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| **Slide No.** | **Slide Title** | | **On-screen Text** | | **Reference Screenshot + Images** | **Audio script** | **Notes to the developer** |
|  | Welcome | | Designing for Intrinsic Safety | | F:\Projects_2020\UL\UL_Template_Screenshots\Wireless\UL_Wireless_Static\1.png  Mature electrician working in white hard hat with cables and wires. Russian people in Russia. Screwdriver in hand | Welcome to the course “Designing for Intrinsic Safety”.    Click Start to begin. |  |
|  | Navigation | |  | |  | You also need to understand how to navigate through the course. If you’ve been here before, you can proceed directly to the course. |  |
|  | Course Overview | | 1. **Designing for Intrinsic Safety** 2. Introduction to Hazardous Locations 3. Thermal Injury Risk 4. The ATEX Directive for Hazardous Locations   **After fading away**  This course will cover basic concepts of intrinsic safety and explore the requirements for intrinsic safety outlined in IEC 60079-11.  This includes defining faults that maybe applied during the evaluation of intrinsically safe equipment and protective components that may be used in the design of such equipment.  **After fading away**  Additionally, the limits of energy permitted in intrinsically safe circuits will be discussed. | | F:\Projects_2020\UL\UL_Template_Screenshots\Wireless\UL_Wireless_Static\2.png  Electrician assembling industrial electric cabinet in workshop.  **After fading away**  F:\Projects_2020\UL\UL_Template_Screenshots\Wireless\UL_Wireless_Static\6.png  Offshore electrical engineer checking electrical equipment. Young oil and gas professional.  Mechanic working in factory,Technician wearing safety working with a vertical milling machine,Machining of a metal part on a metal-cutting machine.  **After fading away** | This is the first module of the four-module series on Hazardous Locations.  **After fading away**  This course will cover basic concepts of intrinsic safety and explore the requirements for intrinsic safety outlined in IEC 60079-11.  This includes defining faults that maybe applied during the evaluation of intrinsically safe equipment and protective components that may be used in the design of such equipment.  **After fading away**  Additionally, the limits of energy permitted in intrinsically safe circuits will be discussed. | Make 4 columns as shown in the screenshot. |
|  | Learning Objectives | | You will be able to:   * **Identify** standards that contain requirements for intrinsically safe equipment * **Define** intrinsic safety * **Provide** examples of equipment that employ intrinsic safety * **Describe** IEC 60079-11 requirements for faults, levels of protection, and separation distance * **Identify** components on which intrinsic safety depends * **Identify** infallible components and assemblies of components * **Define** spark ignition assessment and thermal assessment | | F:\Projects_2020\UL\UL_Template_Screenshots\Wireless\UL_Wireless_Static\3.png  Electrical and instrument operator calibrate level transmitter at offshore oil and gas wellhead remote platform, Onsite service worker. | Take a minute to review the learning objectives of this course. |  |
|  | Course Structure | | Topic 1: Applicable Standards for Intrinsically Safe Equipment  Topic 2: What Is Intrinsic Safety?  Topic 3: Faults  Topic 4: Components on Which Intrinsic Safety Depends  Topic 5: Assessments | | **F:\Projects_2020\UL\UL_Template_Screenshots\Wireless\UL_Wireless_Static\4.png**  engineer working on checking and maintenance equipment at green energy solar power plant: turn on inverter | This course is divided into five topics.   * Applicable Standards for Intrinsically Safe Equipment, * What Is Intrinsic Safety? * Faults, * Components on Which Intrinsic Safety Depends, and * Assessments. |  |
|  | **UNIT 1:**  **Applicable Standards for Intrinsically Safe Equipment** |  | | **F:\Projects_2020\UL\UL_Template_Screenshots\Wireless\UL_Wireless_Static\4.png** | | Let’s begin with the first topic i.e., “Applicable Standards for Intrinsically Safe Equipment”.  Click Next to continue. |  |
|  | Applicable Standards | | Applicable standards are different in different parts of the world.  Note: The standards provided here are just for the intrinsic safety requirements, not the standards for any HazLoc equipment.  *Click each marker to read and learn more.*  Marker\_1: **Canada**  **Applicable Standards in** **Canada**  Table\_1:  Division Classified Areas  **Division Classified Areas**  CAN/CSA C22.2 No. 157-92  Table\_2:  Zone Classified Areas  **Zone Classified Areas**  CAN/CSA C22.2 No. 60079-0  CAN/CSA C22.2 No. 60079-11  Pop-up:  Definitions of division and zone classified areas.  **Division**  The Division defines the probability of the hazardous material being able to produce an explosive or ignitable mixture based upon its presence.  **Zone Classified Areas**  The Zone defines the probability of the hazardous material, gas or dust, being present in sufficient quantities to produce explosive or ignitable mixtures.  Marker\_2: **United States**  **Applicable Standards in the United States**  Note: The standards provided here are just for the intrinsic safety requirements, not the standards for any HazLoc equipment.  Table\_1:  Division Classified Areas  **Division Classified Areas**  Through the reference of UL 913 to UL 60079-0 and UL 60079-11, this results in the requirements for intrinsically safe equipment within the United States to be harmonized with the international requirements for intrinsically safe equipment.  Table\_2:  Zone Classified Areas  **Zone Classified Areas**  UL 60079-0  UL 60079-11.  Pop-up:  What is the difference between division and zone classified areas?  **Division**  The Division defines the probability of the hazardous material being able to produce an explosive or ignitable mixture based upon its presence.  **Zone Classified Areas**  The Zone defines the probability of the hazardous material, gas or dust, being present in sufficient quantities to produce explosive or ignitable mixtures.  Marker\_3: **Europe**  **Applicable Standards in Europe**  These are used for equipment that is evaluated and certified under the ATEX System.  Note: The standards provided here are just for the intrinsic safety requirements, not the standards for any HazLoc equipment.  **What is the ATEX System?**  The **ATEX System** consists of two EU directives describing what equipment and work environments are allowed in an environment with an explosive atmosphere.  ATEX derives its name from the French title of the 94/9/EC directive: Appareils destinés à être utilisés en **AT**mosphères **EX**plosibles.  