation in which there is a pump and a spare pump and the following is required from the protective system:

- that the probability of a multiple failure to be is less than 1 to 1000 / year (M_{MF});
- service pump failure rate 1 to 10 years (M_{TED});
- service pump failure rate1 to 8 years (M_{TIVE}).

Therefore, the correct interval for finding the defect would be:

$$FFI = (2 \times 8 \times 10) / 1000 = 160 / 1000 = 0.16 \text{ years} \quad (2)$$

$$0.16 \text{ years} \times 12 \text{ months} = 2 \text{ months} \quad (3)$$

This does indicate that the backup pump must be checked every two months to be sure it is working properly.

If this check is not performed, the probability of multiple failures increases.

On the other hand, from practice, it appears that maintenance for find the failures is classified into three main types:

- preventive maintenance,
- reactive maintenance, and
- predictive maintenance.

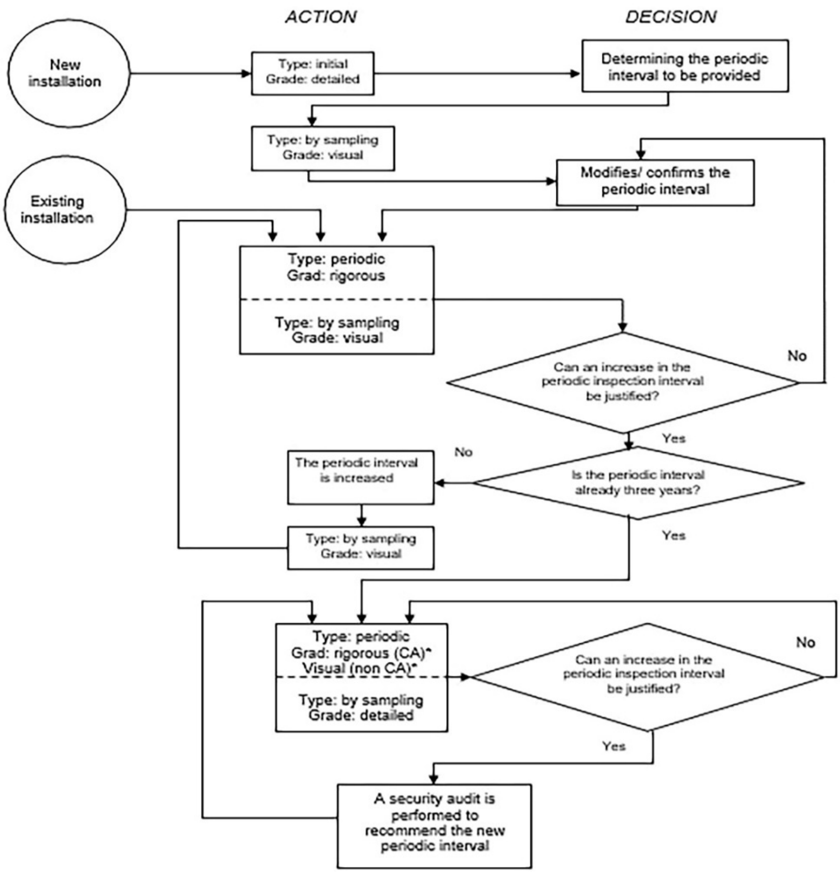
Preventive maintenance consists of interventions that prevent failures and decrease the likelihood of failures in an installation. That is a type of planned maintenance that is performed even when an equipment or installation maintains its operational capacity.

Reactive maintenance (also called corrective) is the activity carried out after a malfunction and the purpose is to restore the equipment or installation to its operating condition.

Predictive maintenance is a practical maintenance strategy that aims to prevent failures. Depending on the data collected and the predictive algorithms, it tries to estimate when a failure will occur. Maintenance activities are then scheduled based on these programs.

Also, since the electrical installations operating in a potentially explosive atmospheres have special characteristics designed to operate in such atmospheres, the requirements of SR EN 60079-17 - Explosive atmosphere. Part 17 - Inspection and maintenance of electrical installations, must also be taken into account [7 - 8]. This standard provides details for the initial inspection, for subsequent periodic inspections, continuous supervision by qualified personnel and for maintenance. The procedure regarding inspections, is summarized in the diagram presented in Figure 2.

In accordance with the requirements from SR EN 60079-17, inspection and maintenance of Ex installations must be carried out only by experienced personnel, whose training has included training on the different types of protection, the requirements from the above-mentioned standard, national regulations as well as the principles of classification of hazardous areas, [9-11]. Proof of relevant experience and the trainings performed must be documented and available.



*CA – Capable of ignition in normal operation, i.e. if the internal components of the appliance produce arcs, sparks or surface temperatures capable of ignition in normal operation.

Fig. 2. General inspection procedure for periodic inspections, [7].

4 Conclusions

Monitoring, inspection, testing, maintenance and implicitly preventive maintenance as a process, is a solution that can ensure increased operational safety and economic efficiency if as many parameters as possible can be tracked.

Adoption of modern maintenance systems and the completion of processes to prevent and / or detect failures ensure, by monitoring the operation, data processing and application of preventive maintenance measures, the success of the reliability and prolongation of use for equipment in the facilities.

Even if a product designed for use in potentially explosive atmospheres is placed on the market after the application of conformity assessment procedures in force, explosion protection characteristics may be altered due to multiple factors such as: incorrect selection of equipment, incorrect installation for product, inadequate inspection operations, inadequate maintenance of equipment, improper overhaul or repair of equipment.

Thus, this paper aims to find the best approaches for detecting defects, performing tests and maintaining equipment in installations that operate in potentially explosive atmospheres. This model is general and can be customized for any installation, following the steps presented, all to minimize the risks that may occur in potentially explosive atmospheres, with major implications for the environment and operational safety in terms of explosion protection safety.

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