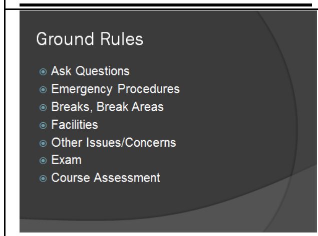
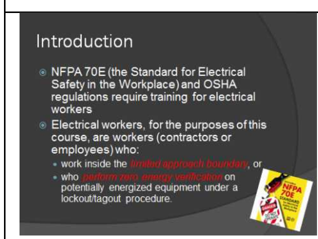
ELC200 Instructor Guide

Slide	Instructor Comments	Activities
	Welcome students to class, identify that the class is for individuals performing energized work activities, including voltage measurements (troubleshooting) and zero energy verification under lockout/tagout.	
	Review agenda – state break policy	
	Review ground rules; ensure ID of restrooms as appropriate; review emergency procedures, including muster location and requirement to wait until verification that all students have exited building. Emphasize the importance of participation and questions. NOTE that the exam is closed book. Explain why the exam is closed book, and note that the questions on page 3 in the book must be answered correctly in order to not retake the class.	Ask if there are any questions before we begin; remind everyone to sign in on the sign in sheet for credit.
	Explain what NFPA 70E is and its importance to the electrical world, and to Sandia, specifically (10CFR851). Introduce LAB concept; Explain why zero energy verification is energized work.	ASK: Why is the performance of zero energy verification considered energized electrical work? What other activities fall in the category of energized electrical work?

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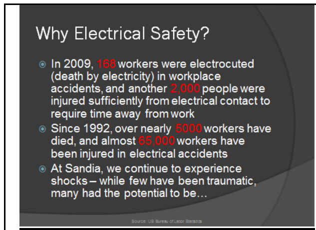
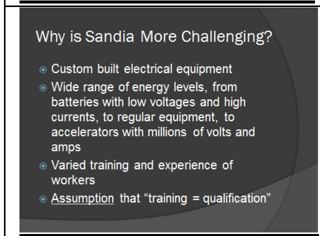
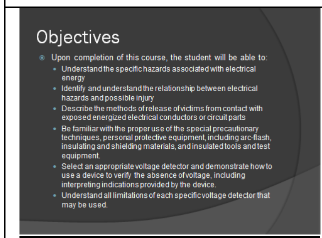
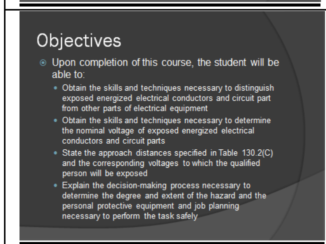
<tr><td>
</td>
<td>Review stats

Review/discuss most recent shock events (consistent with time available in module)</td>
<td>ASK: Has anyone experienced an electric shock?

ASK: What could have been done to prevent this event?

ASK: Why is electrical safety at Sandia more challenging? (note answers on board)</td></tr>
<tr><td>
</td>
<td>Review answers from previous question; discuss in depth the assumption that training = qualification.

Clarify, after discussion, the importance of not only being trained, but having something (knowledge, skills, abilities etc.) in addition to the training.</td>
<td>ASK: Who has perform energized work activities (zero energy verification, live troubleshooting, live work)? Follow up: What qualified you to perform that activity? (ask 3-4 people)

Show video "an unnecessary incident"</td></tr>
<tr><td>
</td>
<td>Review objectives</td>
<td></td></tr>
<tr><td>
</td>
<td>Review objectives; note that these are the minimum requirements found in the OSHA standard and NFPA 70E</td>
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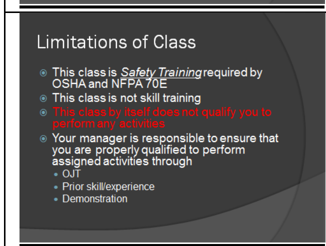
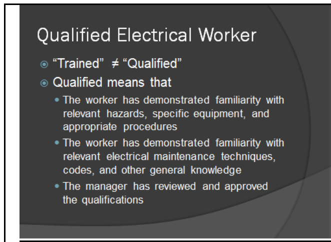
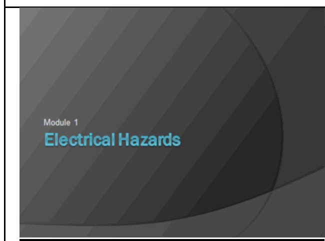
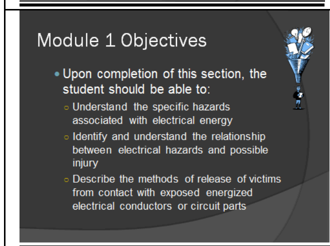
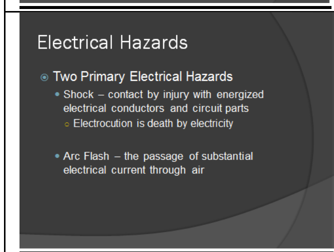
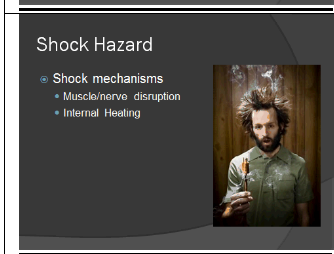
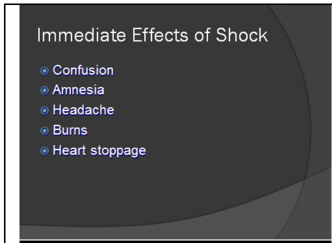
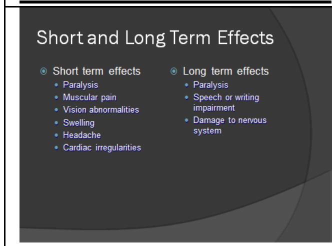
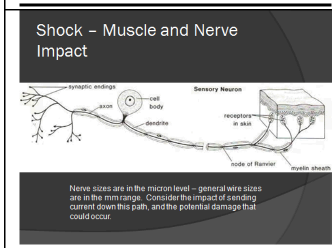
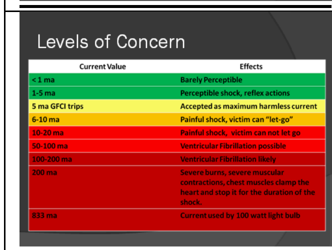
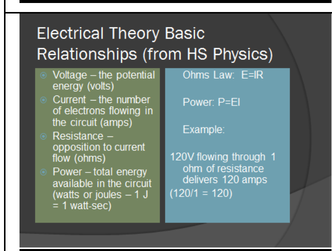
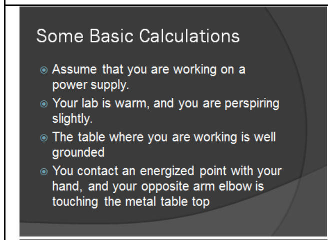
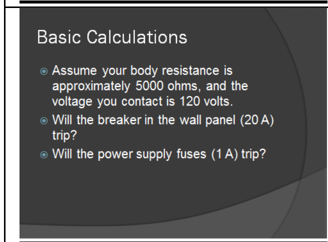
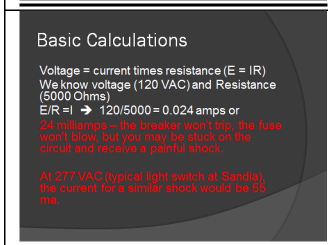
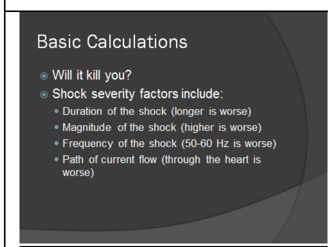
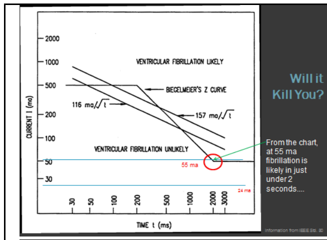
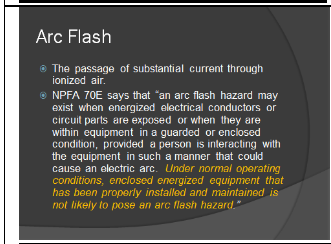
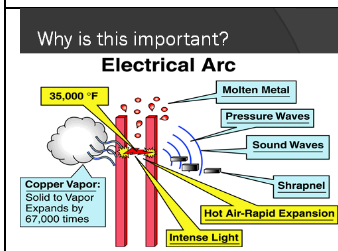
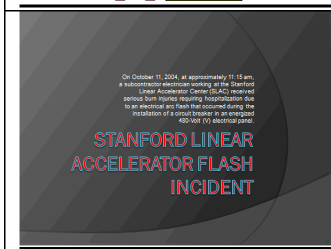
<tr><td>
</td>
<td>Emphasize that this is not a qualification class…but simply safety training. Qualification is the responsibility of the manager based on KSA's…