Marker\_4: **International**  **Applicable International Standards**  These are used for equipment that is evaluated and certified under the IECEx System.  Note: The standards provided here are just for the intrinsic safety requirements, not the standards for any HazLoc equipment.  **What is the IECEx System?**  The objective of the IECEx System is to facilitate international trade in equipment and services for use in explosive atmospheres, while maintaining the required level of safety:   * Reduced testing and certification costs to manufacturer * Reduced time to market * International confidence in the product assessment process * One international database listing * Maintaining International Confidence in equipment and services covered by IECEx Certification | | Marker\_1      Image: CAN/CSA C22.2 No. 157-92    Image: CAN/CSA C22.2 No. 60079-0    Image: CAN/CSA C22.2 No. 60079-11  Marker\_2:      Image: UL 913    Image: UL 60079-0    Image: UL 60079-11  Marker\_3:    Image:    Image: EN 60079-0    Image: EN 60079-11  Marker\_4:      Image: EN 60079-0    Image: EN 60079-11 | Applicable standards are different in different parts of the world.  Note that the standards provided here are just for the intrinsic safety requirements, not the standards for any HazLoc equipment.  Click each marker to read and learn more. |  |

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|  | Challenge | Q1:  The following standards are used for intrinsically safe equipment that is evaluated and certified under the ATEX System.  *Select ALL that apply.*  *Select the correct options and click Check.*   * **EN 60079-0** * IEC 60079-0 * UL 913 * **EN 60079-11** | F:\Projects_2020\UL\UL_Template_Screenshots\Wireless\UL_Wireless_Challenge\2.png  Correct Answer Feedback:  **Excellent, that’s correct!**  **EN 60079-0** and **EN 60079-11** are used for equipment that is evaluated and certified under the ATEX System.  Wrong Answer Feedback:  **Sorry, that’s not quite correct!**  **EN 60079-0** and **EN 60079-11** are used for equipment that is evaluated and certified under the ATEX System. | Let's now see how much you have learned or remember from this topic.  Let's do a small activity to test your knowledge. |  |
|  |  | Q2:  Intrinsically safe equipment intended for use in areas classified under the Division scheme within Canada are evaluated to:  *Select the correct option and click Check.*   * CAN/CSA C22.2 No. 60079-0 * **CAN/CSA C22.2 No. 157-92** * EN 60079-0 * CAN/CSA C22.2 60079-11 | Correct Answer Feedback:  **Excellent, that’s correct!**  Equipment intended for use in areas classified under the Division scheme within Canada are evaluated to **CAN/CSA C22.2 No. 157-92.**  Wrong Answer Feedback:  **Sorry, that’s not quite correct!**  Equipment intended for use in areas classified under the Division scheme within Canada are evaluated to **CAN/CSA C22.2 No. 157-92.** |  | Drop-down activity |
|  | Unit\_2:  What Is Intrinsic Safety? |  | **F:\Projects_2020\UL\UL_Template_Screenshots\Wireless\UL_Wireless_Static\4.png** | We are done with the first topic.  Let’s now move to the second topic i.e. What Is Intrinsic Safety?  Click Next to continue. |  |
|  | Intrinsic Safety | *Click each tab to learn more.*  3 tabs:  What is intrinsic safety?  What it is ideally suited for?  What are the benefits of Intrinsic safety?  Intrinsic safety is a method of protection for electrical equipment intended for use in potentially explosive atmospheres.  It differs from other protection techniques in that it relies on energy limitation within the circuit to ensure that it is not capable of causing ignition under prescribed fault conditions.  Intrinsic safety is ideally suited for:   * Very low power sensors, since it allows the sensor to be directly exposed to the explosive atmosphere * Portable battery-operated equipment, since it does not require the use of bulky explosion-proof enclosures   Benefits of Intrinsic safety include:   * Lower installation costs, since it does not require the use of explosion-proof conduit systems for the wiring * Live maintenance - some equipment that has been constructed to allow for it may be serviced in the explosive atmosphere without the need to shut down the supply | F:\Projects_2020\UL\HBSE\HBSE_templates\Clickable images\2.png  cpu processor hardware unit over motherboard background. computer chip close up. digital technology concept. | Click each tab learn, What Intrinsic safety is, what it is ideally suited for, and the benefits of Intrinsic safety.  Intrinsic safety is a method of protection for electrical equipment intended for use in potentially explosive atmospheres.  It differs from other protection techniques in that it relies on energy limitation within the circuit to ensure that it is not capable of causing ignition under prescribed fault conditions.  Intrinsic safety is ideally suited for very low power sensors, since it allows the sensor to be directly exposed to the explosive atmosphere and Portable battery-operated equipment, since it does not require the use of bulky explosion-proof enclosures  Benefits of Intrinsic safety include, lower installation costs, since it does not require the use of explosion-proof conduit systems for the wiring and live maintenance - some equipment that has been constructed to allow for it may be serviced in the explosive atmosphere without the need to shut down the supply |  |
|  | IEC 60079-11 Definition | IEC 60079-11 defines Intrinsic Safety as, “a type of protection based on the restriction of electrical energy within equipment and of interconnecting wiring exposed to the explosive atmosphere to a level below that which can cause ignition by either Sparking or heating effects”.  *Click each tab to read and learn more.*  2 tabs  Sparking Effects  Heating Effects  **Tab\_1:**  **Sparking Effects**  When determining whether a circuit is capable of causing ignition due to sparking, it is necessary to consider the points at which a spark may occur.  The introduction of a spark is always considered a test of normal operation; however, it is only considered to occur either at points where normal arcing will occur, such as switches, or at points that do not comply with the construction requirements of the standard.  **Example**  If the separation distances between two points of a circuit do not comply with the separation requirements defined in the standard, then the spark test apparatus defined in Annex B of 60079-11 may be introduced at that point in the circuit to determine if the energy available is capable of causing ignition.  Additionally, if it is determined that a connection does not comply with the infallible connection requirements, then the spark test apparatus may be connected in series with those connections.  **Tab\_2:**  **Heating Effects**  It is also necessary to determine the maximum temperature of all of the parts in the circuit.  This includes all components as well as wiring and circuit board traces. | E-waste, technician repairing inside of hard disk by soldering iron. Integrated Circuit. the concept of data, hardware, technician and technology. | IEC 60079-11 defines Intrinsic Safety as, “a type of protection based on the restriction of electrical energy within equipment and of interconnecting wiring exposed to the explosive atmosphere to a level below that which can cause ignition by either Sparking or heating effects”.  Click each tab to read and learn more about the Sparking and Heating effects. |  |
