



Methods to Expedite the Intrinsic Safety Approval Process

**2024 Approval & Certification Center
Approval Workshop
April 15, 2024**

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Electrical Engineer**



Summary of Intended Discussion Times

1. Introduction (approx. 1 min.) **2 slides**
2. Crash course on intrinsic safety (approx. 12 min.) **21 slides**
3. Applicable procedures and policies used by the A&CC for intrinsic safety approvals (approx. 5 min.) **6 slides**
4. 14 Ways to expedite the approval process (approx. 10 min.) **11 slides**
5. 20 Common discrepancies (approx. 12 min.) **7 slides**
6. 11 Other things to be aware of (approx. 5 min.) **3 slides**
7. Questions (15 min.)



What is Intrinsic Safety?

- A hazardous location protection technique comprised of components that are incapable of releasing enough electrical or thermal energy under normal conditions and with up to two faults to ignite a methane-air atmosphere or smolder a coal dust layer.
- Very small niche
- Not taught at any schools or universities
- Cannot be used for everything
- MSHA evaluated according to ACRI2001 (Intrinsic Safety Criteria)



What is Intrinsic Safety?

- Cap lamps
- Gas detectors
- Flashlights
- Machine mounted methane monitoring systems
- Power supplies of low voltage/current output
- Machine control circuits
- Communication and tracking systems
- Others complying with intrinsic safety (I.S.) requirements



What is Intrinsic Safety?



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What is Intrinsic Safety?



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Other Methods of Hazardous Location Protection

- Explosion proof (MSHA accepted)
- Encapsulation (MSHA accepted)
- Flame proof
- Increased safety
- Oil filled enclosure
- Pressurized enclosure
- Sand/powder/quartz filled enclosure
- Non-incendive
- Special protection



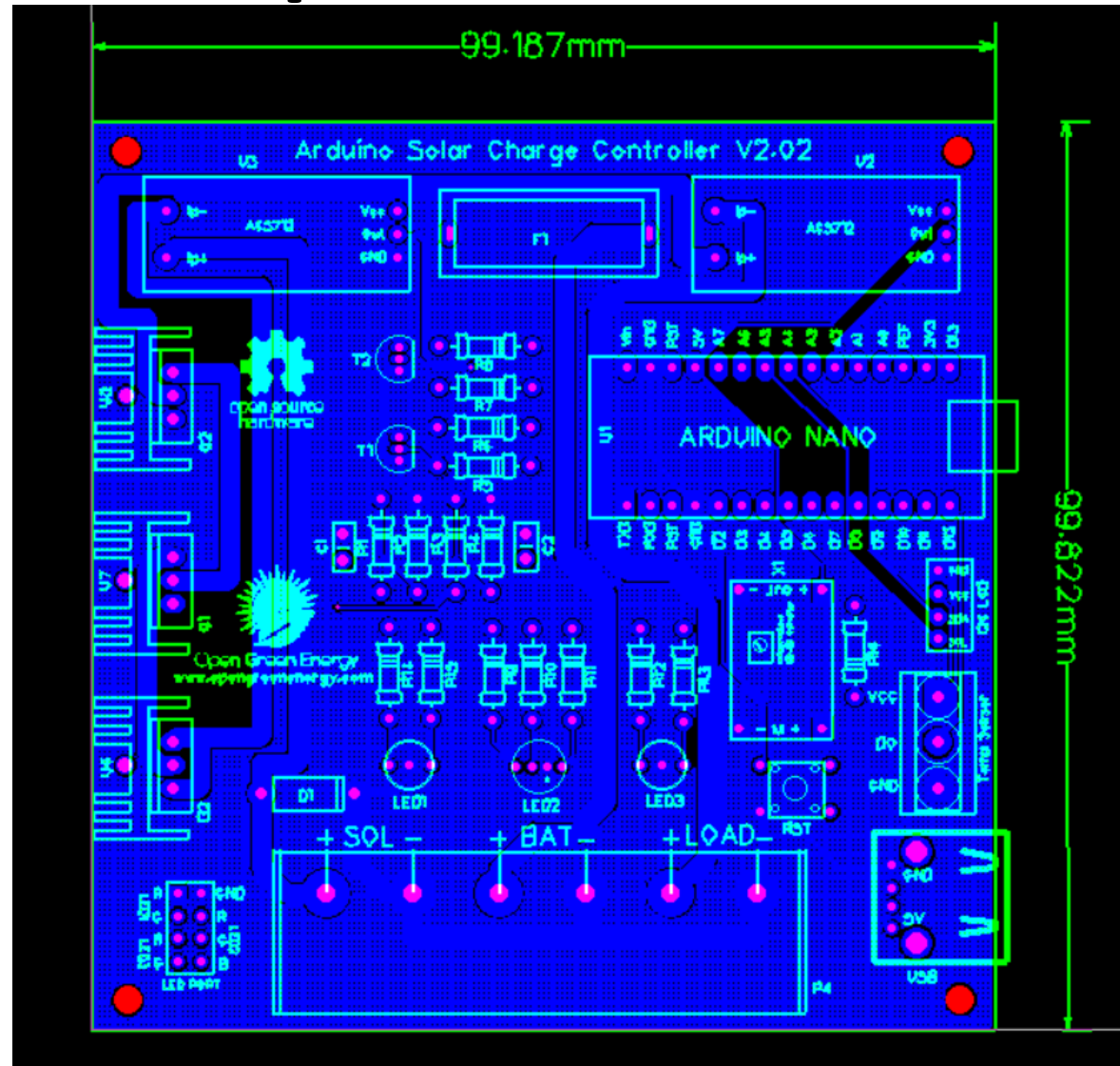
Example Printed Circuit Board



Photograph
obtained from
[www.research
gate.net](http://www.researchgate.net).



Example Gerber Files

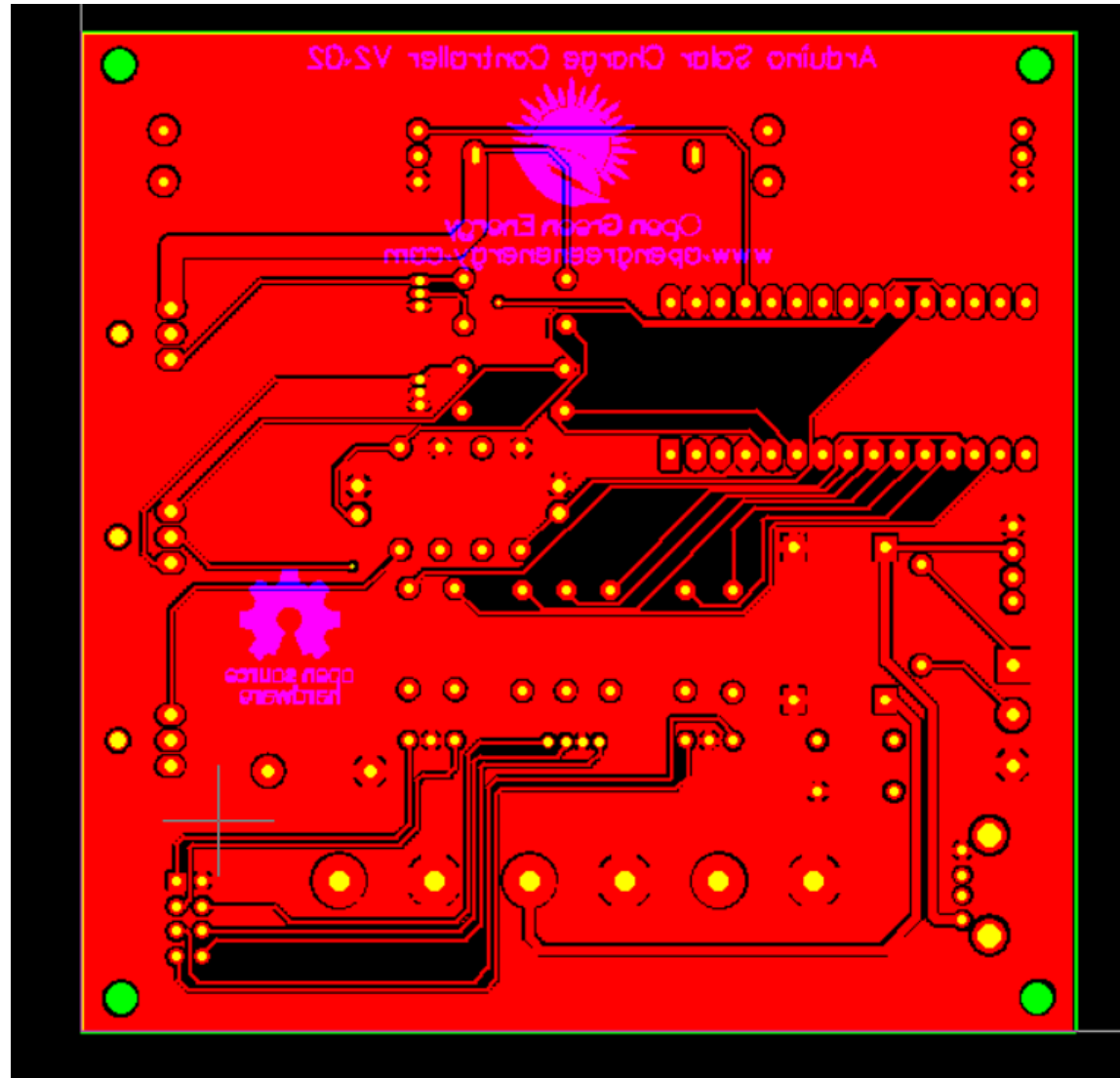


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Example Gerber Files (cont'd)