Discuss purpose of student guide (training aid) – the actual requirements for energized work are found in the Electrical Safety Manual</td>
<td>Emphasize that students are to use the manual when performing energized work activities to ensure all requirements are covered.</td></tr>
</table>

	Review slide, note that the reference for the slide is the SNL Electrical Safety Manual (ESM); Discuss role of the ESM in electrical safety at Sandia…specifically that it is the rule – and should be used whenever performing or considering the performance of energized work.	
	Introduce first major topic – Electrical Hazards Discuss personal fatality accidents from electrical contact	Ask if there are any questions so far… Ask if anyone, or anyone they know has been injured or killed by electricity.
	Review 3 main objectives	Ask "What are the hazards associated with electricity?"
	Briefly discuss the 2 hazards; note that the outcomes (injuries) vary from nothing to severe muscle damage, to fibrillation of the heart, as well as severe burns…many injuries can result in death.	Ask "Why are 'falls' listed as a secondary hazard?"
	Discuss two mechanisms of shock Discuss burning from electric shock, and the requirements for it to occur.	**Show hot dog cooking video**

	Discuss immediate effects of shock	
	Discuss short and long term effects of shock	
	Explain why muscles contract, and why there is a "no-let-go threshold" for shock.	
	Discuss relative values; discuss history (Dalziel experimentation on "volunteers"; identified key differences between AC and DC…note that chart levels are for AC. Include information on differences in detection threshold for men and women – note that women are more sensitive to shock	Ask "So how much is 10 milliamps? In other words, how badly do I have to get into contact with electricity to get to this level?"
	Review basic electrical theory; identify that E = voltage and I = current	

	Discuss initial conditions (reference the video)	
	Write desired outcomes (breaker trip, power supply fuse levels) on board	Ask students what they think…engage / discuss why/why not
	Review actual calculations for 120 volts. Then ask about 277 (standard lighting supply at Sandia) Identify that while the breaker will not trip, both of these levels are above the no-let-go threshold, posing a significant shock hazard.	Ask: Why does this pose a significant shock hazard if the energy levels are below that of defibrillation?
	Review shock severity factors; Review current flow paths to identify worse and better; relate to short term/long term damage (vision impairment, swelling, headache, etc. for paths involving the head	**Review 2700 shock incident (150 kV to head but very low current) – no permanent injury or disability; describe how it could have been worse.**

	Calculations by Dalziel et.al in IEEE Std. 80 identify that time is a severity factor – above 2 seconds, fibrillation is almost always assured even at levels as low as 50 ma.	Ask for questions on shock hazards. Ask what the "other" electrical hazard is
	Define "arc flash" Note that an arc flash generally occurs when the worker is interfacing with the system – operating breakers or disconnects, opening panels, etc. Rarely do they occur during normal or steady-state operation but exceptions apply	Show arc flash demo video
	Refer to video and replay in stops to identify each of the parts of the arc flash; Note that noise levels can exceed 150 dB (jet engine @ 145 dB)	
	Describe event	
		

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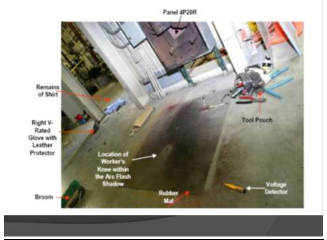
<td>
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</td>
<td>Note that poly/cotton blends melt, rather than burn clear, aggravating any burn injuries</td>
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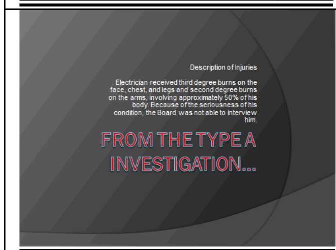
<td>
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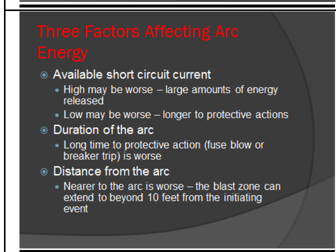
<td>
</td>
<td>Review severity factors, emphasis on available short circuit current, and how that may relate to the second severity factor;

Describe the USN arc flash process and what was done to protect against it; relate to nature of the arc</td>
<td></td>
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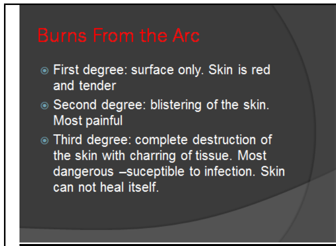
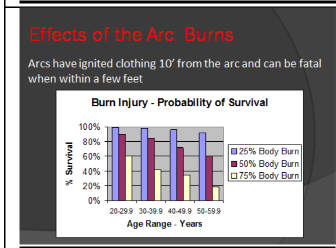
		Ask if anyone has seen the "shortcuts" video– and identify the link in the manual.
	Review survivability statistics	
		Read warning verbatim
	LH – 2nd / 3rd degree – note the blisters on the fingers, indicative of a 2nd degree burn Left middle – severe 1st degree burn on back Right middle – 2nd / 3rd degree on hand – blackening is evidence of a 3rd degree burn RH – 3rd degree burn waiting skin graft	(*B) Discuss LANL capacitor shock event and energy / injuries, including path for current. Discuss hazards of closed labs and working alone
	Serious 3rd degree burns	

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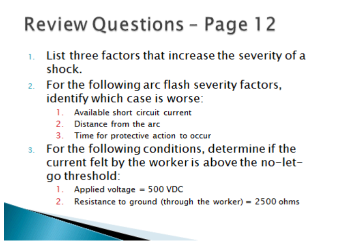
<tr><td>
</td><td>Note that the bad pictures are finished.