|  | Types of Equipment | Intrinsic safety is used for two basic types of equipment: an associated apparatus and an intrinsically safe apparatus.  *Click each image to read and learn more.*  2 images:  Associated apparatus  Intrinsically safe apparatus  Image\_1:  **Associated apparatus**  **Associated apparatus** is equipment that is not necessarily intrinsically safe, and therefore may not be used in a hazardous location, but that contains circuitry that affects the intrinsic safety of circuits connected to it.  Associated apparatus will typically contain circuits that are designed to provide voltage and current limitation to ensure that circuits connected to it will remain intrinsically safe.  **Example**  **•** Shunt zener diode barriers  • Control equipment  • Liquid level consoles  This equipment is provided with components that limit the available voltage, current and power that are available at the intrinsically safe connections.  During the evaluation of an associated apparatus, the intrinsically safe outputs are marked with entity parameters.  These define the maximum voltage, current and power that is available at the terminals under fault conditions.  Additionally they are marked to indicate the maximum capacitance and inductance that can safely be connected to the terminals.  Image\_1:  **Intrinsically safe apparatus**  **Intrinsically safe apparatus** is equipment in which all of the circuits are intrinsically safe.  This includes equipment that is intended for connection to an appropriate associated apparatus and equipment that is portable and battery operated.  **Example**  Since the maximum permitted values of energy for intrinsically safe circuits are very low, the use of intrinsic safety as a protection technique is generally limited to very low power devices, such as:   * Pressure and temperature transducers * Strain gauges * Gas detection equipment   Intrinsically safe equipment intended for connection to an associated apparatus will also be marked with entity parameters. In the case of intrinsically safe equipment, the parameters define the maximum voltage, current and power that can safely be connected to the equipment without invalidating intrinsic safety. Additionally, the terminals are marked to indicate the apparent capacitance and inductance. | F:\Projects_2020\UL\HBSE\HBSE_templates\Clickable images\3.png  F:\Projects_2020\UL\CODE_AUTHORITIES_AND_CODES\Templates\Click_Images\2.png  Electrical Pneumatic Valve and Pressure Gauge  Image:  Pressure transmitter in oil and gas process, Send signal to controller and reading pressure in the system, Electronic transducer and sent data from production process to Processor Logic Controller. | Intrinsic safety is used for two basic types of equipment: an associated apparatus and an intrinsically safe apparatus.  Click each image to read and learn more about these apparatus. |  |
|  | Entity Parameters | Entity parameters allow for the interconnection of associated apparatus and intrinsically safe apparatus without the need to have the combination evaluated.  After fading away  After fading away  This information is used to determine that the combination of an associated apparatus and an intrinsically safe apparatus is acceptable.  The table shows the combination that needs to satisfy in order to ensure that the combination is intrinsically safe.  Note: Interconnecting cable also adds capacitance and inductance and must be accounted for, when determining if installation is safe. | Electric control panel enclosure for power and distribution electricity. Uninterrupted, electrical voltage.  F:\Projects_2020\UL\HBSE\HBSE_templates\Static\5.png  After fading away    **Associated apparatus**  Uo or Voc  Io or Isc  Po  Co or Ca  Lo or La  Lo/Ro or La/Ra  **Required condition**  <  <  <  >  >  >  **Intrinsically safe apparatus**  Ui or Vmax  Ii or Imax  Pi  Ci (+Ccable)  Li (+Lcable)  Li/Ri  After fading away  Electrician builder at work inspecting cabling connection of high voltage power electric line in industrial distribution fuseboard  F:\Projects_2020\UL\CODE_AUTHORITIES_AND_CODES\Templates\Static\4.png | Intrinsically safe apparatus, intended for connection to other devices and associated apparatus are generally provided with entity parameters.  These entity parameters provide the electrical limits of the equipment and are used to determine if a combination of equipment is suitable.  After fading away  In the case of the associated apparatus, the voltage, current and power are the maximum values available at the specified terminals under the fault conditions prescribed by the standard.  The CO and LO indicates the maximum values of capacitance and inductance that can be safely connected to the associated apparatus.  The L/R or inductance to resistance ratio indicates the maximum inductance per ohm of resistance for distributed inductances such as cables that can be safely connected to the associated apparatus without invalidating intrinsic safety.  When considering intrinsically safe apparatus, the voltage, current and power indicated are the maximum values that can safely be connected to the specified terminals without invalidating the intrinsic safety of the device.  The Ci and Li are the apparent values of the capacitance and inductance at the specified terminals.  After fading away  This information is used to determine that the combination of an associated apparatus and an intrinsically safe apparatus is acceptable.  The table shows the combination that needs to satisfy in order to ensure that the combination is intrinsically safe.  It should be noted that interconnecting cable also adds capacitance and inductance and must be accounted for, when determining if installation is safe. |  |
