

DC Work Scenarios

Example Task Description	Hazardous Exposures	Practices	PPE	Other
<p>UPS Battery maintenance and replacement; 240V (+/-) Bank >1kWh</p> <p>Note- See NFPA 70E 320</p>	<p>Shock Burn – High current across tool or jewelry</p> <p>Explosion-short terminals</p> <p>Arc? (note 2)</p> <p>Chemical – must be analyzed for task and equipment</p>	<p>Disconnect from load (sw)</p> <p>Split bank to reduce voltage to 120v or less</p> <p>No work where pos & neg are proximate</p> <p>Add'l barrier if low spacing / replacement problem</p>	<p>Elect/chem. Resis gloves</p> <p><100v / electric optional</p> <p>Consider sealed batteries.</p> <p>No jewelry</p> <p>Min. FR clothing</p>	<p>Probe extensions 12" clearance above batteries (70e) Eng best practice – tilt out batteries Non-sparking / insulated rated tools 70e 320.9 IEEE 484 1187 1188</p> <p>Problem: 70E requires non-sparking / insulated equipment. All equipment may not be available.</p>
<p>Assembly / maintenance of PV array Test/measurement 300-400v 7-100 amps</p>	<p>Shock</p> <p>ARC FLASH N/A</p> <p>Non-DC interface- system tie, etc</p>	<p>Last connection at/near middle of bank –reduces current</p>	<p>V- gloves V—tools</p> <p>eye prot, hard hat, etc as applicable</p>	<p>Need best practice ppe guidance</p> <p>NEC 690</p>
<p>misc equipment testing < 600V</p> <p>HI current / lo voltage, >1kW PS</p>	<p>AC service</p> <p>Current to 1000's of amps– burns</p> <p>Capacitors- to kJoules</p> <p>Arc flash hazards</p>	<p>Guard terminals</p>	<p>Gloves</p> <p>Gen';l ppe as needed</p>	
<p>As above, >600V@5mA or more</p>	<p>Capacitance in DC cable – stored energy 30pF / ft painful shock only (startle)</p> <p>Unguarded BNC connector – possible 500v</p>	<p>Short out cables when disconnecting – shorting plug</p> <p>eng. Control – bleeder resistors;</p>	<p>Gloves if handling live cables</p> <p>V-rated grd stick</p> <p>~10 kJ; Ear prot.</p> <p>UV eyewear</p>	<p>BNC=500v SHV=5kV MHV hazard – can cross connect to BNC</p> <p>Consider active noise canceling ear protection</p>

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	shock Floating PS / connectors- non-grounded outer conductor X-ray @ vacuum UV	interlock switches, Crowbar interlocked to line power. voltage test Verify w/ HV probes if possible Hard ground/short for verification Labeling/ Safe out / Guarding/ Eng. Control shielding		
Cap bank testing and safing	Arc- how to calculate? Lloyd method (LNL), SLAC method? Blast Shock – depends on voltage Explosion- joule value	LOTO charging system. Eng controls: Observable crowbars and resistors. Time constant 10 sec to minutes- slow access by adding bolts, panels, etc. Less desirable: procedures, signs	(Oberon has 100cal ballistic suit.) Face shields, ear prot, safety glasses, Ground hook – hard / soft	Grounding may be part of LOTO verification Must detect for open elements w/capacitance meter – depends on total energy and design of bank.
Inductor Unplanned disconnection- Superconducting Research Magnet Synchrotron Dipole Magnet	High voltage shock- uncontrolled voltage Hi Magnetic field- normal use With superconductor, you cannot	Snubbers – limit voltage to a few volts Administrative- training Built in volt & ammeters Not 100% reliable	N/A Note- Non elect ppe require: cryogenic hazards	No medical implants, pacemakers, etc.

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	assume a fast discharge when power is removed.	Can measure @ current measuring resistor Restrict magnetic tools		
Fuel cells-test/measurement	Little energized exposure Shock hazard depends on how many are stacked Ex: 200kW/240-480V Arc hazard-relatively safe (see note 2)	Eng.controls-guarding terminals	Verification risk low v-Gloves, tools general industrial hazard -ppe as appropriate	Easy to de-energize – turn off reactants.

Notes:

1. Common to all the DC systems is the use of contactors , relays, breakers and disconnect switches. These must be specifically listed and rated for the DC service encountered.
2. 500amp AND 250 V probable lower threshold for arc flash injury