Discuss review questions. Answers:
1: magnitude of current, path of shock, duration of shock
2: high or low; closer; longer
3. Above (200 ma)</td><td></td></tr>
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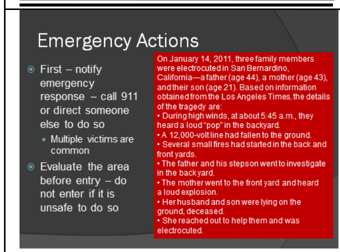
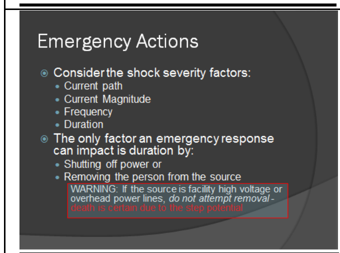
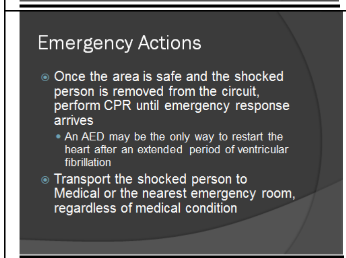
</td><td></td><td>Ask for questions on arc flash.

Ask what should be done in the event of an electrical accident – class discussion</td></tr>
<tr><td>
</td><td>Emphasize the importance of initiating the emergency response system and assessing initial conditions

Discuss hazards and actions around high voltage</td><td>Review electrocution news article

Show power line arcing video</td></tr>
<tr><td>
</td><td>Review slide – once EMS is activated…THINK before you act;

Discuss victim removal</td><td>Ask how to remove victim safely.</td></tr>
<tr><td>
</td><td>Review slide; note that CPR may or may not be required.

Discuss importance of AED</td><td>Ask how to get victim to medical. Drive self?</td></tr>
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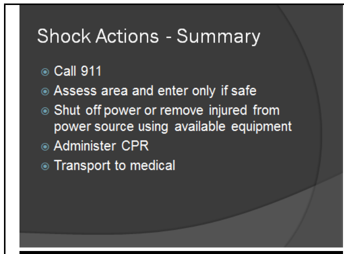
<td>
</td>
<td>Summarize shock actions</td>
<td>Ask why 911 first; Ask when a victim should not be removed from an energized circuit;

Ask about CPR and its effectiveness in treating shock
Ask why an AED is critical in shock victim recovery

Ask about when a shock victim doesn't have to be treated.</td>
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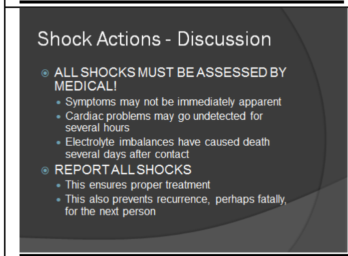
<td>
</td>
<td>Review medical assessment;

Review reporting requirements – emphasize delayed injury response and potential for another victim</td>
<td>Ask when shocks must be reported and why</td>
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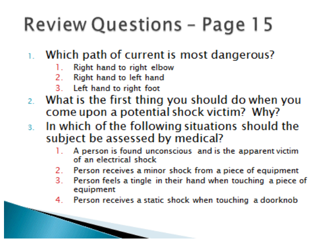
<td>
</td>
<td>Discuss Review Questions on page 16
Answers:
1. RH to LH or LH to RF – both paths are across the heart
2. Call 911 – ensure emergency response is activated in case you are injured in the rescue
3. All except static shock</td>
<td>Emphasize the importance of reporting all shocks, however minor</td>
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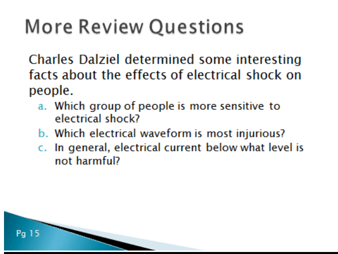
<td>
</td>
<td>Discuss review questions
A – women
B – AC – 60 Hz
C – 5 ma</td>
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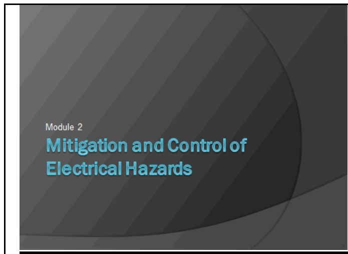
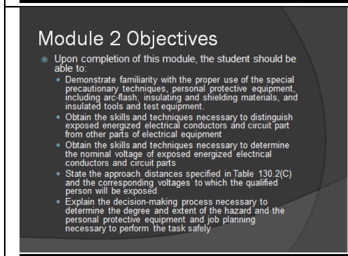
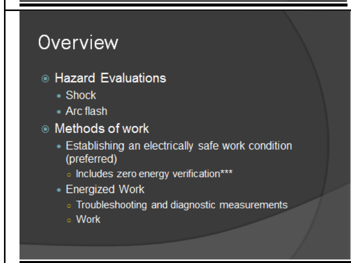
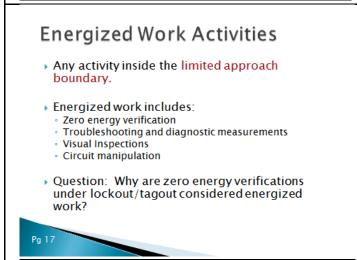
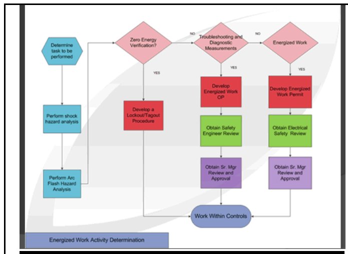
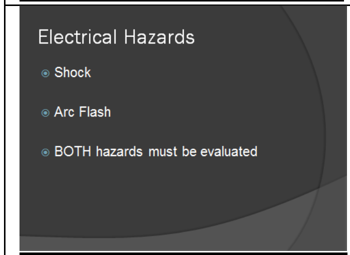
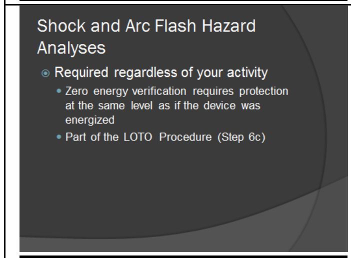
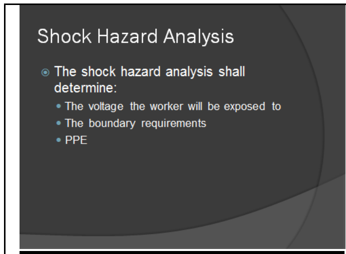
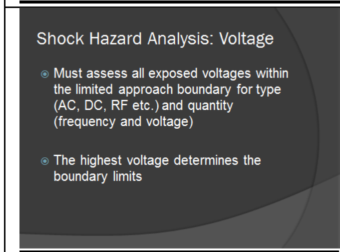
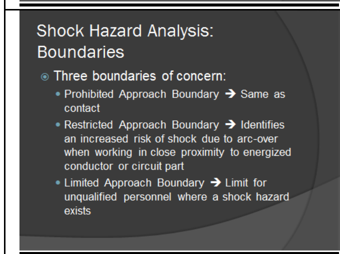
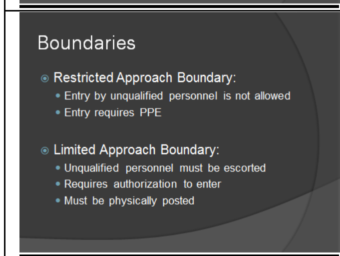
	Evaluate need for break (10-12 minutes) after 60 minutes classroom time. Introduce topic: In the first module, we learned about the potential hazards of electricity. In this module, we will figure out how to manage those hazards.	Ask what the primary and secondary hazards of shock are (shock, arc flash/blast, and falls)
	Review specific objectives	
	Emphasize that the primary way to prevent electrical accidents/injuries is to shut off the equipment and lock it out. Energized work should be performed only when absolutely necessary (not out of convenience) and only then when *authorized and justified.*	
	Define energized work Define and explain the limited approach boundary	Demonstrate LAB concept Ask "why are zero energy verifications under lockout/tagout considered energized work?