|  | Challenge | Q1:  All of the below are examples of an associated apparatus EXCEPT:  *Select the correct option and click Check.*   * Shunt zener diode barriers * Control equipment * Liquid level consoles * **Strain gauges** | F:\Projects_2020\UL\UL_Template_Screenshots\UL_Programs\UL_Programs_Challenge\1.png  Correct Answer: All the options are yes  Correct Answer Feedback:  **Excellent, that’s correct!**  All of these are examples of an associated apparatus EXCEPT strain gauges.  Strain gauges are an example of an intrinsically safe apparatus.  Wrong Answer Feedback:  **Sorry, that’s not quite correct!**  All of these are examples of an associated apparatus EXCEPT strain gauges.  Strain gauges are an example of an intrinsically safe apparatus. | Let's now see how much you have learned or remember from this topic.  Let's do a small activity to test your knowledge. |  |
|  |  | Q2:  Select the required condition based on the entity parameters chart.  *Select the correct option from the drop-down list and click Check.* | **Associated apparatus**  Uo or Voc  Co or Ca  Po  Lo or La  **Required condition**  Drop down options  **Intrinsically safe apparatus**  Ui or Vmax  Ci (+Ccable)  Pi  Li (+Lcable)  Correct answer  <  >  <  >    Correct Answer Feedback:  **Excellent, that’s correct!**    Wrong Answer Feedback:  **Sorry, that’s not quite correct!** |  | Drop down activity |
|  | Unit\_3:  **Faults** |  | **F:\Projects_2020\UL\UL_Template_Screenshots\Wireless\UL_Wireless_Static\4.png** | We are done with the second topic.  Let’s now move to the third topic i.e. Faults.  Click Next to continue. |  |
|  | Levels of Protection | Levels of protection are identified in clauses 5.2 - 5.4.  Intrinsic safety is categorized in three different levels, ia, ib, and ic. In each case the fault count refers to the number of countable faults that may be applied to the circuit.  There is no limit to the number of non-countable faults that may be applied to a circuit.  It is with both the countable and non-countable faults applied that a circuit is analysed to determine if it is capable of causing either thermal or spark ignition.  The required number of countable faults to be applied to the circuit is directly dependant on the intended use of the equipment.  Pop-up:  **Faults**  “Any defect of any component, separation, insulation or connection between components, not defined as infallible by IEC 60079-11, upon which intrinsic safety depends.”  Faults can be countable or non-countable.  **Countable fault**  Fault that occurs in parts of electrical apparatus conforming to the requirements of IEC 60079-11.  **Non-countable fault**  Fault that occurs in parts of electrical apparatus not conforming to the constructional requirements of IEC 60079-11. | F:\Projects_2020\UL\CODE_AUTHORITIES_AND_CODES\Templates\Static\10.png    **Level of Protection**  ia  ib  ic  **Zone or Division**  Zone 0 and Division 1  Zone 1 and Division 2  Zone 2 and Division 2  **Fault Conditions**  2  1  0 | Intrinsic safety is categorized in three different levels, ia, ib, and ic.  In each case the fault count refers to the number of countable faults that may be applied to the circuit.  There is no limit to the number of non-countable faults that may be applied to a circuit.  It is with both the countable and non-countable faults applied that a circuit is analysed to determine if it is capable of causing either thermal or spark ignition.  The required number of countable faults to be applied to the circuit is directly dependant on the intended use of the equipment.  Equipment and circuits that are intended for use in either a Zone 0 or division 1 location are required to remain intrinsically safe with the application of up to two countable faults and those non-countable faults that results in the most onerous condition and are given the level of protection ia.  Equipment and circuits that are intended for use in a zone 1 location are required to remain intrinsically safe with the application of one countable fault and those non-countable faults that result in the most onerous condition and are given the level of protection ib.  It should be noted that under the division area classification, these circuits and devices would be limited to division installations.  Equipment and circuits that are intended for use in a Zone 2 location are not subject to fault conditions however, not be capable of not causing an ignition when subjected to requirements of a standard.  In this case the equipment is given the level of protection ic.  It should be noted that within the U.S. these circuits and devices may also be used in a division 2 area.  Click the more info tab for the definition of Faults and its types. |  |
|  | Separation Distances | When considering separation distances as identified in clause 6.3, two options exist.  For levels of protection “ia” and “ib” the distance between two conductive parts determines whether a fault can be applied to the separation.  *Click each tab to read and learn more.*  2 tabs  Table 5  Annex F  On clicking tab\_1:  **Table 5**  When considering separation distances with respect to Table 5, there are three conditions to consider:   1. Distances that comply with the requirements 2. Distances that are less than the requirements, but greater than one-third of the requirement 3. Distances that are less than one-third the required value   In the case of separation distances that comply with Table 5 requirements, the two points in question cannot be shorted together.  If the separation distance is less than the required value, but greater than one-third, then the two points can be shorted together; however, this would require one fault to be counted. In the case of separation distances less than one-third the required value, then the two points can be shorted and no fault is counted. | F:\Projects_2020\UL\CODE_AUTHORITIES_AND_CODES\Templates\Click tabs\2020-07-13 09_31_01-Window.png  HVAC technician working on a capacitor part for condensing unit.    Image: Table 5    Image: Annex F    Image: Annex F | When considering separation distances as identified in clause 6.3, two options exist.  For levels of protection “ia” and “ib” the distance between two conductive parts determines whether a fault can be applied to the separation.  Click each tab to read and learn more. |  |