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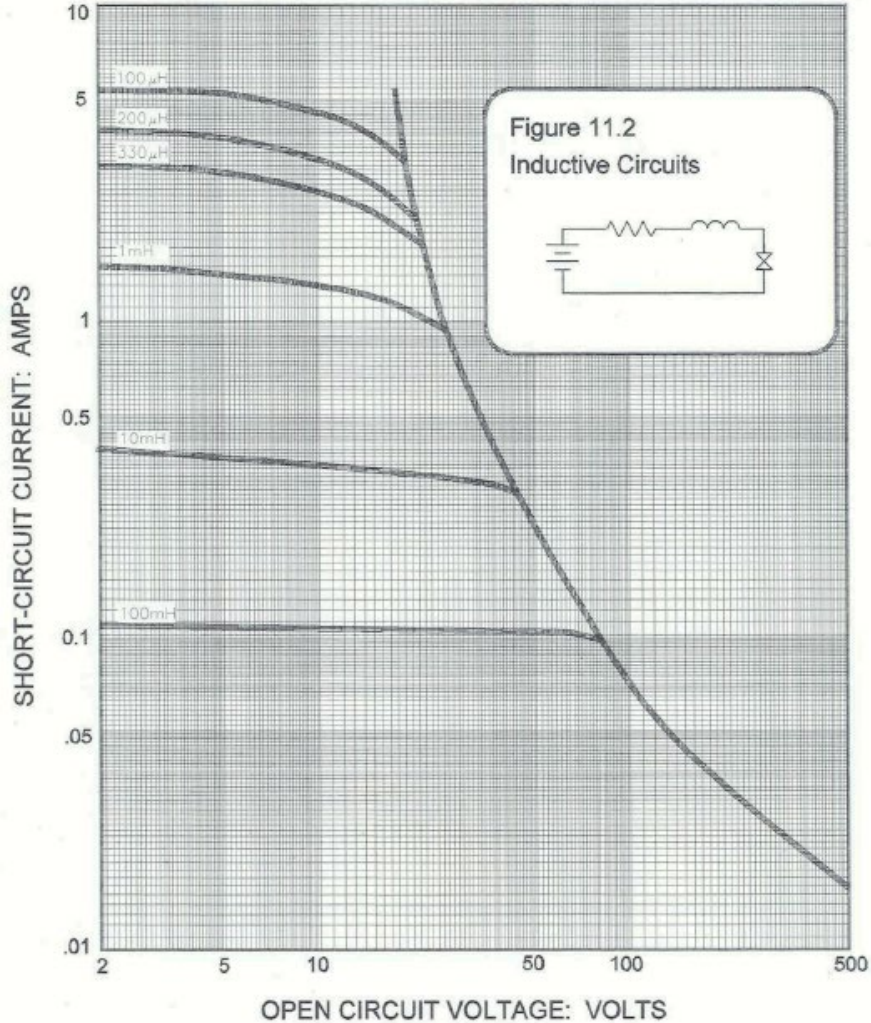
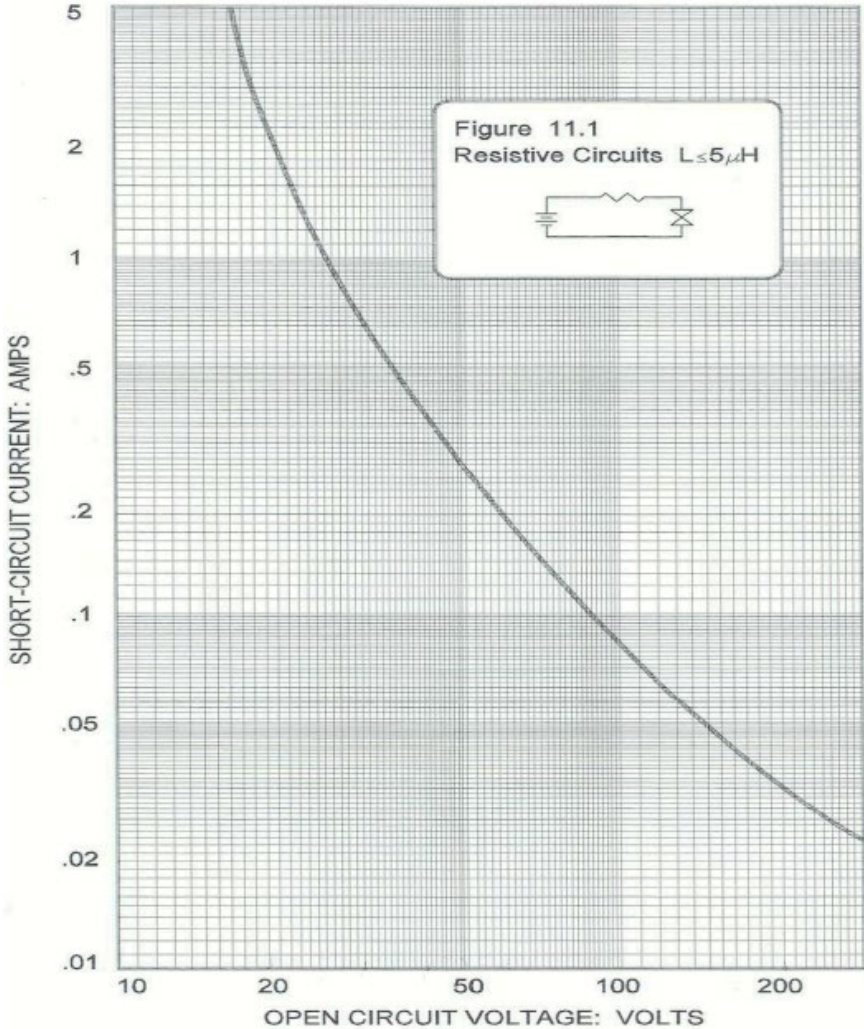
Ignition Hazards

- Resistive spark ignition of 8.3% methane-air
- Capacitive spark ignition of 8.3% methane-air
- Inductive spark ignition of 8.3% methane-air
- Combinations of circuits igniting 8.3% methane-air

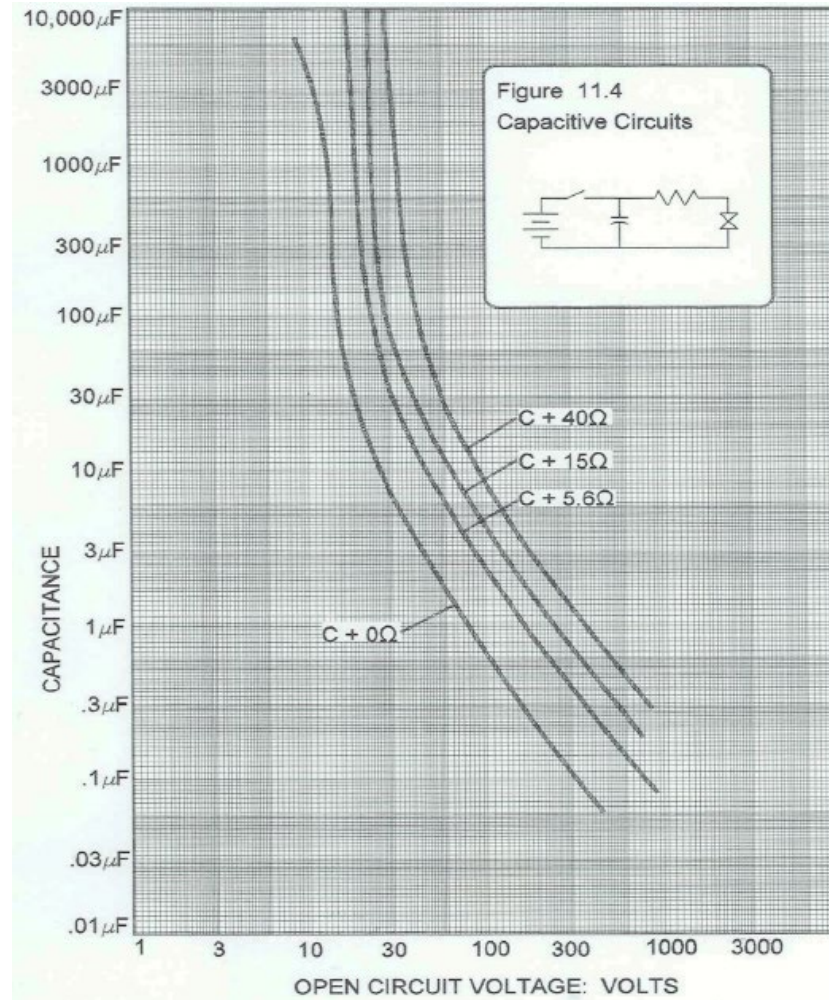
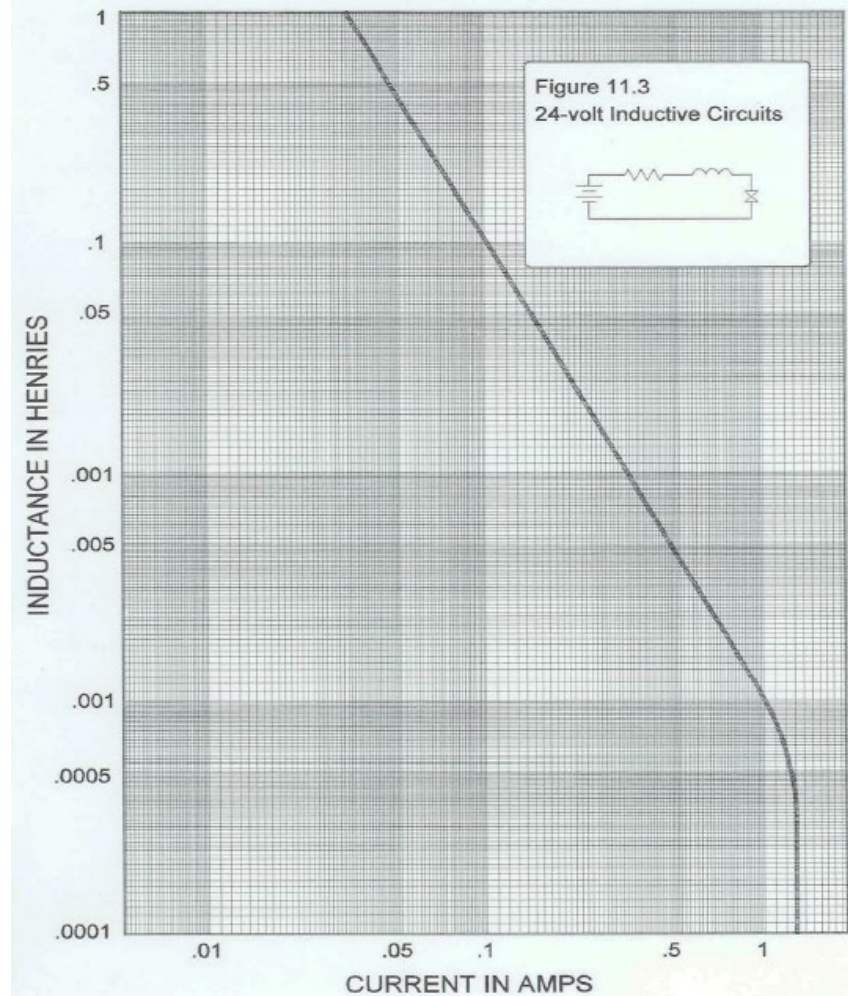
- Thermal ignition of 200 mesh coal dust (150° C, 302° F)
- Thermal ignition of 7.7% methane-air (530° C, 986° F)