 	Describe flow chart – used to determine what is being done, as well as defining the need for the various hazard analyses. Inform students that the flowchart is in the back of the student guide.	
 	Identify that both hazards have to be assessed.	Ask "What are the two primary hazards associated with energized electrical components / circuit parts?" Show slide
 	Discuss when (and why) the 2 analyses must be performed	Ask how this is implemented in the LOTO procedure
 	Introduce the Shock Hazard Analysis	Ask what people think the analysis consists of.

	Identify that the analysis must contain three requirements: -Voltage (and type) -Boundaries (based on voltage / type) -PPE for exposure level	Note that both electrical hazard analyses first determine the magnitude of the hazard, then the boundaries (based on the magnitude) and then appropriate compensatory measures.
	Discuss / reemphasize the differences between AC and DC; Briefly discuss RF hazards and exposure / damage (IEEE C95.1)	Ask: Which is more dangerous: AC or DC?
	Discuss / Explain electrical boundary concept	Ask which boundary identifies the need for PPE Ask at which boundary do we consider energized work taking place?
	Emphasize the requirements for entry into each boundary -LAB – authorization -RAB - PPE	Ask – what determines the qualification of a worker?

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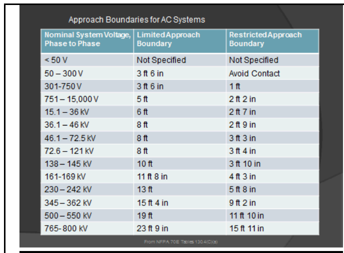
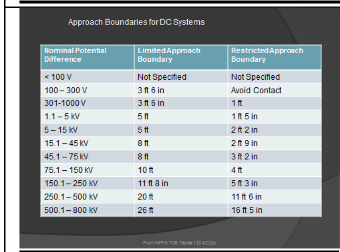
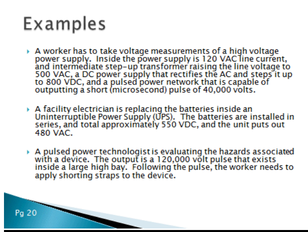
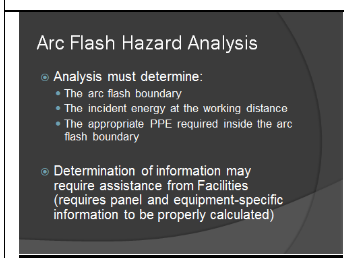
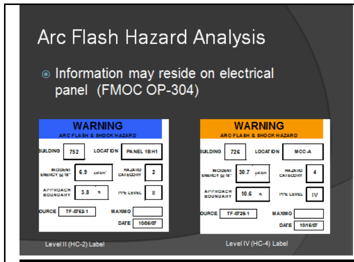
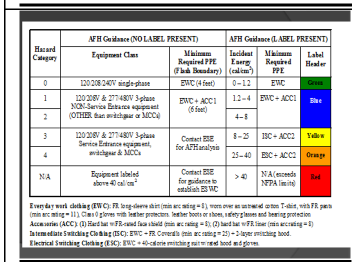
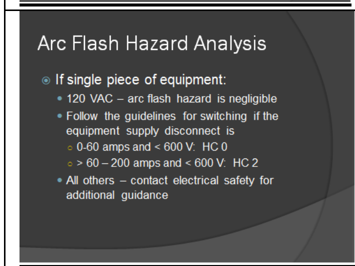
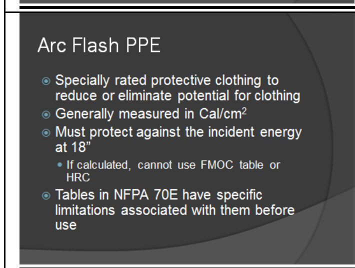
<td>
Approach Boundaries for AC Systems
<table>
<tr><th>Nominal System Voltage, Phase to Phase</th><th>Limited Approach Boundary</th><th>Restricted Approach Boundary</th></tr>
<tr><td>< 50 V</td><td>Not Specified</td><td>Not Specified</td></tr>
<tr><td>50 – 300 V</td><td>3 ft 6 in</td><td>Avoid Contact</td></tr>
<tr><td>301-750 V</td><td>3 ft 6 in</td><td>1 ft</td></tr>
<tr><td>751 – 15,000 V</td><td>5 ft</td><td>2 ft 2 in</td></tr>
<tr><td>15.1 – 36 kV</td><td>6 ft</td><td>2 ft 7 in</td></tr>
<tr><td>36.1 – 46 kV</td><td>8 ft</td><td>2 ft 9 in</td></tr>
<tr><td>46.1 – 72.5 kV</td><td>8 ft</td><td>3 ft 3 in</td></tr>
<tr><td>72.6 – 121 kV</td><td>8 ft</td><td>3 ft 4 in</td></tr>
<tr><td>138 – 145 kV</td><td>10 ft</td><td>3 ft 10 in</td></tr>
<tr><td>161-169 kV</td><td>11 ft 8 in</td><td>4 ft 3 in</td></tr>
<tr><td>230 – 242 kV</td><td>13 ft</td><td>5 ft 8 in</td></tr>
<tr><td>345 – 362 kV</td><td>15 ft 4 in</td><td>9 ft 2 in</td></tr>
<tr><td>500 – 550 kV</td><td>19 ft</td><td>11 ft 10 in</td></tr>
<tr><td>765- 800 kV</td><td>23 ft 9 in</td><td>15 ft 11 in</td></tr>
</table>
From NFPA 70E Tables 130.4(C)(a)</td>
<td>Emphasize chart is for AC voltages</td>
<td>Ask: How close can an unqualified worker get to 48,000 VAC?