|  | Failure of Components, Connections and Separations | Clause 7.6 of IEC 60079-11 describes the various faults that can be applied to a circuit as part of the assessment of intrinsic safety.  This includes the faults that may be applied to components, connections and separation distances.  *Click each number to read and learn more.*  8 numbers  **Number\_1:**  Where a component is not rated in accordance with 7.1, its failure shall be a non-countable fault.  Where a component is rated in accordance with 7.1, its failure shall be a countable fault.  **Number\_2:**  Where a fault can lead to a subsequent fault or faults, then the primary and subsequent faults shall be considered to be a single fault.  If during the application of a fault it results in other components being used in excess of their ratings these other components can then be faulted as non-countable.  **Number\_3:**  The failure of resistors to any value of resistance between open circuit and short circuit shall be taken into account except for current-limiting resistors complying with clause 8.5.  This can be significant when determining the maximum temperature of the component, since it allows the component to be failed to a point where it dissipates the matched power in the circuit.  However, current-limiting resistors that comply with the requirements of clause 8.5 can only be considered failing to an open circuit condition.  **Number\_4:**  Semiconductor devices shall be considered to fail to short circuit or to open circuit and to the state to which they can be driven by failure of other components.   * Surface temperature classification - the component is considered to dissipate the maximum matched power in the circuit. * Any combination of short and open circuits - any capacitance and inductance connected to the device is to be considered in its most onerous connection. * Voltage available on external pins - it is assumed that the enhanced voltage is present at all of the external pins of the integrated circuit.   **Number\_5:**  Connections with an intrinsically safe device are also considered to be subject to application of faults.  In the case of wiring, the connections shall be considered to fail to open-circuit and if free to move, may connect to any part of the circuit within the range of movement.  The initial break is considered one countable fault and the reconnection is considered a second countable fault.  **Number\_6:**  Separation distances are considered to fail as previously discussed.  **Number\_7:**  Capacitors are considered to fail to open-circuit, short-circuit and any value less than the maximum specified value.  **Number\_8:**  Inductors are considered to fail to open-circuit, short-circuit but only to inductance to resistance ratios lower than that derived from the inductor specifications.  Clause 7.1 requires components in both normal operation and after the application of faults to be used within two-thirds of the manufacturer’s specified ratings taking into consideration the service temperature and mounting conditions. | F:\template sb\screenshots1\Interactivities\image279.jpg  Overloaded electrical circuit causing electrical short and fire. Short circuit faults burnt consumer unit. | Clause 7.6 of IEC 60079-11 describes the various faults that can be applied to a circuit as part of the assessment of intrinsic safety.  This includes the faults that may be applied to components, connections and separation distances.  Click each number to read and learn more on the Overview of Clause 7.6 Requirements. |  |
|  | Additional Clause 7.6 Requirements | The additional requirements of clause 7.6 are:  Insertion of the spark test apparatus to effect an interruption, short-circuit or earth fault shall not be considered as a countable fault but as a test in normal operation.  The spark test apparatus may not be inserted in series with infallible connections or across infallible separations unless the connections and separations are not protected by an enclosure of at least IP20, including when exposing connection facilities. | F:\Projects_2020\UL\UL_Template_Screenshots\HBSE\HBSC_Static\23.png  Technicain checking car fuse by lamp tester which nagative pole of lamp tester connected with car frame and positive pole measure at secondary of fuse box. | The additional requirements of clause 7.6 are as follows. |  |
|  | Challenge | Q1:  Equipment and circuits that are intended for use in either a Zone 0 or Division 1 location are required to remain intrinsically safe with the application of up to\_\_\_\_countable faults.  *Select the correct option and click Check.*  Options:   * 0 * 1 * **2** * 3 | F:\Projects_2020\UL\UL_Template_Screenshots\UL_Programs\UL_Programs_Challenge\1.png  Correct Answer Feedback:  **Excellent, that’s correct!**  Equipment and circuits that are intended for use in either a Zone 0 or Division 1 location are required to remain intrinsically safe with the application of up to 2 countable faults.  Wrong Answer Feedback:  **Sorry, that’s not quite correct!**  Equipment and circuits that are intended for use in either a Zone 0 or Division 1 location are required to remain intrinsically safe with the application of up to 2 countable faults. | Let's now see how much you have learned or remember from this topic.  Let's do a small activity to test your knowledge. |  |
|  |  | Q2:  In equipment and circuits that are intended for use in either a Zone 0 or Division 1 location, non-countable faults that results in the most onerous condition are given the\_\_\_level of protection  *Select the correct option and click Check.*   * **ia** * ib * ic | Correct Answer Feedback:  **Excellent, that’s correct!**  In equipment and circuits that are intended for use in either a Zone 0 or Division 1 location, non-countable faults that results in the most onerous condition are given the “ia” level of protection.  Wrong Answer Feedback:  **Sorry, that’s not quite correct!**  In equipment and circuits that are intended for use in either a Zone 0 or Division 1 location, non-countable faults that results in the most onerous condition are given the “ia” level of protection. |  |  |
|  |  | Q3:  Integrated circuits are considered to fail such that:   * They dissipate the maximum fault power in the circuit * Any combination of open and short circuits of external pins can occur * Any voltages present on an external pin can be considered to be present on all external pins * **All of the above** | Correct Answer Feedback:  **Excellent, that’s correct!**  Integrated circuits are considered to fail such that:   * They dissipate the maximum fault power in the circuit * Any combination of open and short circuits of external pins can occur * Any voltages present on an external pin can be considered to be present on all external pins   Wrong Answer Feedback:  **Sorry, that’s not quite correct!**  Integrated circuits are considered to fail such that:   * They dissipate the maximum fault power in the circuit * Any combination of open and short circuits of external pins can occur * Any voltages present on an external pin can be considered to be present on all external pins |  |  |