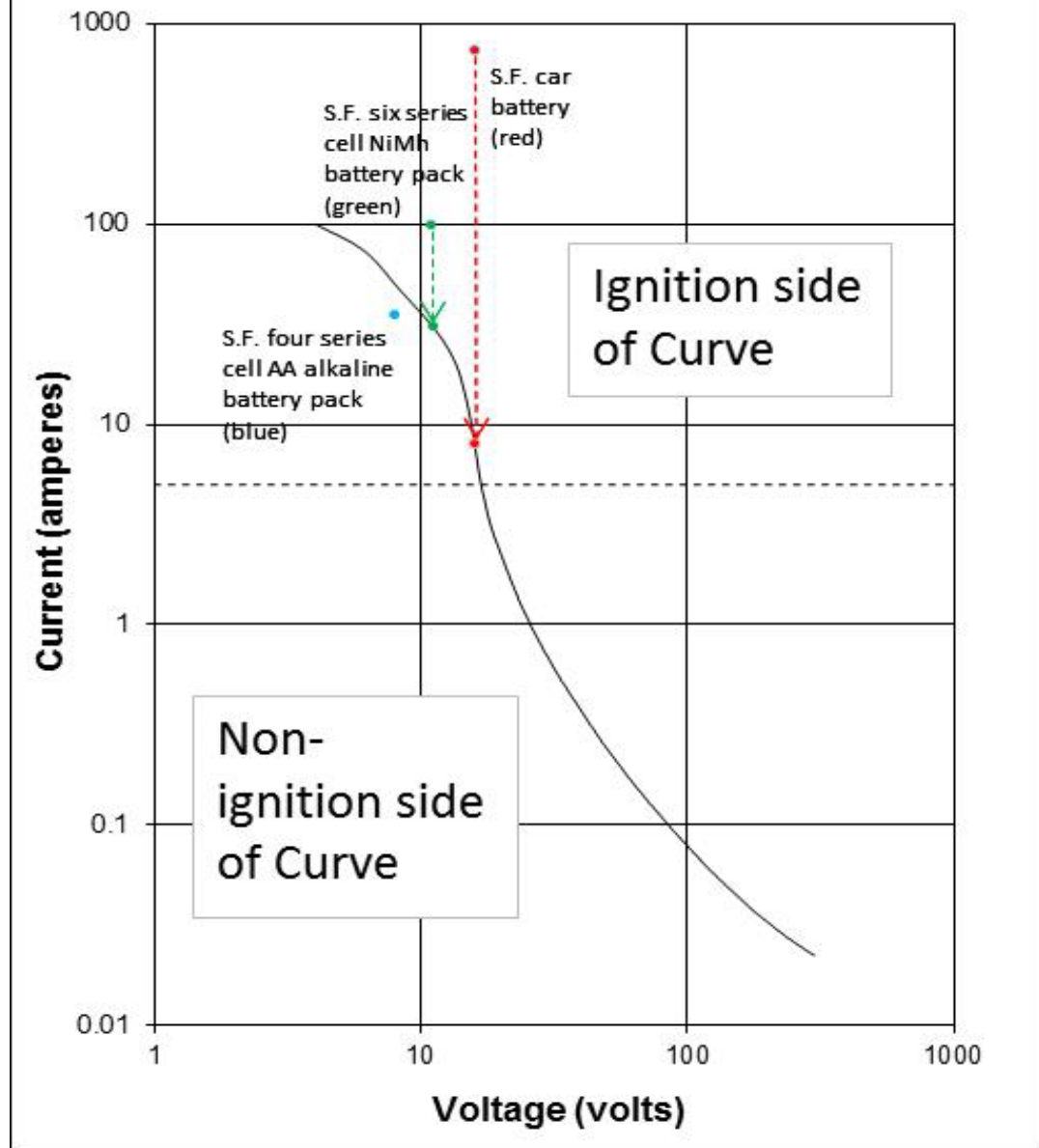
MSHA Methane-Air Ignition Curves



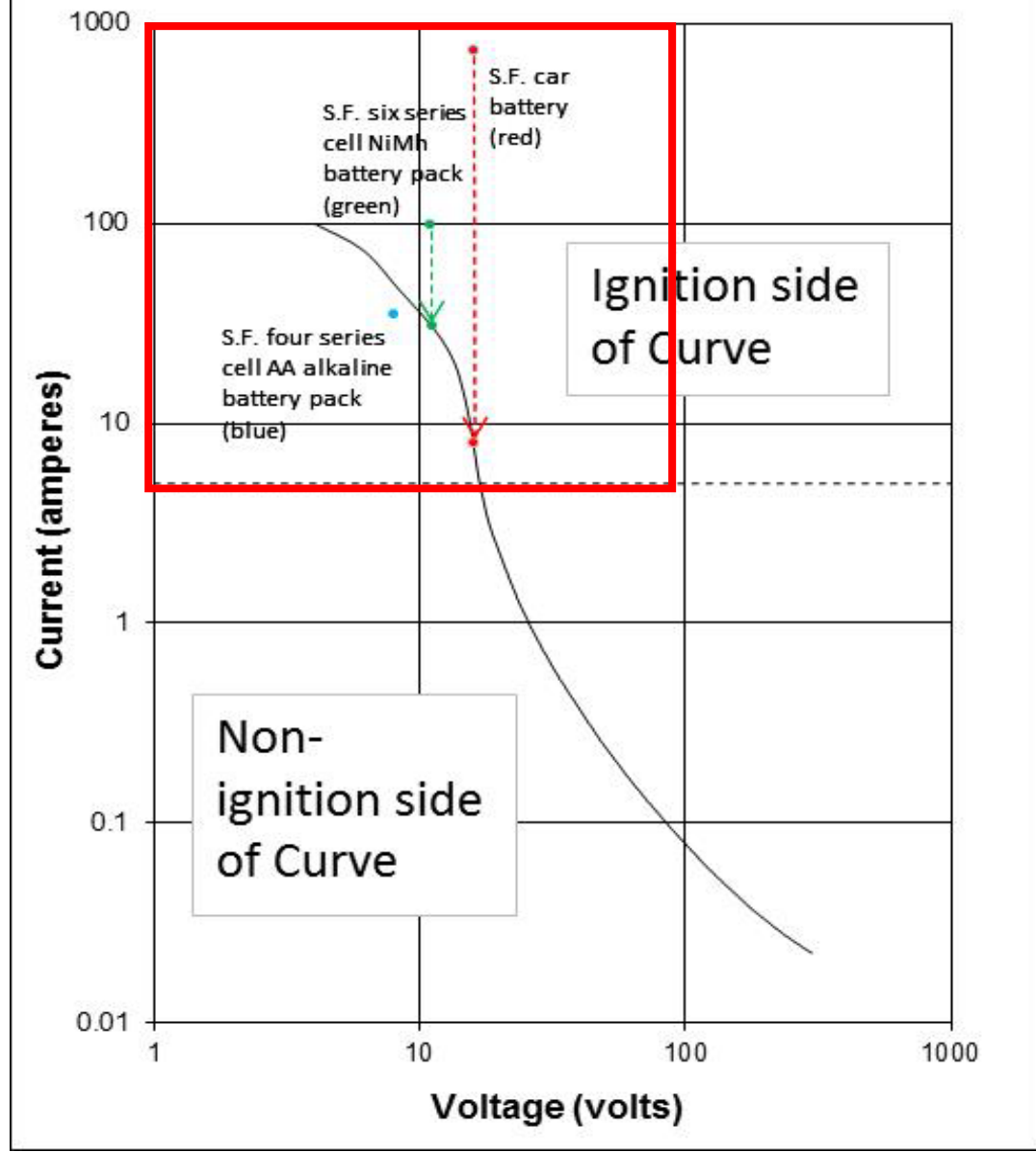
MSHA Methane-Air Ignition Curves (cont'd)