Ask: What distance will a worker need to don PPE before working on 12,470 VAC?</td>
</tr>
<tr>
<td>
Approach Boundaries for DC Systems
<table>
<tr><th>Nominal Potential Difference</th><th>Limited Approach Boundary</th><th>Restricted Approach Boundary</th></tr>
<tr><td>< 100 V</td><td>Not Specified</td><td>Not Specified</td></tr>
<tr><td>100 – 300 V</td><td>3 ft 6 in</td><td>Avoid Contact</td></tr>
<tr><td>301-1000 V</td><td>3 ft 6 in</td><td>1 ft</td></tr>
<tr><td>1.1 – 5 kV</td><td>5 ft</td><td>1 ft 5 in</td></tr>
<tr><td>5 – 15 kV</td><td>5 ft</td><td>2 ft 2 in</td></tr>
<tr><td>15.1 – 45 kV</td><td>8 ft</td><td>2 ft 9 in</td></tr>
<tr><td>45.1 – 75 kV</td><td>8 ft</td><td>3 ft 2 in</td></tr>
<tr><td>75.1 – 150 kV</td><td>10 ft</td><td>4 ft</td></tr>
<tr><td>150.1 – 250 kV</td><td>11 ft 8 in</td><td>5 ft 3 in</td></tr>
<tr><td>250.1 – 500 kV</td><td>20 ft</td><td>11 ft 6 in</td></tr>
<tr><td>500.1 – 800 kV</td><td>26 ft</td><td>16 ft 5 in</td></tr>
</table>
From NFPA 70E Tables 130.4(C)(b)</td>
<td>Emphasize chart is for DC voltage.

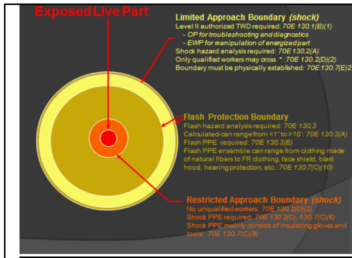
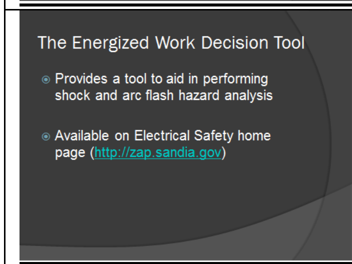
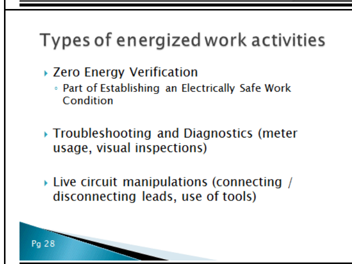
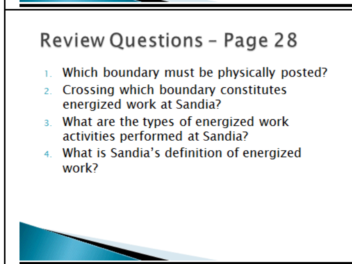
Note difference in AC and DC, especially at lower voltage – 100 vs. 50

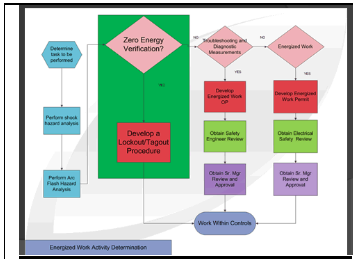
Emphasize that while the shock hazard is lower, the burn hazard from DC increases with current (think “wrench on car battery terminals”).</td>
<td></td>
</tr>
<tr>
<td>
</td>
<td>Refer students to tables; Use board to identify voltages, then appropriate table to identify boundary</td>
<td>Ex 1: 120 VAC LAB is 3’6”, RAB is avoid contact
500 VAC – LAB is still 3’6”, but RAB is now 1’
40 kv dc – LAB is 8 ft, and RAB is 2’9”
Ex. 2 550 VDC and 480 VAC LAB is 3’6” and RAB is 1’
Ex.3 120 kv dc LAB is 10’, RAB is 4’

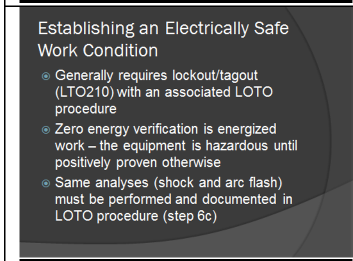
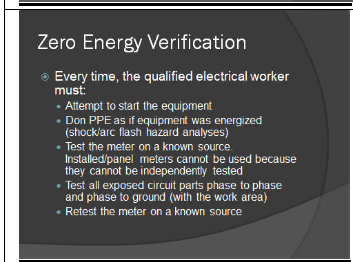
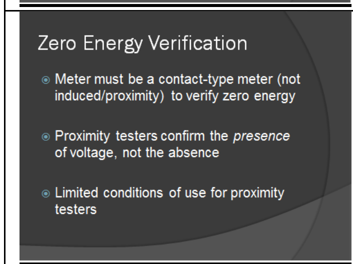
Ask for questions; Ask for def on energized work</td>
</tr>
<tr>
<td>
</td>
<td>Review terms – Incident energy – the amount of energy impressed on a surface, a certain distance from the source, generated during an electrical arc event (cal/cm^2)</td>
<td></td>
</tr>
</table>

<table>
<tr>
<td>
</td>
<td>Typical panel warning labels at Sandia. Identify the components of the warning label</td>
<td>Ask “why is 18” selected as working distance?”
Ask, “what if you are working closer?”</td>
</tr>
<tr>
<td>
<table>
<tr><th rowspan="2">Hazard Category</th><th colspan="2">AFH Guidance (NO LABEL PRESENT)</th><th colspan="3">AFH Guidance (LABEL PRESENT)</th></tr>
<tr><th>Equipment Class</th><th>Minimum Required PPE (Flash Boundary)</th><th>Incident Energy (cal/cm²)</th><th>Minimum Required PPE</th><th>Label Header</th></tr>
<tr><td>0</td><td>120/208/240V single-phase</td><td>EWC (4 feet)</td><td>0 – 1.2</td><td>EWC</td><td>Green</td></tr>
<tr><td>1</td><td rowspan="2">120/208V & 277/480V 3-phase NON-Service Entrance equipment (OTHER than switchgear or MCCs)</td><td rowspan="2">EWC + ACC1 (6 feet)</td><td>1.2 – 4</td><td rowspan="2">EWC + ACC1</td><td rowspan="2">Blue</td></tr>
<tr><td>2</td><td>4 – 8</td></tr>
<tr><td>3</td><td rowspan="2">120/208V & 277/480V 3-phase Service Entrance equipment, switchgear & MCCs</td><td rowspan="2">Contact ESE for AFH analysis</td><td>8 – 25</td><td>ISC + ACC2</td><td>Yellow</td></tr>
<tr><td>4</td><td>25 – 40</td><td>ESC + ACC2</td><td>Orange</td></tr>
<tr><td>N/A</td><td>Equipment labeled above 40 cal/cm²</td><td>Contact ESE for guidance to establish ESWC</td><td>> 40</td><td>N/A (exceeds NFPA limits)</td><td>Red</td></tr>
</table>
Everyday work clothing (EWC): FR long-sleeve shirt (min arc rating = 8), worn over an untreated cotton T-shirt, with FR pants (min arc rating = 11), Class 0 gloves with leather protectors. leather boots or shoes, safety glasses and hearing protection
Accessories (ACC): (1) Hard hat w/FR-rated face shield (min arc rating = 8); (2) hard hat w/FR liner (min arc rating = 8)
Intermediate Switching Clothing (ISC): EWC + FR Coveralls (min arc rating = 25) + 2-layer switching hood.
Electrical Switching Clothing (ESC): EWC + 40-calorie switching suit w/rated hood and gloves.</td>
<td>FMOC arc flash PPE requirements. Note that for most lab workers, arc flash hazards seldom exceed HRC 2 (8 cal/cm^2) due to system design characteristics. There are exceptions, however (WETL, 820, etc.)</td>
<td>Demonstrate videos with</td>
</tr>
<tr>
<td>
</td>
<td>Review guidelines, note that they are only guidelines. If a certain activity is impaired by guidance PPE, contact building manager or electrical safety for additional analysis. ($$)</td>
<td></td>
</tr>
<tr>
<td>
</td>
<td>NFPA 70E allows two methods of determination of the appropriate clothing – tables in the standard and calculation – but the two methods cannot be mixed…if calculated at 8.3 cal / cm^2, that level of PPE must be worn – but if identified from the tables as HRC 2, then an HRC 2 ensemble must be worn.</td>
<td>Show video of arc flash wear (and non-arc flash wear)