|  | Unit-4  Components on Which Intrinsic Safety Depends |  | **F:\Projects_2020\UL\UL_Template_Screenshots\Wireless\UL_Wireless_Static\4.png** | We are done with the third topic.  Let’s now move to the fourth topic i.e., Components on Which Intrinsic Safety Depends.    Click next to continue. |  |
|  | Requirements | Components on which intrinsic safety depends must satisfy **two requirements:**   * Separation distances as defined in clause 6.3 * Ratings as required by clause 7.1 | F:\Projects_2020\UL\UL_Template_Screenshots\HBSE\HBSC_Static\19.png  Electrical and instrument technician just maintenance electric system, offshore oil and gas electrical and instrument services. | Now that we have reviewed the faults that can be applied to circuits, we can discuss components that can be relied on to ensure that the voltage and current within a circuit are within the limits permitted by the standard.  Components on which intrinsic safety depends must satisfy two requirements:  • Separation distances as defined in clause 6.3 and  • Ratings as required by clause 7.1 |  |
|  | Components Permitted to Operate at Their Normal Ratings | Components permitted to operate at their normal ratings include:  Transformers  Fuses  Thermal Trips Relays  Relays  Optocouplers  Switches  All other components are required to be used within two-thirds of their ratings taking into consideration the service temperature and the mounting conditions.  Tolerances of components must also be considered. For example, a zener diode that is rated 10V, 10% tolerance is assumed to have a maximum clamping voltage of 11V. | F:\Projects_2020\UL\UL_Template_Screenshots\Wireless\UL_Wireless_Static\17.png | Components permitted to operate at their normal ratings include:  Transformers  Fuses  Thermal Trips Relays  Relays  Optocouplers  Switches |  |
|  | Clauses | The standard has requirements for specific components that may be used as protective.  *Click each tab to read and learn more.*  7 tabs  **Tab\_1: Clause 7.3**  **Tab\_2: Clause 7.5**  **Tab\_3: Clause 8.2 & 8.3**  **Tab\_4: Clause 8.5**  **Tab\_5: Clause 8.6**  **Tab\_6: Clause 8.7**  **Tab\_7: Clause 8.9**  **Tab\_1:**  **Clause 7.3**  The requirements for **fuses** can be found in clause 7.3 and according to the requirements, fuses are to be used within their voltage rating and have a breaking capacity greater than or equal to the maximum perspective current in the circuit.  Additionally, fuses are required to be encapsulated in accordance with clause 6.6 if they carry current when located in the explosive atmosphere.  Tab\_2:  **Clause 7.5**  Clause 7.5 discusses the requirements for **semiconductors** that are used as protective components. It should be noted that controllable devices such as transistors may not be in “ia” applications for limitation of current for spark ignition purposes.  Tab\_3:  **Clause 8.2 & 8.3**  Clauses 8.2 and 8.3 contain the requirements for **transformers** that are used as protective components.  In general, they are required to comply with the separation requirements and the insulation used in the construction must have a temperature rating greater than or equal to the maximum temperature of the windings when subjected to the type tests for transformers.  Tab\_4:  **Clause 8.5**  Clause 8.5 gives the requirements for **current-limiting resistors**. It defines the permitted constructions which are limited to film type, wire wound with protection to prevent unwinding of the wire in the event of breakage and printed resistors as used in hybrid and similar circuit covered by a coating conforming to 6.3.9 or encapsulated in accordance with 6.6. Additionally, the cold resistance of fuses and filaments of bulbs may be considered infallible current-limiting resistors.  Tab\_5:  **Clause 8.6**  Requirements of **capacitors used as protective components** are given in clause 8.6. Capacitors are required to be high reliability solid dielectric types. Electrolytic or tantalum capacitors shall not be used.  Tab\_6:  **Clause 8.7**  The requirements for **shunt safety assemblies** are given in clause 8.7 and requires that where diodes or zener diodes are used as the shunt component they form at least two parallel paths.  If diodes are connected such that they may be subject to power faults, then a transient analysis is necessary to determine that, in addition to being used within two-thirds or their ratings under steady-state conditions, that the transient ratings of the diode are not exceeded.  Tab\_7:  **Clause 8.9**  The requirements for **galvanically separating components**, such as optical isolators are given in clause 8.9. This requires that the internal separation distances comply with the applicable separation requirements. | F:\Projects_2020\UL\UL_Template_Screenshots\Wireless\UL_Wireless_Interactives\8.png  Engineer to use multimeter check circuit wiring terminals in the electrical Cabinet. Electrical wires or cables are connected to electrical equipment    Clause 7.3  TTEC4847: Diode  Clause 7.5    Clause 8.2 & 8.3    Clause 8.5    **Clause 8.6**  File:Zener diode symbol-2.svg - Wikimedia Commons  Clause 8.7    Clause 8.9 | The standard has requirements for specific components that may be used as protective.  Click each tab to read and learn more. |  |
|  | Challenge | Q1:  Components permitted to operate at their normal ratings include:  Select ALL that apply.  *Select the correct options and click Check.*   * **Fuses** * **Thermal Trips** * **Relays** * **Switches** | F:\Projects_2020\UL\UL_Template_Screenshots\UL_Programs\UL_Programs_Challenge\1.png  Correct Answer Feedback:  **Excellent, that’s correct!**  All of these components are permitted to operate at their normal range.  Wrong Answer Feedback:  **Sorry, that’s not quite correct!**  All of these components are permitted to operate at their normal range. | Let's now see how much you have learned or remember from this topic.  Let's do a small activity to test your knowledge. |  |
|  |  | Q2:  Clause 7.5 discusses the requirements for \_\_\_\_\_\_\_\_\_\_\_ that are used as protective components.  *Select the correct option and click Check.*   * Transformers * Fuses * **Semiconductors** * Current-limiting resistors | Correct Answer Feedback:  **Excellent, that’s correct!**  Clause 7.5 discusses the requirements for **semiconductors** that are used as protective components.  Wrong Answer Feedback:  **Sorry, that’s not quite correct!**  Clause 7.5 discusses the requirements for **semiconductors** that are used as protective components. |  |  |
