3 Installation & Inspection of IS apparatus - An introduction

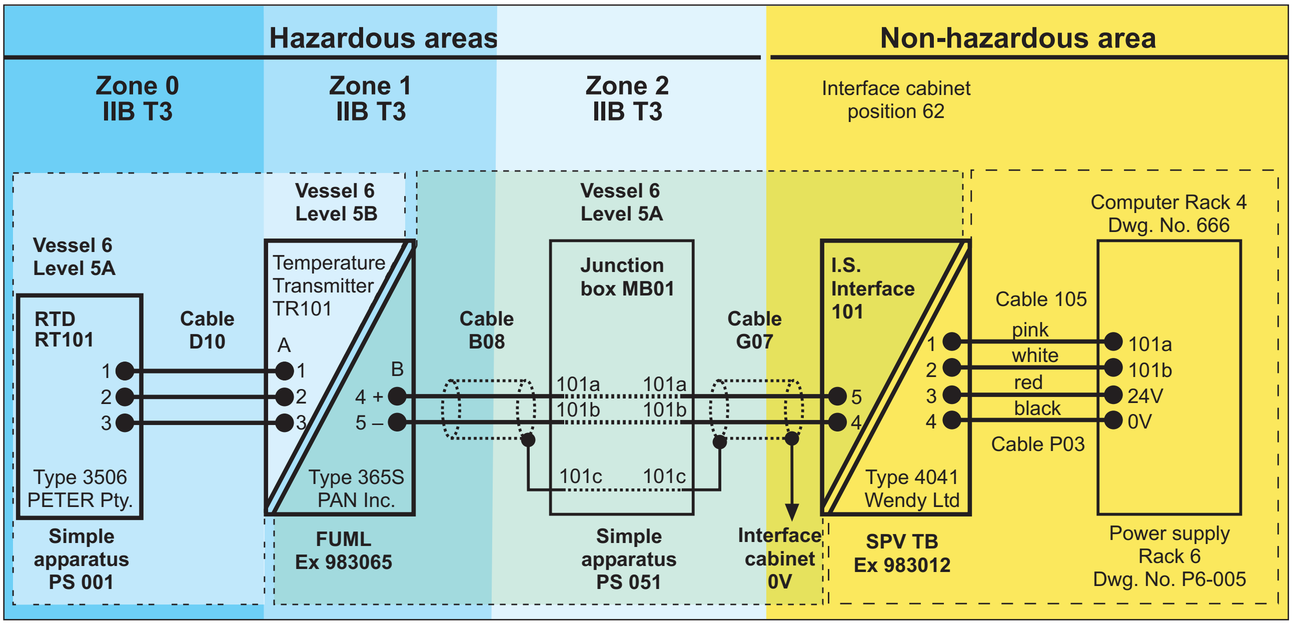

Figure 3.1 - Typical installation drawing for IS system

3.1 General

The long term continued safety of an intrinsically safe system depends on adequate inspection and maintenance.

The relevant IEC standard is IEC 60079-17, which deals comprehensively with all methods of protection. Where installations are required to comply with the European 'user' Directive 1999/92/EC a documented inspection procedure becomes a part of the required risk analysis.

Any work on a hazardous plant needs to take into account overall plant safety. Consequently it is necessary to comply with the safety practices of the particular installation (for example work permits), even though the risk of ignition from the intrinsically safe circuits is minimal, and gas clearance certificates are not necessary. In some ways this is even more important in the pre-commissioning stage.

If there are significant changes in the plant operation, which for example modify the area classification then the safety analysis must be reviewed, the documentation modified, and possibly the inspection procedure changed and/or repeated.

The procedure places the onus for ensuring that the equipment used is suitable for its location on the creator of the installation drawing. The nature of an inspection depends on how well the installation drawing, which changes the system design drawing into a drawing specific to a particular installation, has been carried out.

If the documentation is inadequate then any inspection can only be carried out by someone with detailed knowledge of the plant and exceptional expertise in hazardous area practice. Because such a person rarely exists, this analysis assumes that the documentation is adequate, and uses Figure 3.1 to illustrate the process.