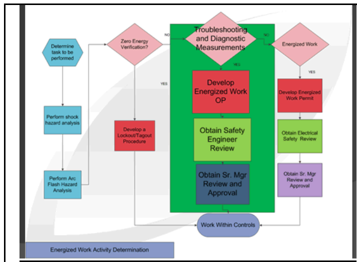
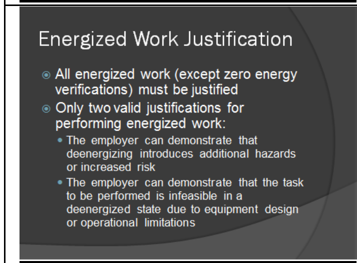
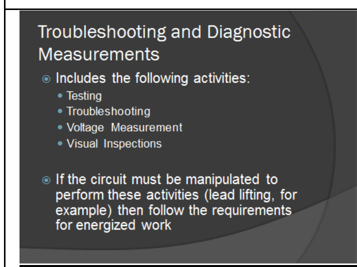
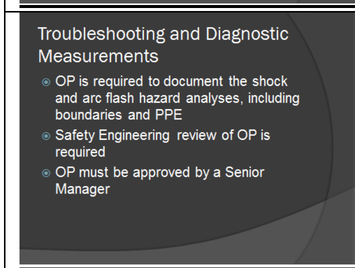
Display actual arc flash PPE, if available</td>
</tr>
</table>

	Review Table – emphasize the requirements for each boundary (LAB, RAB, AFB)	Ask for questions on boundaries. **<BLANK SCREEN> Review boundary requirements q&a**
	The EWDT is a tool to help you perform activities inside the LAB. Discuss EWDT limitations (20 kV, arc flash analysis)	Walk through using the EWDT
	Now we know what constitutes energized work, and how to protect ourselves from it. We still have to figure out how to justify and authorize the work.	Refer to manual chart on Energized work activity determination. Ask "What are the three types of energized work activities at Sandia?"
	Discuss Review Questions on page 29 1. LAB 2. LAB 3. LOTO zero energy verification; troubleshooting and diagnostic measurements, live circuit manipulation 4. Any activity inside the LAB of exposed and energized conductors and circuit parts	

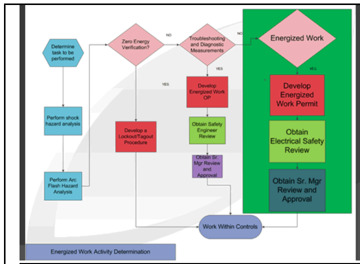
<table>
<tr>
<td>
</td>
<td>Once we’ve performed our analysis, we have to decide if we are working energized, or working de-energized.

Of course, the preferred method is always to lock out the equipment</td>
<td>Ask “which do you think is preferred? Energized or locked out?” Why?</td>
</tr>
<tr>
<td>
</td>
<td>Emphasize second bullet – this is a form of energized work…the equipment is energized until positively proven otherwise</td>
<td>Emphasize that the application of LOTO can be a hazardous operation – everything is energized until positively proven otherwise</td>
</tr>
<tr>
<td>
</td>
<td>Review zero energy verification process (ref NFPA 70E Art. 120)</td>
<td></td>
</tr>
<tr>
<td>
</td>
<td>Discuss when use of proximity tester is appropriate, and limiting conditions</td>
<td>Demonstrate two types of meters – show shortfall with non-contact type detectors

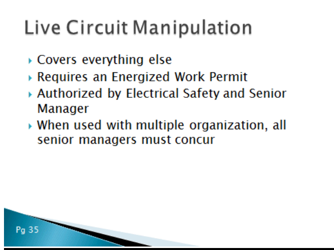
Review recent occurrences where zero energy verification was not effectively performed (SNL/Complex/NIOSH FACE)</td>
</tr>
</table>

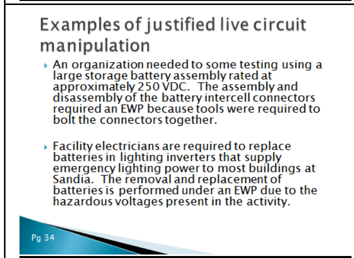
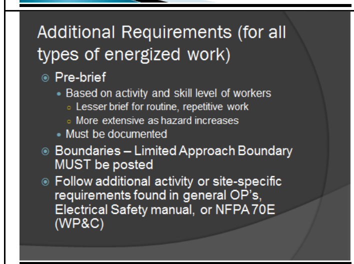
	Review General Process for troubleshooting	
	Discuss justification requirements with examples of acceptable and unacceptable energized work. Emphasize that convenience and cost savings are not operational limitations. Note that energized work , other than zero energy verification, is always high rigor. Review Canada's permit requirements for requestor to sign on permit	Ask why energized work is always high rigor (emphasize the risk)
	Review requirements	Provide examples (in book) of activities that are troubleshooting and diagnostic measurements, and ones that are not.
	Discuss review and authorization (remind on justification)	

Examples of troubleshooting and diagnostic measurements ▸ A thermal chamber is not heating properly. A power off test for circuit continuity and heater functionality did not identify any problems. It is infeasible to determine if the correct voltage is applied to the heaters while the circuit was deenergized, so the senior manager approved voltage testing inside the thermal chamber.  Pg 32	Review the reasoning for each example	Refer student to page 33 in manual
Examples of troubleshooting and diagnostic measurements ▸ Facilities maintenance received a trouble call that a receptacle in an office wasn't working. It was not immediately apparent where the outlet was powered from, so the facility electrician traced the wires back to a junction box. The box provided circuit information, and the worker confirmed that power was, and other receptacles on the circuit were functioning. The facility worker, under OP-304, is allowed to open the junction box cover to determine if voltage is present. He discovered that a wire for the receptacle had come loose from the wire nut. He would have to lock out the circuit to perform repairs. *If the worker had to install the wire into a live circuit, this is considered a circuit manipulation, not troubleshooting and diagnostic measurement, and would require additional authorization.* Pg 32		
Examples of troubleshooting and diagnostic measurements ▸ A test procedure to certify a piece of equipment requires voltage and current measurements to be taken periodically, in multiple places, during the equipment startup and operation. The worker set up a series of meters to allow the readings to be performed, but due to the construction of the device, had to enter the limited approach boundary to read some of the meters. An OP approved by the senior manager would be required when the limited approach boundary was entered. The meter installation was performed under lockout/tagout. Pg 33		
Examples of troubleshooting and diagnostic measurements ▸ As part of a troubleshooting operation, the technical representative from the vendor of a programmable logic controller requested information on controller sequencing. This required the observation of several lights and recording of the light sequence. The lights were positioned on the inside of a 480 VAC control unit, and could only be seen from approximately 18" away. An OP approved by the senior manager would be required in this case, although it is only a visual inspection, because the limited approach boundary was crossed. No PPE would be required, however, because the restricted approach boundary was never breached (1 foot at 480 VAC). Pg 33		