|  | Unit\_5:  Assessments |  | **F:\Projects_2020\UL\UL_Template_Screenshots\Wireless\UL_Wireless_Static\4.png** | We are done with the fourth topic.  Let’s now move to the fifth topic i.e. Assessments.  Click Next to continue. |  |
|  | Assessment Process | An assessment of the circuit in question is done to determine its ability to cause ignition of a specified explosive atmosphere.  *Click each step to read and learn more.*  **3 tabs:**  **Tab\_1: Create a block diagram**  **Tab\_2: Calculate voltage, current and power in each block**  **Tab\_3: Assess permissible limits for spark ignition and determine maximum temperature**  **of components**  **Tab\_1:**  **Create a block diagram**  Create a block diagram that is a representation of the overall device, but includes only those components that are being relied on to provide the voltage and current limitation. In addition, any components that would affect the available energy in the circuit, for example, energy storage components such as capacitors and inductors are identified as well as their location in the circuit.  Sub-steps include:   * Determine protective components * Identify capacitors and their location in each block * Identify inductances and their location in each block   **Tab\_2:**  **Calculate voltage, current and power in each block**  When the block diagram is completed it is used to calculate the voltage, current and power available in each section of the circuit.  **Tab\_3:**  **Assess permissible limits for spark ignition and determine maximum temperature**  **of components**  This information is then used to determine if each portion of the circuit is within the limits for spark ignition as well as to determine the maximum temperature of components used in the circuit.  Sub-steps include:   * Conducting a comparison to the curves and tables in Annex A of 60079-11 to determine if the circuit is within the permissible limits for spark ignition * Conducting an evaluation of the separation distances using the block diagram in conjunction with the schematic and circuit board layout | F:\Projects_2020\UL\UL_Template_Screenshots\Wireless\UL_Wireless_Interactives\5.png | An assessment of the circuit in question is done to determine its ability to cause ignition of a specified explosive atmosphere.  The following steps are involved in the assessment of circuits.  Click each step to read and learn more. |  |
|  | Spark Ignition Assessment | There are two types of assessments:  2 tabs   * Spark ignition assessment * Thermal assessment   *Click each tab to learn more.* | F:\Projects_2020\UL\HBSE\HBSE_templates\Clickable tabs\3.png | There are two types of assessments Spark ignition assessment and Thermal assessment.  Click each tab to learn more. |  |
|  | Branch\_1:  Spark ignition assessment | The determination of a circuit’s ability to cause ignition is very often determined through comparison of the circuit parameters with the predefined limits given in the curves and tables of Annex A.  Circuits are grouped into:   * Resistive * Capacitive * Inductive * Combination circuits   Fade away | F:\Projects_2020\UL\CODE_AUTHORITIES_AND_CODES\Templates\Static\10.png  Fade away | The determination of a circuit’s ability to cause ignition is very often determined through comparison of the circuit parameters with the predefined limits given in the curves and tables of Annex A.  Circuits are grouped into either Resistive, capacitive, inductive or combination circuits.  Fade away  For resistive circuits, that have no countable faults or only one countable fault applied, a safety factor of 1.5 is applied by increasing the current.  So, if the short circuit current of the circuit is 1A, the test or comparison would be conducted at 1.5 A.  Circuits that were determined using 2 countable faults applied are tested or assessed with a unity factor.  It should be noted that the resistive curve given in figure A1 and the associated table A1 are limited to simple resistance limited circuits.  A circuit that would have a load characteristic of other than a straight line as drawn between open circuit voltage and short circuit current cannot be reliably assessed based on comparison to the curve in table.  Similar to the resistive circuits, a 1.5 factor is applied to circuits for comparison or test.  If the circuit was determined with no countable faults or only one countable fault applied.  However in the case of capacitive circuits, the factor is applied to the voltage, since capacitors are voltage sensitive.  As with resistive circuits, if the circuit under consideration was determined with two countable faults applied then a unity test factor is used.  It should be noted that the capacitive curves are based on the discharge of a capacitor only.  However during the evaluation and testing of a circuit, the power supply is typically connected as well. This results in the discharge of energy not only from the capacitor but from the power supply as well.  Therefore when making comparisons to the capacitive curves, intrinsic safety cannot always be inferred. If the resistive circuit that the capacitor is connected to only has a small margin of safety, then it is possible that connection of the capacitance to the circuit will cause ignition, even if the curve would indicate otherwise.  For inductive circuits that have no countable faults or only one countable fault applied a safety factor of 1.5 is applied by increasing the current. So, if the short circuit current is 1A, the test or comparison would be conducted at 1.5 A.  Circuits that would determine using two countable faults applied are tested or assessed with a unity factor.  Combination circuits are circuits that contain both capacitive and inductive components.  In circuits where both are present, it is possible to have a combination of capacitance and inductance, that while considered separately are not capable of causing ignition, will cause ignition when considered together.  As with the previous examples, it is also necessary to consider a safety factor applied to the circuit for spark ignition purposes.  However, since the circuit two types of reactive components, one voltage sensitive and the other current sensitive, it is necessary to conduct testing with the factor applied to the voltage, and then another with a factor applied to the current.  There are no curves that can be used to represent these circuits. So when the condition is determined to exist, it is necessary to conduct tests. |  |