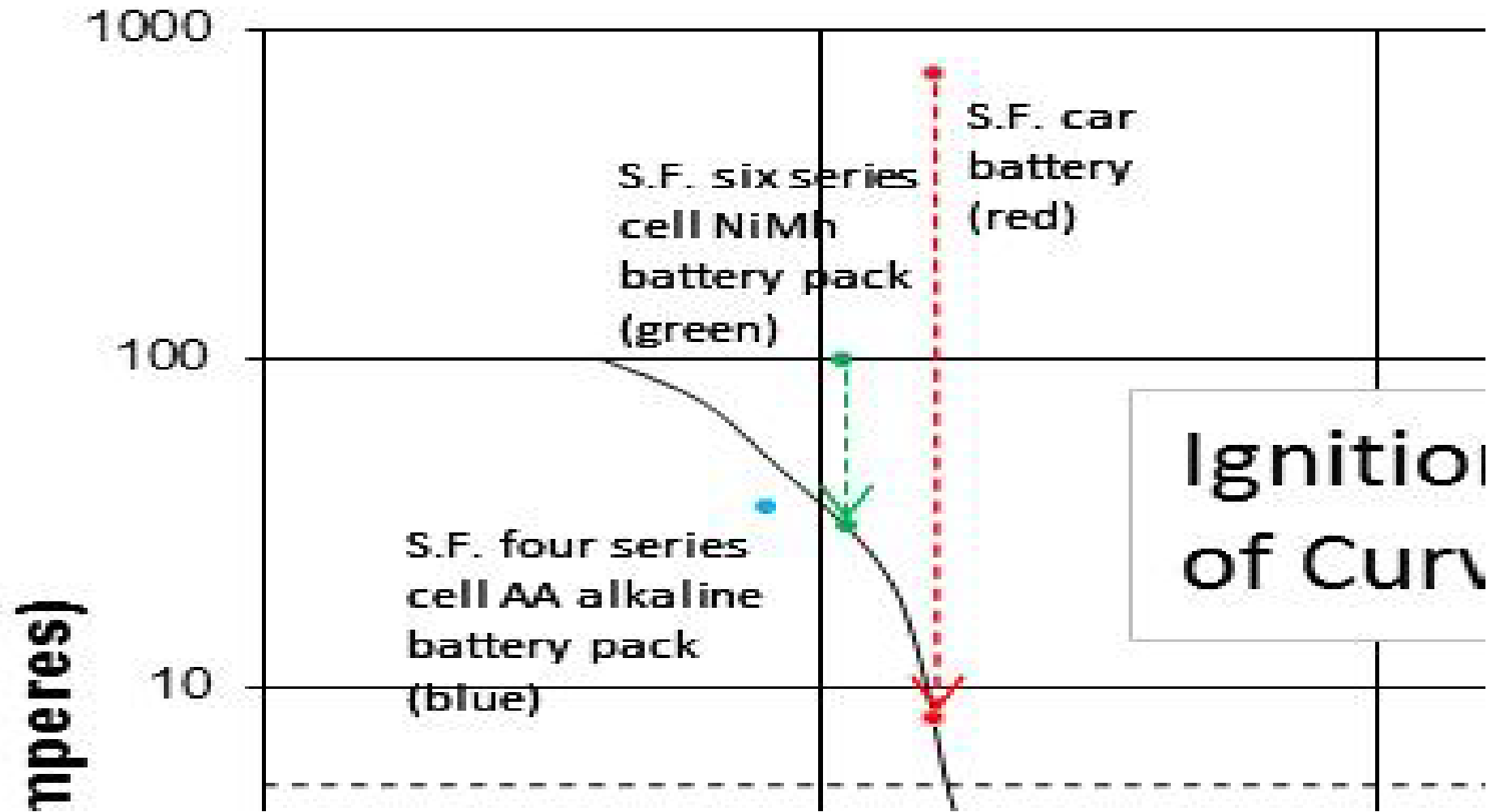
Resistive Methane-air Spark Ignition Curve