<table>
<tr>
<td>
</td>
<td>Discuss differences between OP and Permit

Discuss similarities between OP and Permit</td>
<td>Ask – Can the general format for an EWP be used for an energized work OP for troubleshooting and voltage measurements?

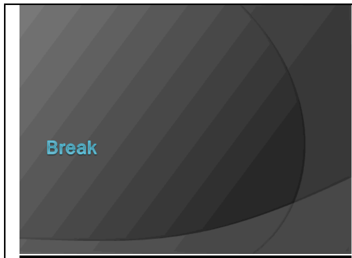
What's different (refer to EWP on page xx)</td>
</tr>
<tr>
<td>
</td>
<td>Review requirements – note differences…permits must be approved by Electrical Safety

Most hazardous operations, requires additional backup to ensure activity is performed safely</td>
<td></td>
</tr>
<tr>
<td>
</td>
<td>Review examples – discuss problems inherent with batteries</td>
<td></td>
</tr>
<tr>
<td>
</td>
<td>Review additional requirements

Note that the LAB must be physically posted anytime energized work (including zero energy verifications) is performed</td>
<td>Review – what does entry into the LAB require?

What does entry into the RAB require?

When is energized work, other than zero energy verifications, allowed to be performed?</td>
</tr>
</table>

<table>
<tr>
<td>
</td>
<td>Allow 10 minutes</td>
<td></td>
</tr>
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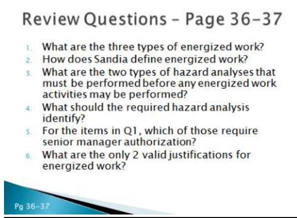
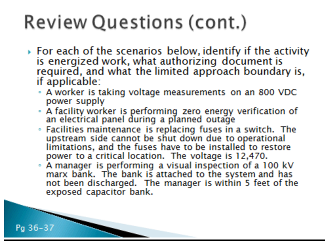
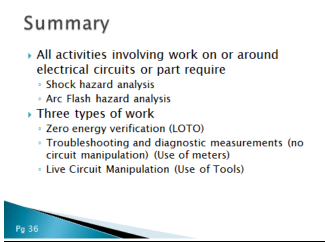
<td>
</td>
<td>Discuss review questions on pp 37-38
1. ZEV, TS&D, Live ckt manip;
2. Any activity inside the LAB
3. Shock and arc flash
4. Magnitude of hazard, boundaries, PPE
5. TS&D, Live ckt manip
6. Greater hazard, infeasible</td>
<td>Discuss answers – allow students to provide answers (go around the room)</td>
</tr>
<tr>
<td>
</td>
<td>1: YES, OP, 3’6”
2: YES, ESLP, 3’6”
3: YES</td>
<td></td>
</tr>
<tr>
<td>
</td>
<td>Review Summary</td>
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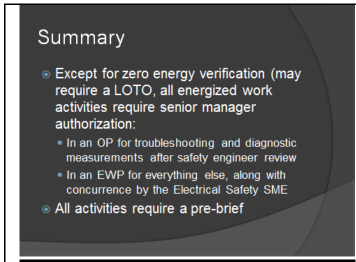
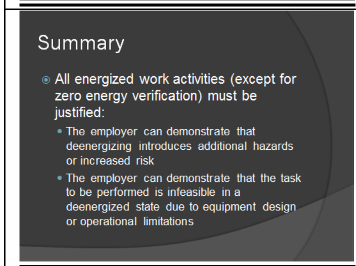
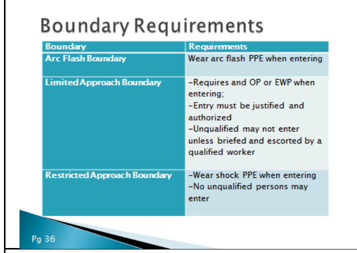
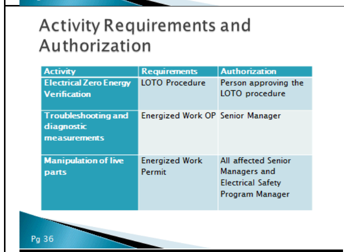
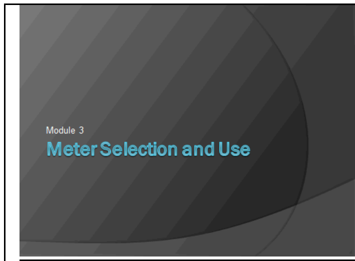
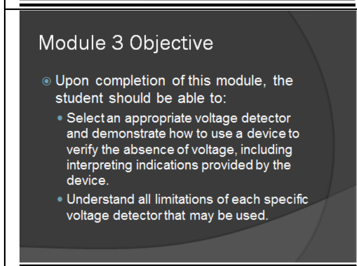
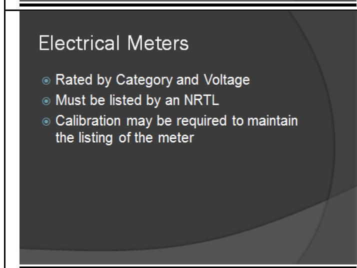
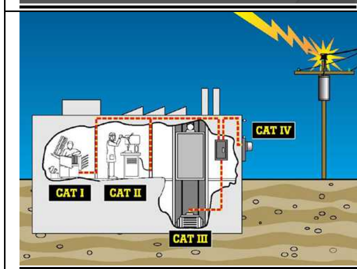
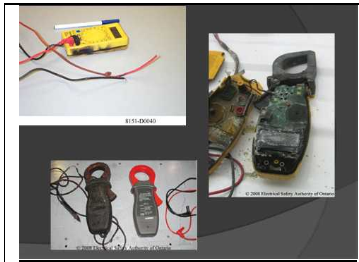
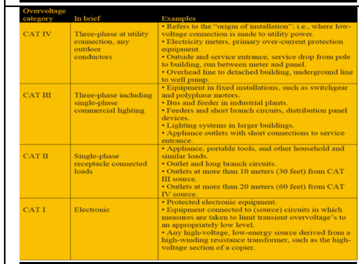
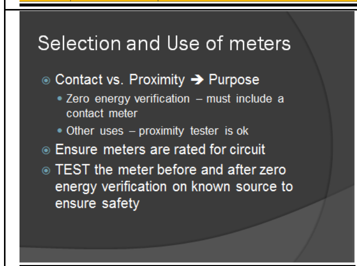
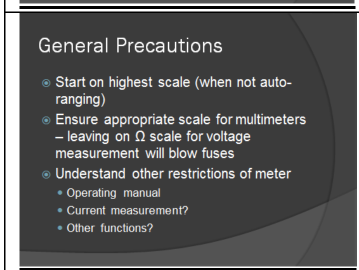
	Review Summary	
	Review Summary	Direct Students to questions in book on page xx – go around the room to answer the questions. Ask for any additional questions.
	Review Boundary Requirements. Emphasize difference between shock boundaries and arc flash boundaries	
	Review Activity Requirements and Authorization; emphasize that the safe work condition (LOTO) is the first choice – intentional activities on live circuits should always be the last resort.	

