Are the Intrinsically Safe Loops in Your Process Compromised by the CRT in Your Control Room?

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Electrical equipment used where flammable vapors may be present must be designed so that they are not an ignition source. One method of accomplishing this is by use of power equipment (for example: 4-20 mA transmitters and positioners) to nata such equipment not an intrinsically safe loop. These loops are energy limited so that key faults in the equipment or wiring will not create an ignition on capable spark.

The energy generated for intrinsically safe loops typically is contained within an intrinsically safe module. The use of barriers eliminates the need to invest gate the control equipment connected to the transmitter and positioners. However, the now popular use of cathode ray tube monitors may require the use of FM or CCA certification of the barriers and result in a system that would be rejected by inspectors.

The difficulty arises from the fact that the vast majority of intrinsically safe barriers have either a marked or a presumed voltage that appears to the control equipment. This voltage may be specified as:

- Max. safe area voltage: 250 V or
- V_{\text{max}} < 250 V
- Unspecified equipment: V < 250 V

The intent of the modules is to form the user that faults in the control equipment should not result in more than 250 V being applied to the barrier. ANSI/SA RP1261987, expands this as follows:

Associated apparatus and control room apparatus connected to it shall not be powered by more than 250 V (rms or dc) to the barrier and shall not generate any voltage internal in excess of this value.

Summary, the Appendix F of the Canadian Electrical Code states:

F313 Control room equipment shall not be powered by more than 250 V rms ac or dc to the barrier and shall not generate internal voltage in excess of these values unless the barrier device or the associated apparatus is specifically approved and marked for a higher voltage or the equipment separately approved and marked to permit connection.

Since the control equipment should not contain any voltage sources higher than 250 V, the obvious conclusion is that a monitor using a high voltage cathode ray tube (CRT) may not be used for intrinsically safe loops.

This may be a surprising statement to many, and due to the nce CRTs are becoming a way of life in industry, a new nsta atas and rectifies. The intent of this article is to explain the problem and identify situations being used.

The issue was first brought to the attention of the Instrument Society of America (ISA) SP12 committee by a major manufacturer of process control equipment. This manufacturer ran a test on the high voltage on the cathode ray tube (CRT) was allowed to discharge to the signal wire to an intrinsically safe barrier in order to show the effectiveness of the barrier. The discharge was not even made to the signal wire but to the signal return terminal. See Figure 1. The signal return terminal was then connected to ground with several feet of 12 AWG wire. The resistance of the current was on a small fraction of the max um one ohm resistance permitted. Although the discharge lasted on m cross-sections the signal current evated the barrier ground terminal. Several hundreds of voltage signals the signal return to arc in the hazardous location to grounded metal. The arc was then capable of...
The test demonstrated that the barrier components were not an event. The arc was independent of the zener type the fusing the transistors or any other barrier parameter. It is NOT POSSIBLE FOR THE NTR NS C SAFETY BARRER TO PROVIDE THE NEEDED PROTECTION. The fault current in the ground lead was the problem.

Fortunately at the time of the demonstration it was clear that manufacturers ordered the zener transistors separate on between the CRTs in the control room and the NTR NS C safety barriers in the equipment cabinets. Some manufacturers had several transistors on each board and cabinets such that the energy to the discharge was dissipated destroying these transistors. These manufacturers were able to demonstrate that the maximum voltage applied to the barrier during a fault never exceeded 250 V. Other manufacturers separated the CRT from the barrier by a data highway. Each end of the data highway was protected by surge suppressors to absorb the transients. Again, it was possible to show that the maximum voltage reaching the barrier did not exceed 250 V. In essence, the large fault current had been routed away from the NTR NS C safety barrier ground lead to other parts of the system.

An additional consideration was the zener spark to semiconductor devices posed by the high voltage and the energy stored within the CRT Monitor manufacturers provided arc suppressors around the CRT in order to short circuit arcs or sparks directly to the flyback transformer. A solid state generator practice to ground the second anode return so that as much as possible faults not propagate outside the enclosure. The direct ploy affected whether or not energy was dispersed internally or externally to the monitor.

A final conclusion was that the safety hazard caused by the 15,000 to 30,000 second anode voltage. The attempts made to provide users safety by so at the high voltage level, would be expected to provide so at to reduce the risk of getting an explosive atmosphere. CRT Monitor contains primary radiation under the Safety Standards for data processing equipment UL 478 and CSA C22.2 No. 220. These standards do not contain specific guidelines for segregating the high voltage from the signal circuits but rely primarily on a dielectric strength test. This provides approximate values test factor. Underwriters Laboratories requires both that the users will be used and that the connection to the CRT be securely fastened. So these
guarantees do not appear to ensure adequate separation on CRTs. Indeed, it is not uncommon to see the high voltage second anode ead touch grounded or read above the other CRTs.

The British industry, the expected a. As in the case of the previous issue in 1979, the industry had addressed this problem of CRT protection. They stated the following:

The majority of systems would require a multiplicity of fuses for the high voltage of the CRT to break through to the barrier terminal. Where the risk of break through to the barrier cannot be readily assessed to be better than 10⁻¹⁶/annum, then add a protection on the form of an adequate voltage-rated high voltage suppressor for each CRT. A grounded terminal should be used. Since this protection is a secondary safeguard, no protection on the components within the unit is necessary but the suppressor should be capable of safeguarding against the full range of voltage and current pulses which can be envisaged from the available power source. When a system connected to safety barriers contains a CRT, then the safety documentation should contain a clear statement that the high voltage is adequate and segregated or made safe by the use of surge suppressors. This statement may be made either by the supplier of the system, the CRT manufacturer, or the end user.

The growing need to locate CRTs outside of the control room or at the periphery of the equipment room or at the process makes it essential that proper grounding and data highways provide the necessary surge protection. Fundamental to the safety of the anode is a grounded eave to provide the CRT enclosure, there is the possibility that an arc can occur. As demonstrated, the experiment the ground terminal is necessary, the suppression can be evolved hundreds of volts to the point that CRTs rated on 500 volts are not available. A high-voltage arc to a grounded metal and provide an effective on source.

The main thrust of protecting CRTs is to ensure that equipment connected to ntrns can be safely operated, either by providing a good return path within the CRT enclosure or by providing a separate path within the CRT enclosure to be defeated. At this time, the challenge would seem to be with the CRT monitors manufacturers to design units in which the key that the second anode voltage would arc to the grounded metal and cause a large fault current to exit the CRT enclosure. Ensuring that fault paths would be unkey to compromise the basic insulation on the second anode would be accomplished by spacing the second anode from other CRTs per TABLE 1. Encasing the second anode in a grounded braided metal sleeve (bonded at the flyback transformer) or encasing the second anode in a second protective jacket. Where none of the above is appropriate, each CRT eave from the second contact to the CRT by a transient suppressor.

<table>
<thead>
<tr>
<th>Voltage (kV)</th>
<th>Spacing (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>35 (1.4)</td>
</tr>
<tr>
<td>25</td>
<td>45 (1.8)</td>
</tr>
<tr>
<td>30</td>
<td>55 (2.2)</td>
</tr>
<tr>
<td>35</td>
<td>65 (2.6)</td>
</tr>
<tr>
<td>40</td>
<td>75 (3.0)</td>
</tr>
</tbody>
</table>

TABLE 1: Spacings Based on FIG. 7 of IEC 60064.