Resistive Methane-air Spark Ignition Curve



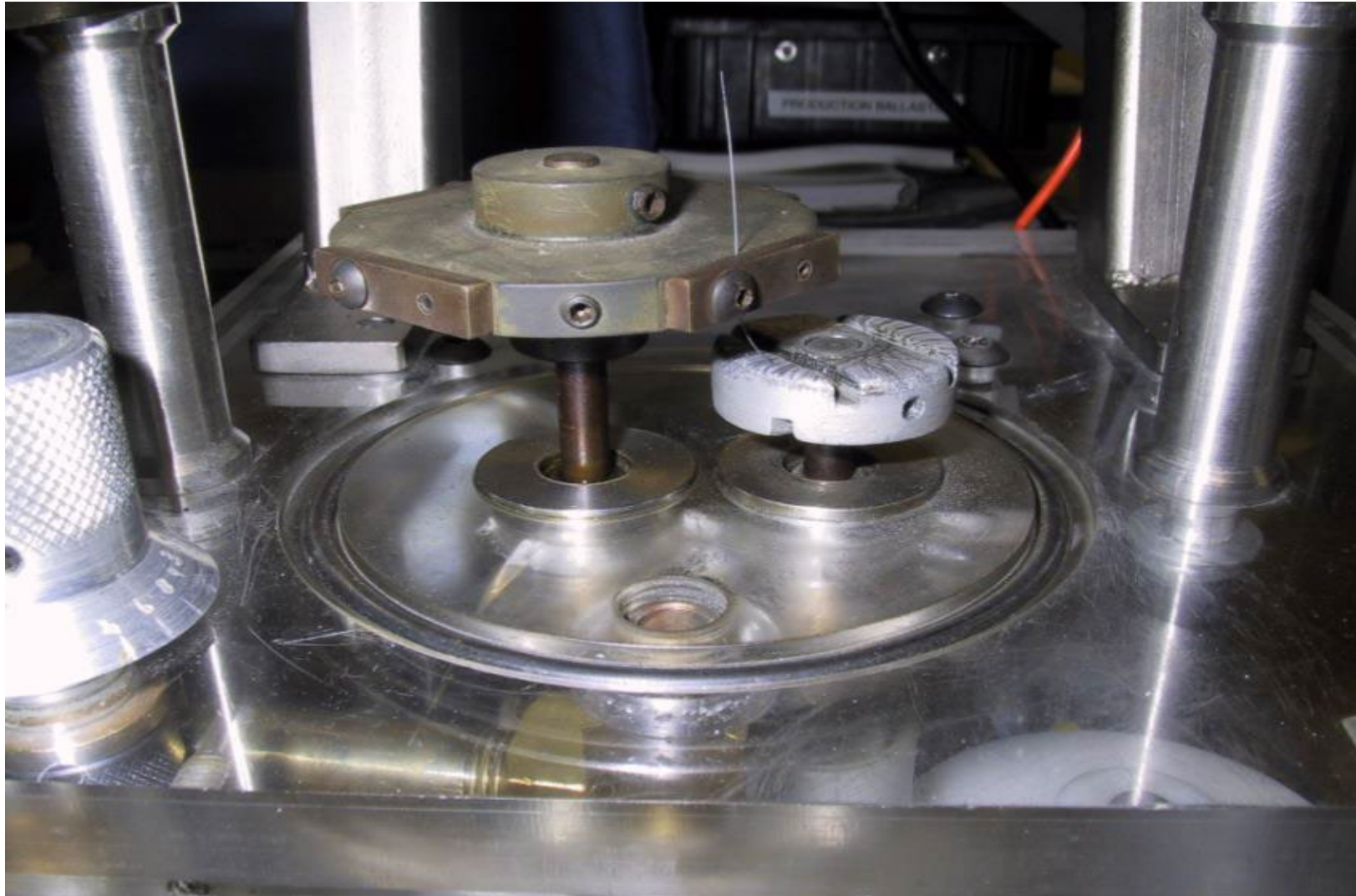
Resistive Methane-air Spark Ign

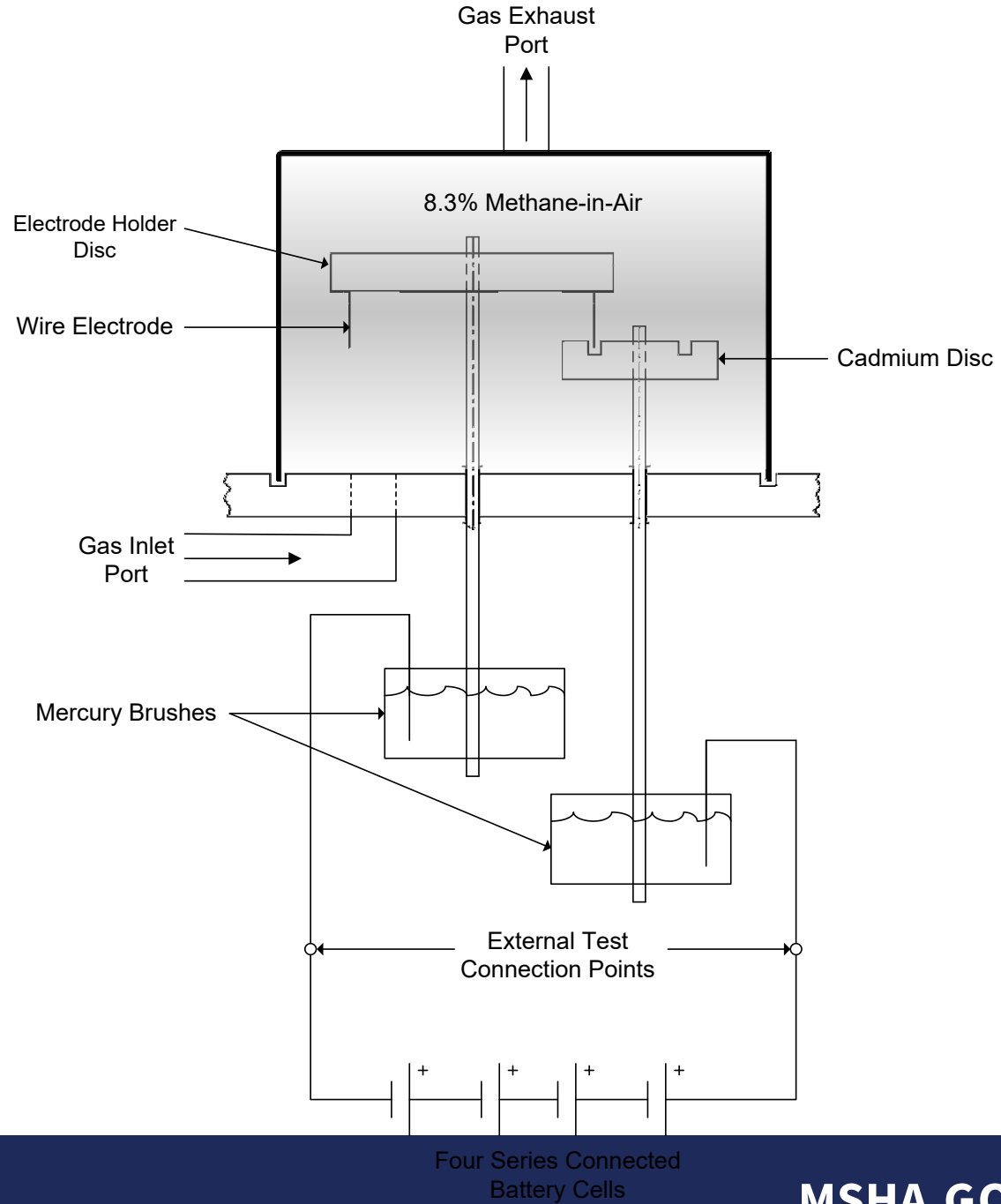


MSHA Spark Test Apparatus



MSHA Spark Test Apparatus

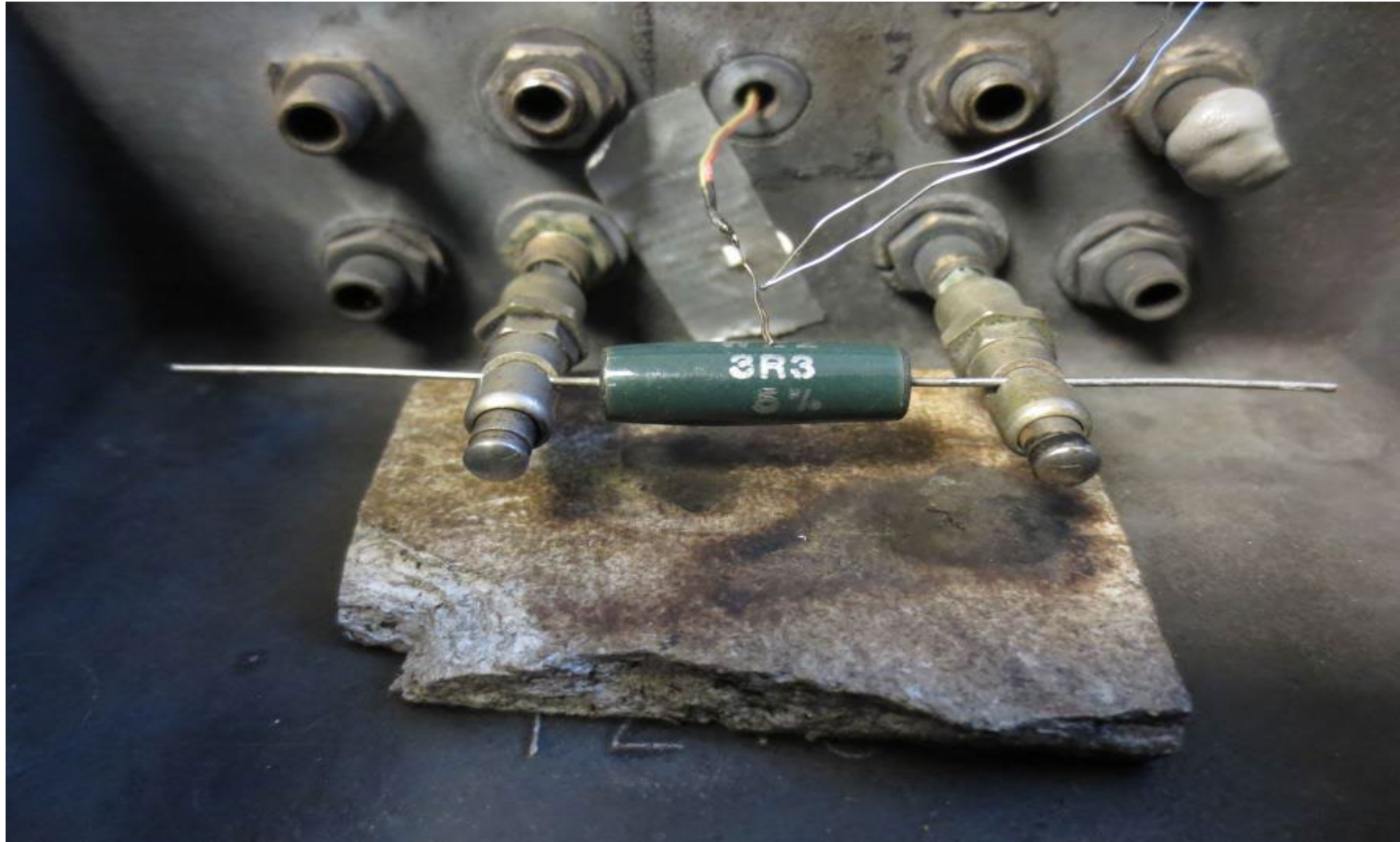




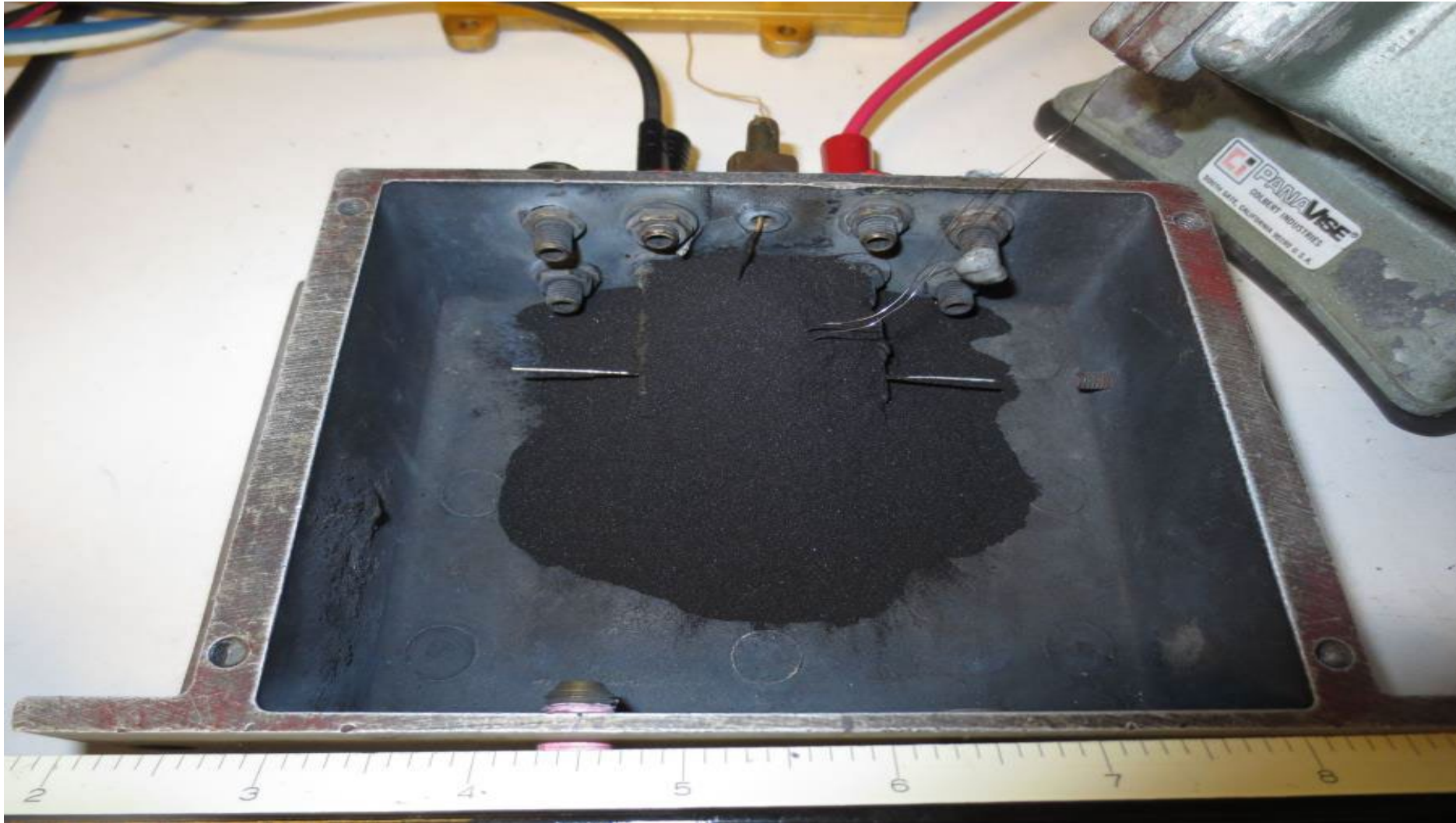
Methane-Air Thermal Ignition Testing



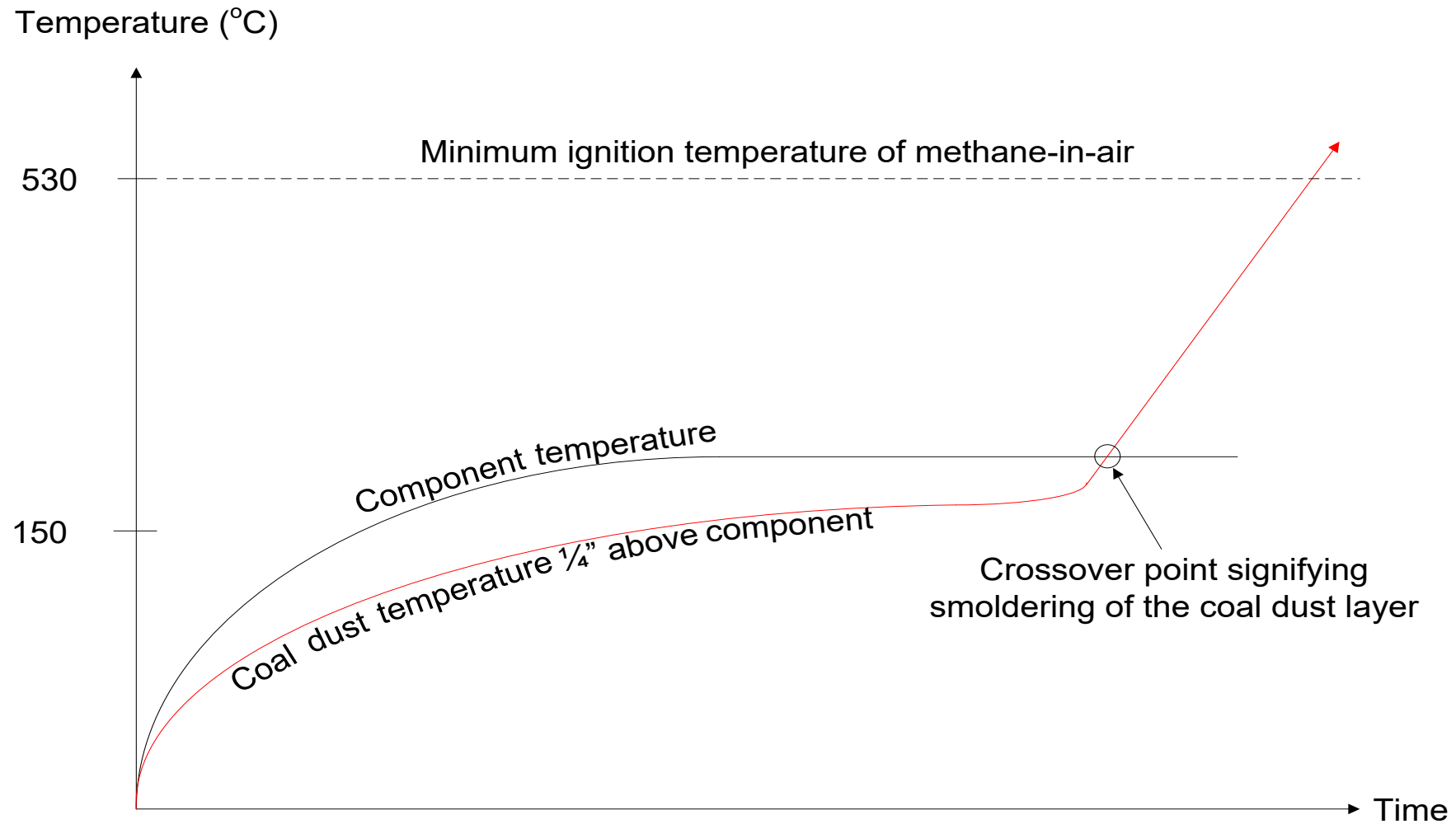
Coal Dust Thermal Ignition Testing



Coal Dust Thermal Ignition Testing



COAL DUST THERMAL IGNITION




Compliance Information Guides

- Go to www.msha.gov MSHA home page.
- Type “approval” in search box in upper right corner.
- Click top link titled “Equipment Approval and Certification”.
- Scroll midway down the page to “Compliance Information Guides”.
- Click “Electrical Safety Division”.



Compliance Information Guides



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Mine Safety and Health Administration - MSHA
- Protecting Miners' Safety and Health Since 1978

Compliance Information Guide for Approval and Certification Center Electrical Safety Division Approval and Acceptance Programs

The following data base lists all the A&CC's Electrical Safety Division's product approval/acceptance programs and guides manufacturer's through what regulation requires that product to be approved or accepted, how to apply for approval or acceptance of the product, and the applicable policies and test procedures that are applied or used by the Approval and Certification Center to conduct tests as required by 30 CFR.

Please select a category below and then select the Go button.

- Battery Powered Mobile Machines
- Batteries for Mobile Machines
- Blasting Units - Multiple Shot Units
- X/P Connection Boxes/Enclosures
- X/P Plug and Receptacles/Connectors

Some or all of the files available on this page are PDF. For more information on PDF, PDF readers and accessibility issues, please use [this link](#).



Compliance Information Guides

- Intrinsically safe categories of equipment include the following:
 - Blasting Units (30 CFR Part 18)
 - Electric Cap Lamps (30 CFR Part 19)
 - Flashlights (30 CFR Part 20)
 - Intrinsically Safe Instruments (30 CFR Part 18)
 - Intrinsically Safe Relays (30 CFR Part 18)
 - Lighting Systems (30 CFR Part 18)



Compliance Information Guides

- Intrinsically safe categories of equipment include the following (continued):
 - Communications Systems (30 CFR Part 23)
 - Multi-Gas Detectors - Handheld (30 CFR Part 22)
 - Machine Methane Monitoring Systems (30 CFR Part 27)
 - Mine Wide Monitoring Systems (30 CFR Part 18)
 - Intrinsic Safety Experimental Permits (30 CFR Part 18)
 - Telephones and Signaling Devices (30 CFR Part 23)



Compliance Information Guides

Compliance Information Guide for Approval and Certification Center Electrical Safety Division Approval and Acceptance Programs

TYPE OF EQUIPMENT - - Intrinsically Safe Instruments

APPLICABLE REGULATIONS

[30 CFR Part 6](#)

[30CFR Part 18.68](#)

APPLICATION PROCEDURES

[ASAP1005 - RAMP Application Procedures](#)

[ASAP2016 - Intrinsic Safety Application Procedures](#)

APPLICABLE POLICIES & TEST PROCEDURES