	Introduce new topic	
	Review objective	
	Review requirements for listing – remind that this applies to *all* electrical equipment, not just meters Refer meter cal questions to cal lab – direct students to follow calibration CPR	
	Describe the four categories of meters and general ranges (0-600, 0-1000) Describe results of improper meter use	Show additional file pics of damaged meters

<table>
<tr>
<td>
</td>
<td>Discuss event summaries and outcomes
-injuries
-death</td>
<td></td>
</tr>
<tr>
<td>
<table>
<tr><th>Overvoltage category</th><th>In brief</th><th>Examples</th></tr>
<tr><td>CAT IV</td><td>Three-phase at utility connection, any outdoor conductors</td><td>• Refers to the "origin of installation"; i.e., where low-voltage connection is made to utility power.
• Electricity meters, primary over-current protection equipment.
• Outside and service entrance, service drop from pole to building, run between meter and panel.
• Overhead line to detached building, underground line to well pump.</td></tr>
<tr><td>CAT III</td><td>Three-phase including single-phase commercial lighting</td><td>• Equipment in fixed installations, such as switchgear and polyphase motors.
• Bus and feeder in industrial plants.
• Feeders and short branch circuits, distribution panel devices.
• Lighting systems in larger buildings.
• Appliance outlets with short connections to service entrance.</td></tr>
<tr><td>CAT II</td><td>Single-phase receptacle connected loads</td><td>• Appliance, portable tools, and other household and similar loads.
• Outlet and long branch circuits.
• Outlets at more than 10 meters (30 feet) from CAT III source.
• Outlets at more than 20 meters (60 feet) from CAT IV source.</td></tr>
<tr><td>CAT I</td><td>Electronic</td><td>• Protected electronic equipment.
• Equipment connected to (source) circuits in which measures are taken to limit transient overvoltage's to an appropriately low level.
• Any high-voltage, low-energy source derived from a high-winding resistance transformer, such as the high-voltage section of a copier.</td></tr>
</table></td>
<td>Review Chart</td>
<td>Direct students to full chart on page xx</td>
</tr>
<tr>
<td>
</td>
<td>Review difference between contact and proximity testers, and potential uses

Emphasize ratings of meter, and testing meter before/after use on known live source</td>
<td>Why test meter?</td>
</tr>
<tr>
<td>
</td>
<td>Review meter testing precautions

Relate testing concerns => safety and reliability</td>
<td></td>
</tr>
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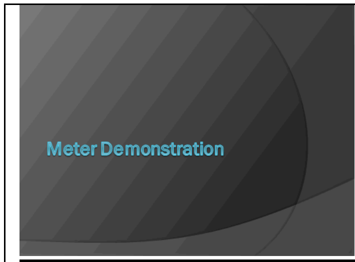
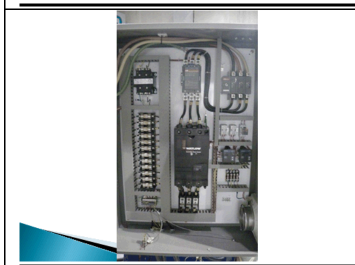
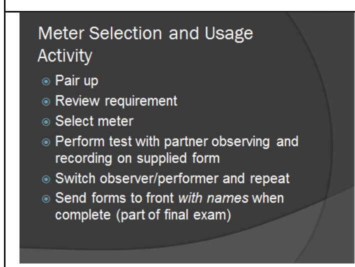
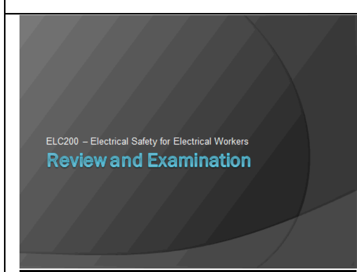
<tr><td>
</td><td>For the final objective, you have the opportunity to demonstrate that you can actually use a meter.</td><td></td></tr>
<tr><td></td><td>Walk through circuit descriptions, noting code violations (multiple power sources, incorrect wire colors, etc.) Note that there is a 120 VAC cord and plug that provides alternate power to the 120 VAC heater (SCR) control in addition to the xfmr that is not visible from the front of the equipment. Additionally, the fuses to the left provide power to heaters, and this device is one of six identical heater controllers. Emphasize that backfeed from other units is possible in the event of miswiring, which is why 70E mandates testing “all exposed points phase to phase and phase ground”.</td><td></td></tr>
<tr><td>
</td><td>Describe meter test process</td><td>At no time is any worker authorized to connect the meter with actual hazardous voltage as a part of this class. Qualification for energized work activities is a responsibility of your manager, not the electrical safety program.

Perform meter testing exercise</td></tr>
<tr><td>
</td><td></td><td></td></tr>
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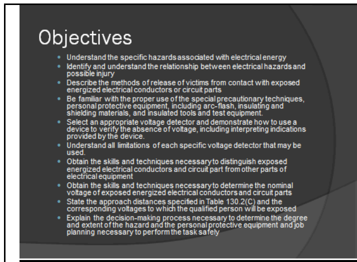
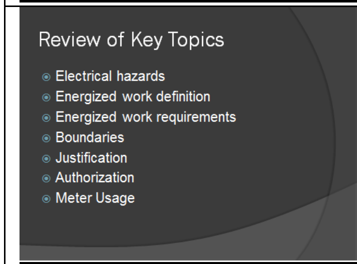
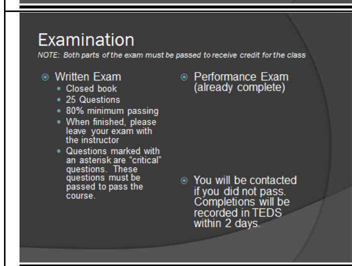
<tr><td>
</td><td>Review objectives</td><td></td></tr>
<tr><td>
</td><td>Review key issues – safety, energized work definition / requirements, boundaries, justification, authorization, and meter usage; Remind students of differences in shock and arc flash boundaries, and what they are.</td><td></td></tr>
<tr><td>
</td><td>Ask for questions</td><td></td></tr>
<tr><td>
</td><td>Introduce examination – note that it is closed book. Ask if you don't understand the exam. Remind students that Q1, Q2, and Q3 must be correct or they will have to retake the class.

Review passing criteria – note that the exams will not be graded until after all exams are turned in, and TEDS completions will be recorded within 2 days.</td><td></td></tr>
</table>