|  | Branch\_2:  **Thermal assessment** | **Purpose**: to determine that the device is not capable of causing ignition due to heating effects.  There are two steps to be followed during thermal assessment.  *Click each tab to read and learn more.*  2 tabs:  Step\_1  Step\_2  **Step\_1:**  Thermal assessment conducted to determine maximum temperature of:  - Components  - Wiring  - Circuit board traces  This can be explained by the Jacobi’s Law.  **Jacobi’s Law:**  “Maximum power is transferred when the internal resistance of the source equals the resistance of the load, when the external resistance can be varied, and the internal resistance is constant.”  Components that are not designated as protective and satisfying all of the requirements for the type of component can be considered to fail in a way that would result in the component dissipating the maximum available power in the circuit.  As stated in Jacobi’s Law, this occurs when the load resistance is equal to the source resistance. Since it can be difficult to test components at this state, the thermal characteristics of components are used to calculate the maximum theoretical temperature when the maximum power is dissipated.  **Step\_2:**  When the maximum temperature is determined, this is used to assign the proper temperature classification marking to the overall product.  This is used in conjunction with the other markings to determine if a given product is suitable for a specific installation.  **Temperature Class Table:**    **Temperature Class**  T1  T2  T3  T4  T5  T6  **Maximum surface temperature °C**  450  300  200  135  100  85 | F:\Projects_2020\UL\CODE_AUTHORITIES_AND_CODES\Templates\Click tabs\2020-07-13 09_31_01-Window.png | The purpose of this assessment is to determine that the device is not capable of causing ignition due to heating effects.  There are two steps to be followed during thermal assessment.  Click each tab to read and learn more. |  |
|  | Challenge | Q1:  Match each step in the correct order.  *Click and drag each item into their relevant spaces provided and click Check.*  Options:  **Label 1**  Requirements  **Label 2**  Symbol  **Label 3**  Other marks  **Label 4**  Description   * Regulation 765/2008 describes CE marking principles and requirements * No other marks may be used to indicate compliance with RoHS. * The CE Mark means the product conforms to all applicable provisions and meets the conformity assessment requirements. * All EEE that complies with RoHS must bear the CE Mark. | Correct answer:  **Label 1**  Requirements  All EEE that complies with RoHS must bear the CE Mark.  **Label 2**  Symbol  The CE Mark means the product conforms to all applicable provisions and meets the conformity assessment requirements.  **Label 3**  Other marks  No other marks may be used to indicate compliance with RoHS.  **Label 4**  Description  Regulation 765/2008 describes CE marking principles and requirements  Correct Answer Feedback:  **Excellent, that’s correct!**  **Label 1**  Requirements  All EEE that complies with RoHS must bear the CE Mark.  **Label 2**  Symbol  The CE Mark means the product conforms to all applicable provisions and meets the conformity assessment requirements.  **Label 3**  Other marks  No other marks may be used to indicate compliance with RoHS.  **Label 4**  Description  Regulation 765/2008 describes CE marking principles and requirements.  Wrong Answer Feedback:  **Sorry, that’s not quite correct!**  **Label 1**  Requirements  All EEE that complies with RoHS must bear the CE Mark.  **Label 2**  Symbol  The CE Mark means the product conforms to all applicable provisions and meets the conformity assessment requirements.  **Label 3**  Other marks  No other marks may be used to indicate compliance with RoHS.  **Label 4**  Description  Regulation 765/2008 describes CE marking principles and requirements. | Let's now see how much you have learned or remember from this topic.  Let's do a small activity to test your knowledge. |  |
|  |  | Question 2:  For resistive circuits that have no countable faults or only 1 countable fault applied, a safety factor of \_\_\_\_ is applied by increasing the current.  *Select the correct option and click* ***CHECK****.*  Options:   * 1 * **1.5** * 2 * 2.5 | F:\Projects_2020\UL\UL_Template_Screenshots\UL_Programs\UL_Programs_Challenge\1.png  Correct Answer Feedback:  **Excellent, that’s correct!**  For resistive circuits that have no countable faults or only 1 countable fault applied, a safety factor of **1.5** is applied by increasing the current.  Wrong Answer Feedback:  **Sorry, that’s not quite correct!**  For resistive circuits that have no countable faults or only 1 countable fault applied, a safety factor of **1.5** is applied by increasing the current. | Let's now see how much you have learned or remember from this topic.  Let's do a small activity to test your knowledge. |  |
|  | Course Summary | Congratulations, you have completed the course, “Designing for Intrinsic Safety”.  In this course, you learned the basic concepts of intrinsic safety and explored the requirements for intrinsic safety outlined in  IEC 60079-11.  You should now be able to:   * Identify standards that contain requirements for intrinsically safe equipment * Define intrinsic safety * Provide examples of equipment that employ intrinsic safety * Describe IEC 60079-11 requirements for faults, levels of protection, and separation distance * Identify components on which intrinsic safety depends * Identify infallible components and assemblies of components * Define spark ignition assessment and thermal assessment | Male Technician Holding Clipboard While Examining Fusebox | Congratulations, you have completed the course, “Designing for Intrinsic Safety”.  In this course, you have learned about the EU’s Directive governing EEE.  The scope, responsibilities, requirements, associated products, global adoption, and enforcement were also discussed.  You should now be able to:   * **Identify** standards that contain requirements for intrinsically safe equipment * **Define** intrinsic safety * **Provide** examples of equipment that employ intrinsic safety * **Describe** IEC 60079-11 requirements for faults, levels of protection, and separation distance * **Identify** components on which intrinsic safety depends * **Identify** infallible components and assemblies of components * **Define** spark ignition assessment and thermal assessment |  |
|  | Thank You | Thank You. Stay SAFE!  For more information on this and additional topics,  please visit: http://www.ul.com/lms  or call 1.888.503.5536 | Portrait of an electrician at work | If you have any questions or comments about this course, please call – 1-8-8-8-5-0-3-5-5-3-6.  Thank you. |  |