[ACRI2001 - Criteria for Intrinsically Safe Apparatus](#)

[ACRI2011 - Intrinsically Safe Active Voltage/Current Power Source Criteria](#)

[APOL1009 - Center Cancellation Policy](#)

[APOL2048 - Documenting Subassemblies not Manufactured by the Applicant](#)

[ASOP2024 - Processing MSHA Part 6 Applications for MSHA Applicants and Independent Laboratories](#)

[ASOP2211 - Design of Instrument Approval Plates](#)

[ASTP2202 - Battery Flash Current Test](#)

[ASTP2206 - Current Limiting Resistor Surface Temperature Test](#)

[ASTP2207 - Coal Dust Thermal Ignition Test](#)

[ASTP2216 - Optical Isolator Test](#)

[ASTP2219 - Encapsulated Assembly Impact Test](#)

[ASTP2220 - Protective Transformer Test](#)

[ASTP2224 - Force Test for Encapsulated IS Apparatus](#)

[ASTP2226 - Drop Test for Portable IS Apparatus](#)

[ASTP2230 - Piezoelectric Device Impact Test](#)

[ASTP2232 - Spark Ignition Test](#)

[ASTP2233 - Maximum Surface Temperature Test for Components](#)

[ASTP2234 - Dielectric Strength Test](#)

[Program Policy for 18.68](#)



MSHA Application Procedures

- Follow the designated application procedures and in some cases there may be two (e.g. general/specific)
- MSHA approves the design as documented on the controlled drawings. Therefore, having all critical design features documented is of utmost importance.
- MSHA is not approving the submitted sample of the product. MSHA is only confirming a submitted sample matches the controlled drawings. Exception: experimental permits.



Ways to Expedite the Approval Process

1. Consider use of a free MSHA consultation prior to designing the product.
2. Incorporate I.S. per MSHA criteria into the design process. Not many products will luck into being I.S.
3. Have a detailed user manual documenting proper installation, use, and maintenance of the device (revision controlled).
4. Have an understanding that the submitted drawing package will likely need to be modified.



Ways to Expedite the Approval Process

5. Suggest submitting an applicant report of how the product complies with MSHA I.S. requirements from both an I.S. requirements and documentation standpoint. Limits reliance on MSHA.
6. Share design philosophy including an uncontrolled marked up sample of an artwork drawing detailing the key separation zones, if applicable.
7. Make all drawings including schematics, Bills of Materials (BOMs), and component layout drawings searchable PDF files to aid in quickly locating components (e.g. to efficiently find R251 on a 20 page schematic).



Ways to Expedite the Approval Process

8. Providing Gerber files for all circuit boards including component layout layer(s), a layer stack if a multilayer board, and conformal coating areas.
9. Make connections between boards and to other intended circuits clear on the schematics. If not clear on schematics, a wiring diagram is recommended to be created.
10. Stay organized with drawing submissions throughout the approval process including submission dates, drawing file name ID number prefix matching drawing list (e.g. 1_dwg_date.pdf), and not resend unmodified drawings.