If the person doing an inspection does not understand some aspect of the drawing, or believes it could be wrong, then they should be encouraged to question the document. IEC 60079-17 requires the identification of 'a technical person with executive function' to be responsible for inspection related matters in each installation. This person should be known to the technician doing the inspection, and should be available and able to answer questions.

The installation drawing should take into account what can be checked on the installation. For example, quoting permissible capacitance and inductance for a cable is not useful, because although it is possible to check these parameters, it is not easy to do so. Stating an acceptable type and length is much more useful.

3.2 Initial inspection

An initial inspection to ensure that the installation complies with the installation drawing is critical.

Where an adequate drawing such as Figure 3.1 exists, the initial inspection should ensure that the actual installation conforms to the drawing.

Usually this involves checking each individual loop stage by stage, which involves a good deal of opening enclosures and clambering over structures. Where the technician involved is suitably qualified this inspection can be combined with the operational checks. However some organisations separate the two requirements, preferring 'independent' safety inspections. This separation of functions is not conducive to shortening start up times.

Frequently the initial inspection demonstrates the inadequacy of plant labelling, and the opportunity to improve this feature should not be missed.

3.3 Periodic inspections

The objective of periodic inspections is to ensure the system has not appreciably deteriorated and has not been modified in an unauthorised way.

The required frequency of periodic inspections is influenced by many factors, such as the immediate environment, the presence of corrosive atmospheres and the susceptibility to mechanical damage. A usual starting point is to consider a three-year cycle, inspecting a third of the apparatus every year. If the inspection shows widespread deterioration then the inspection period should be shortened and remedial action taken.

Establishing that the intended apparatus is still in place is relatively easy providing that the apparatus has a unique identity. Usually the manufacturers type number is adequate. Much has been written about checking the marking on the labels but except, as an intellectual exercise there is little point. Providing that the inspector is convinced that the apparatus is the intended apparatus then he has fulfilled his function. He should be encouraged to ask questions if he is unhappy about the apparatus or if the circumstances of use have changed but fundamentally it is not reasonable to expect a detailed analysis of every loop.

It is usually worth creating separate drawings of such things as interface cabinets and junction boxes so that they can be readily checked for any sign of unauthorised modification. Similarly preparing short lists of field equipment grouped in a particular area with their essential points of inspection can shorten the time required.

Most modern (smart) instruments can be identified from the safe area computer. It is relatively simple for the computer to check that the field instrument is unchanged and raise a flag if it is changed. This can be done frequently. The periodic inspection for that apparatus is then reduced to checking for deterioration.

There is a strong link between the need for periodic inspections for operational and safety reasons and it is usual to combine the requirements. For example, the short piece of field wiring used for the final connection to the instrument is often prone to mechanical damage and consequently is usually included in the inspection procedure even though its open or short-circuit failure would not create an incendive spark.

The check for mechanical deterioration is usually a quick check for corrosion, impact damage, efficiency of seals, security of mounting and adequacy of cable glands. Some judgement on the need for repair or replacement is required, and the need for operational reliability usually determines the necessary action.

There is however no substitute for a well-trained technician with the right attitude.

3.4 Testing of apparatus

Sometimes it is suggested that apparatus should be removed for periodic testing.

In practice, if an intrinsically safe loop is functional then it is very unlikely to have failed in a dangerous mode. Components critical to safety are derated, so the probability of external circumstances causing them to fail without causing a malfunction is small.

There is a bigger risk that a mistake could be made during the removal and replacement of the apparatus being tested. The argument for not interfering with a system, which has survived the initial inspection and is still functional, is very powerful.

A particular case sometimes cited is regarding shunt-diode safety barriers. Failure rate statistics can always be questioned, but the undetected failure rate to danger of a barrier (i.e. the shunt diodes not failing to an open circuit condition), can be readily demonstrated to be in better than 10^{-16}/annum. With this probability of failure they should remain untou ched forever. If they are removed for any other reason a simple continuity check has some merit.

If a malfunction does occur, there is a risk that safety components could also have been damaged and power to the system should be removed as a precaution. A repair should be carried out as quickly as possible. Apparatus or wiring, which remains damaged or is not in use for a considerable time, should be removed from the hazardous area as it represents an unnecessary risk.