Ways to Expedite the Approval Process (pt. 10, drawing submission)

DRAWING LIST

Company Name
 Model XYZ
 Built According to Drawing No. 9006-111-44, sheet 1 of 1
 Intrinsic Safety Evaluation No. 18-ISAXXxxxxx-0
 Investigation No. IA-XXXXX

<u>No.</u>	<u>TITLE</u>	<u>DRAWING NO.</u>	<u>REVISION</u>	<u>SUBMISSION DATE</u>
1	ABC Drawing List	9006-1111-444	F	1/1/2023
2	Part 1	9007-2222-333	S1	3/5/2023
3	Part 2	9008-1234-555	S2	2/4/2023
4	Assembly Drawing 1	9009-5678-666 (3 sheets)	2	1/16/2022
5	Assembly Drawing 2	9999-0000-111 (3 sheets)	2	1/9/2023
6	Module 1	8888-1234-000 (5 sheets)	3	5/7/2023
7	PCB 1 Artwork	7777-5678-000 (4 sheets)	4	1/10/2023
8	PCB 1 Schematic	7777-5678-001	1	1/10/2023
9	PCB 1 BOM	7777-5678-002	C	1/10/2023



Ways to Expedite the Approval Process (pt. 10, drawing submission)

DRAWING LIST










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8	PCB 1 Schematic	7777-5678-001	1	1/10/2023
9	PCB 1 BOM	7777-5678-002	C	1/10/2023



Ways to Expedite the Approval Process (pt. 10, drawing submission)










Disorganized Drawing Directory

Name	Date modified	Type	Size
 7777-5678-000_pcb 1 art	1/26/2024 6:06 PM	Adobe Acrobat D...	34 KB
 7777-5678-001_pcb 1 schem	1/26/2024 6:07 PM	Adobe Acrobat D...	54 KB
 7777-5678-002_pcb 1 bom	1/26/2024 6:07 PM	Adobe Acrobat D...	33 KB
 8888-1234-000_mod 1	1/26/2024 6:04 PM	Adobe Acrobat D...	33 KB
 9006-1111-444_XYZ Drawing List	1/26/2024 6:13 PM	Adobe Acrobat D...	128 KB
 9007-2222-333_part 1	1/26/2024 6:01 PM	Adobe Acrobat D...	33 KB
 9008-1234-555_part 2	1/26/2024 6:02 PM	Adobe Acrobat D...	33 KB
 9009-5678-666_assy 1	1/26/2024 6:03 PM	Adobe Acrobat D...	36 KB
 9999-0000-111_assy 2	1/26/2024 6:05 PM	Adobe Acrobat D...	36 KB



Ways to Expedite the Approval Process (pt. 10, drawing submission)

Organized Drawing Directory

Name	Date modified	Type	Size
 1_9006-1111-444_XYZ Drawing List_1-1-23	1/26/2024 6:13 PM	Adobe Acrobat D...	128 KB
 2_9007-2222-333_part 1_3-5-23	1/26/2024 6:01 PM	Adobe Acrobat D...	33 KB
 3_9008-1234-555_part 2_2-4-23	1/26/2024 6:02 PM	Adobe Acrobat D...	33 KB
 4_9009-5678-666_assy 1_1-16-22	1/26/2024 6:03 PM	Adobe Acrobat D...	36 KB
 5_9999-0000-111_assy 2_1-9-23	1/26/2024 6:05 PM	Adobe Acrobat D...	36 KB
 6_8888-1234-000_mod 1_5-7-23	1/26/2024 6:04 PM	Adobe Acrobat D...	33 KB
 7_7777-5678-000_pcb 1 art_1-10-23	1/26/2024 6:06 PM	Adobe Acrobat D...	34 KB
 8_7777-5678-001_pcb 1 schem_1-10-23	1/26/2024 6:07 PM	Adobe Acrobat D...	54 KB
 9_7777-5678-002_pcb 1 bom_1-10-23	1/26/2024 6:07 PM	Adobe Acrobat D...	33 KB

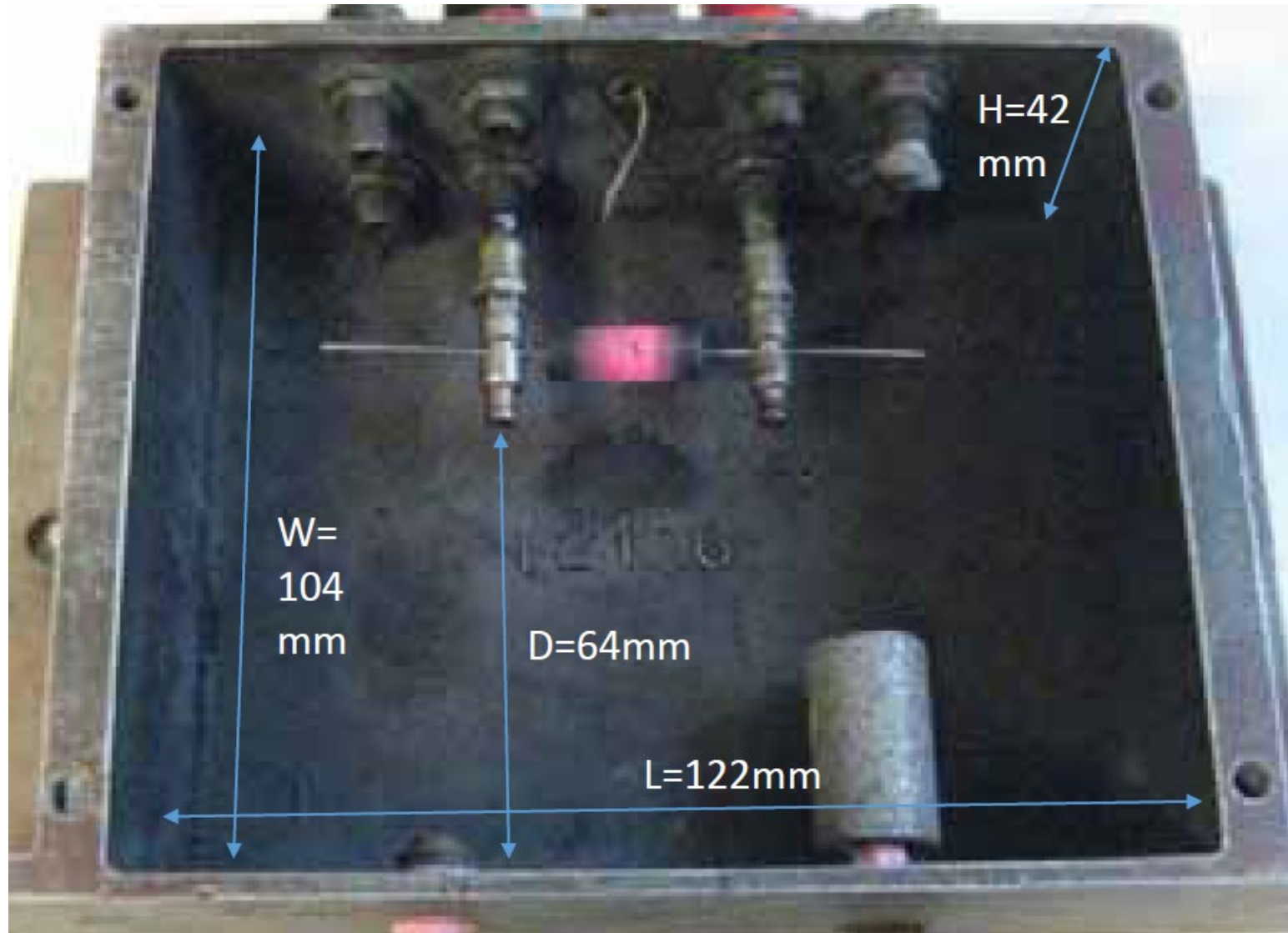


Ways to Expedite the Approval Process

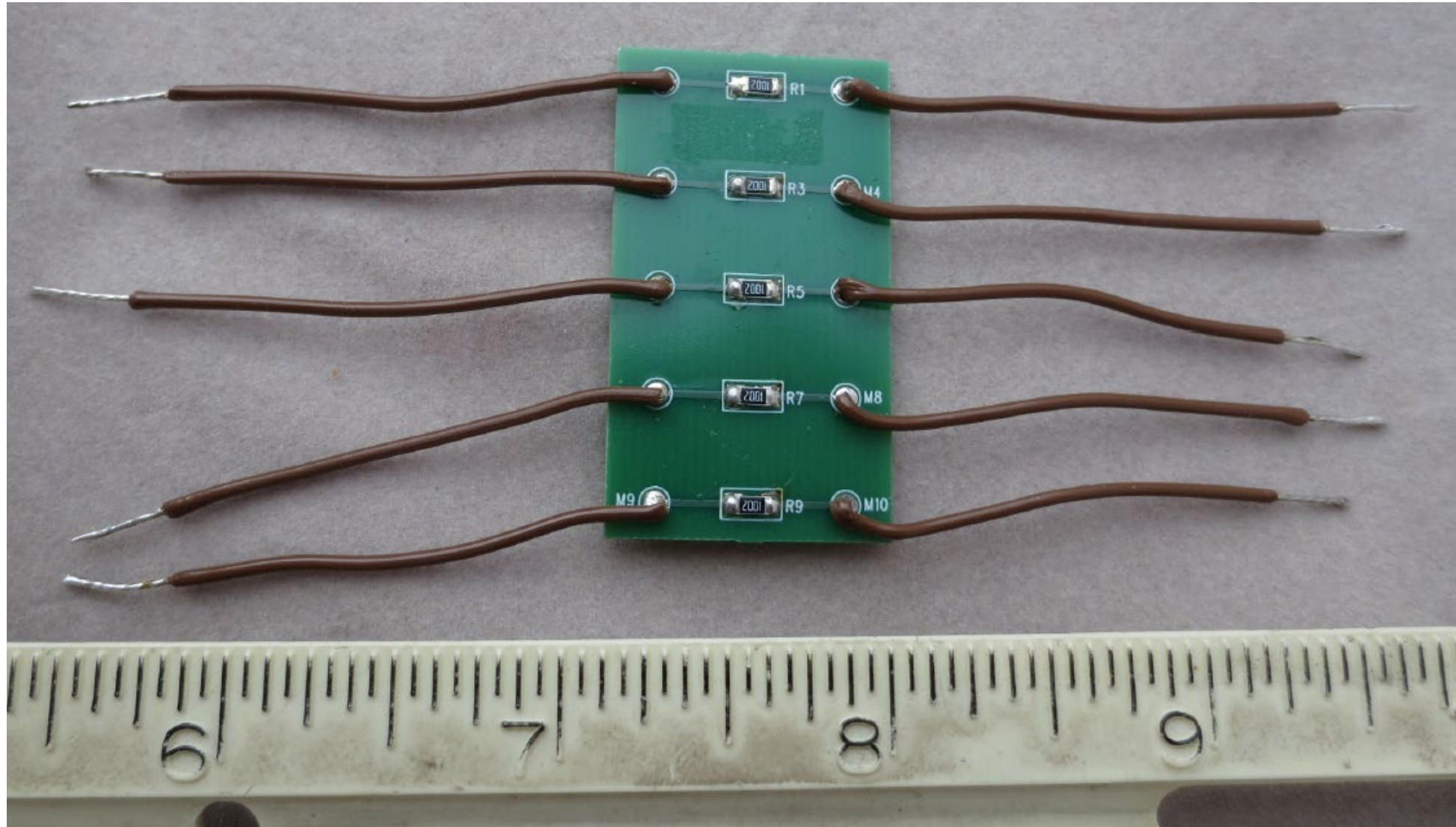
11. Use and document an enclosure that complies with ACRI2001 as being dust-tight. This gives greater leeway in the acceptance of hot components (e.g. 530° C vs. 150° C).
12. Use and document conformal coating on circuit boards. Reduces required creepage distance by approximately factor of 3.
13. Have all components rated adequately to negate the need for testing.
14. Have samples of surface mount technology (SMT) components on test boards representative of the actual board that are capable of fitting in the MSHA test enclosure.



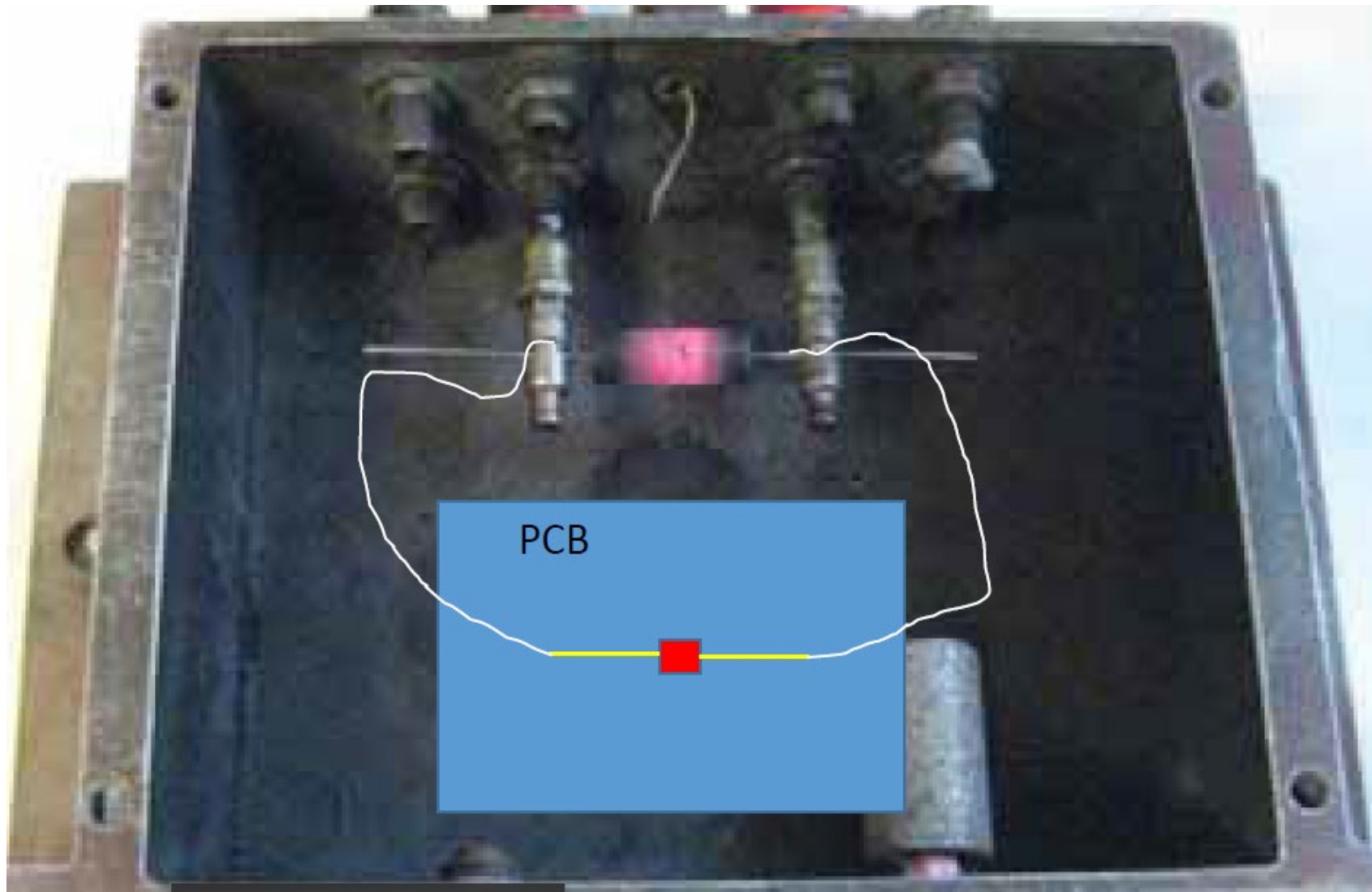
Ways to Expedite the Approval Process (pt. 14, SMT sample submission)



Ways to Expedite the Approval Process (pt. 14, SMT sample submission)



Ways to Expedite the Approval Process (pt. 14, SMT sample submission)



Common Discrepancies

1. A complete technical description of circuit operation is not being provided including operational descriptions of circuits, safety features, voltage generating components/circuits, etc. A company evaluation report addressing these points would satisfy this request.
2. The submitted drawing list does not exactly match the submitted drawings (e.g. drawing number, revision, sheet numbers) to ensure MSHA has the complete drawing package.



Common Discrepancies

3. Not having all drawings referenced by each other. If this does not occur, then a drawing list detailing all drawings must be submitted and serve as the controlled top-level drawing.
4. Not documenting specific material(s) of plastic enclosures. For example, Lexan 123 as opposed to plastic or polycarbonate. Note: for metallic enclosures, the type of metal (e.g. steel, aluminum, brass, etc.) is sufficient.
5. A percentage tolerance as opposed to a maximum resistance is documented for zero ohm resistors (e.g. 0 ohm, ¼ W, 5% resistor is not acceptable).



Common Discrepancies

6. All component designations on layout and schematic (e.g. X1, TP3, etc.) must be documented with either detailed specifications or that they are not fitted.
7. Schematics and BOMs have conflicting electrical specifications (e.g. schematic indicates specific details while BOM gives a range or options). Recommendation: only include component designations (e.g. Q1, R100, C10, etc.) on the schematic while the BOM contains all required specifications.



Common Discrepancies

8. Refrain from using the words “or equal” or “or equivalent” as opposed to specifications or details.
9. Components listed as being both “not fitted” and having electrical specifications. The only information that should be on a line for a component indicated as being not fitted is the component designation and that it is not fitted.
10. Critical components are installed over top of circuit board traces with no details of spacings between traces and component body.



Common Discrepancies

11. Drawings indicate that the board is “conformally coated” while upon inspection of the board it is not fully “conformally coated” (e.g. missing around areas such as connectors). Drawings must describe these exclusion zones from the coating process.
12. Not detailing that the boards are “conformally coated” in accordance with ACRI2001 section 7.5 and instead just stating boards are “conformally coated” or “coated”.



Common Discrepancies

13. A controlled drill file drawing is not being included with the artwork drawings showing locations of drilled holes, hole diameters, whether the holes are plated or unplated, and the plating thickness.
14. The artwork drawings do not describe the copper thickness of traces which differs from that of vias.
15. The thickness between copper layers of circuit boards not documented to determine if faults between layers is to be considered.



Common Discrepancies

16. Current ratings of switches and inductors are not being documented.
17. Minimum wire gauge(s) and material(s) used for interconnections are not documented.
18. PCB-to-PCB connector current ratings are not documented.
19. Part numbers of all integrated circuits and LEDs are not being provided. Not acceptable to simply state “IC” or “LED”.
20. Not documenting all components in strict accordance with applicable application procedures.



Other Things to Be Aware of

1. Caution installing paper labels on circuit boards or components as they may be a potential fire hazard. Any such labels observed on submitted samples will need material and location documented on drawings.
2. Other combustible materials nearby or against other components (e.g. battery cardboard insulators or battery cells wrapped in fish paper).
3. Consideration of hot components to nearby enclosure walls (e.g. melting through defeating dust-tight integrity or having an external surface temperature in excess of 150° C).



Other Things to Be Aware of

4. Components required to be used in testing (spark or thermal) will be required to be documented by manufacturer and part number.
5. The minimum internal resistance of battery cells is being required to be documented (new requirement).
6. Although acceptance by another lab to another standard is a good start it does not mean your product will be compliant to MSHA requirements.



Other Things to Be Aware of

7. It is recommended to document component/PCB dimensions rather than indicating they are “to scale” since the scaling is difficult to control with drawing conversions.
8. The application procedures are viewed as the minimum documentation requirements. For MSHA to review drawings for compliance with application procedures, draft discrepancies, and review responses to tell applicants what is needed is costly.



Other Things to Be Aware of

7. Place the energy limiting components as close as practical to the energy source/point in the circuit that needs limited
8. Redundancy for two fault analysis
9. Use intrinsic safety evaluations in their entirety
10. Combine multiple drawing numbers describing a common concept into a single drawing that has one drawing number
11. Use cables with separately shielded conductor pairs



Questions?

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