3.5 Testing of earth connections

It is always difficult to balance the traditional methods of testing earth connections with the need to ensure that an unacceptable risk to the plant is not introduced. Injecting significant voltages and currents into ill-defined circuits is not compatible with avoiding unnecessary risks.

In almost all intrinsically safe installations cable screens contribute to system safety and need to be earthed. In some apparatus such as shunt diode safety barriers and apparatus using a particular type of transformer, the earth connection is an important part of the method of protection.

Where surge protection against induced voltages (usually from lightning) is introduced then this introduces a further complication.

The design of the earthing system needs to be done with some care and provision made to enable the system to be tested safely. This is frequently done by providing duplicate leads.

The subject is considered in detail in the section on earthing and it is not possible to adequately summarise the process.

If you believe in testing earths by injecting a significant current then think very hard about the possible paths that the current will use to come back to its point of origin.

If you are confident that the path is well defined and safe - then there is no point in testing it!

3.6 Testing insulation

Insulation testing is usually carried out using a high voltage (500V or more), which is not compatible with the intrinsic safety concept. (The ignition capable capacitance corresponding to 500V rms in IIC is 160pF. This is the capacitance of approximately 1m of cable).

Where insulation testing is considered essential, it should be carried out using a suitably certified instrument. This instrument will apply a low voltage only (less than 6V) and have a low current capability (less than 10mA). However, bear in mind that it is difficult to ensure that there is no flammable gas at all points along an instrument circuit during the period of test.

If high voltages are applied, care should be taken to ensure that the connected equipment can not be damaged by the testing. For example, it may be necessary to disconnect any surge suppression devices that are connected in the circuit. It will also be necessary to take care to discharge any charge that may have accumulated in the equipment during testing.

Intrinsically safe circuits are usually fully floating or earthed at one point. The reason for this is that if a circuit is earthed at more than one point, the differential potential between the two points will cause an undefined current to flow through an unknown inductance. On a well-bonded plant the voltages are low and the resultant current may not be incendive, but it is still unknown, could possibly be incendive and is therefore not desirable.

Many intrinsically safe circuits that use shunt-diode safety barriers are designed to 'fail-safe' in the presence of an earth fault, and consequently there is no need to test the insulation. Some circuits, but not many, are provided with earth leakage detection systems and these do not need testing. Fully isolated circuits would require two separate faults to earth points some distance apart before the circuit could possibly be dangerous. The probability is that two such faults would also create an operational failure and consequently routine insulation testing of these circuits is not considered necessary.

There are a few remaining circuits that are not covered by the above, but the level of voltage and current necessary to cause an earth fault to be incendive (arguably greater than 9V and 100mA) would almost always causes an operational failure. Consequently, routine insulation testing of a functioning circuit on a well-bonded plant is not necessary or desirable.

The overall conclusion is that routine insulation testing of intrinsically safe circuits, which are functional, is not necessary. The emphasis on 'functioning circuits' does however reinforce the argument for rapid repair of non-functional circuits discussed elsewhere.

Theoretically, just removing the power from a circuit with multiple earth connections does not make it safe if significant differences in plant potential exist. If insulation testing is thought to be desirable for other reasons it should be carried out with care using a suitably approved tester. Where apparatus has to be disconnected during the testing process then special care is required to ensure that the reconnection is correct, since this is an obvious risk. This usually involves at least a functional check.

3.7 Reference to apparatus certificates

Occasionally it will be thought desirable to refer to the certificate of a piece of apparatus. Sometimes a copy is available but the preferred technique is to check on the web for the latest version. Most manufacturers and some certification authorities make their certificates available by this means. For example, MTL certificates are available on the web-site http://www.mtl-inst.com/ and IEC Ex certificates are available on web-site http://www.iec.ch/

The use of the web ensures that the most recent version of the certificate is available and that the certificate is complete.

This extract is part of MTL Application Note AN9003 as published on the MTL web site.

http://www.mtl-inst.com/appnotes/an9003/