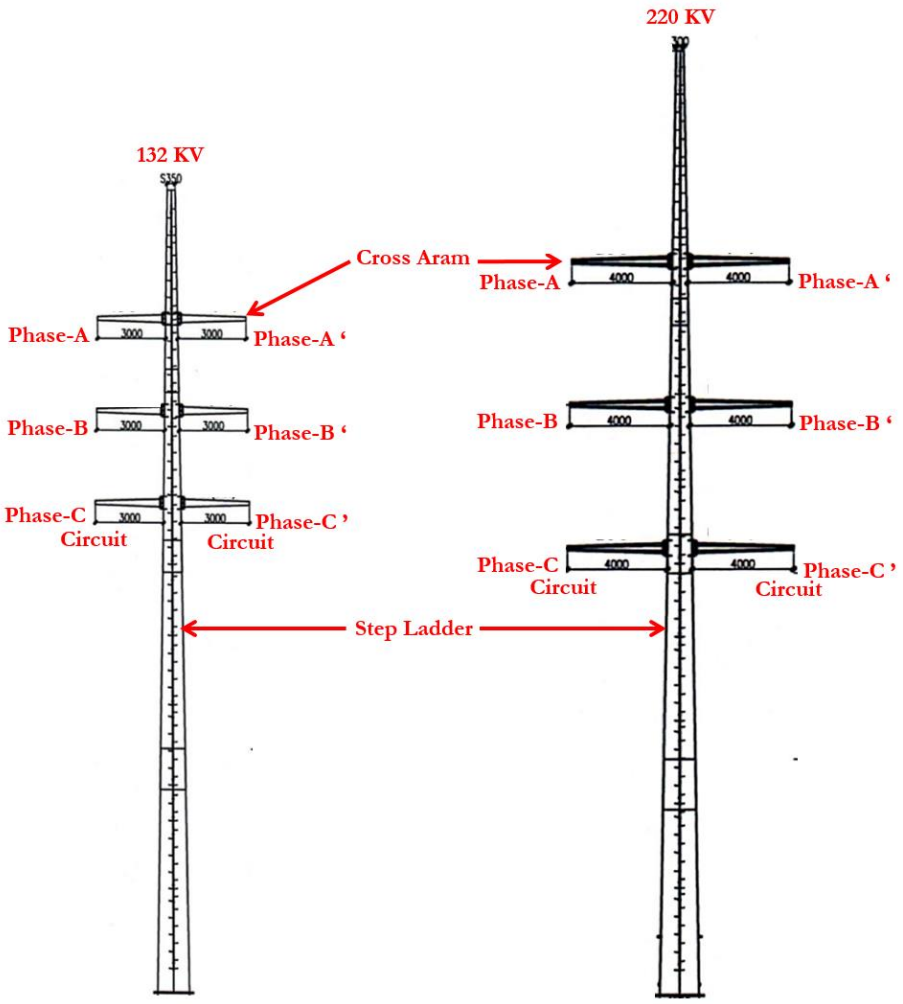
NEPRA Clarification-Safe Approach Distance

Problem Statement March 8, 2023

A monopole has two transmission circuits, each with six conductors corresponding to three phases. Normally, both circuits are operational and energized. It is commercially not viable to de-energize both circuits at a time to take a wide-area shutdown. The monopole is designed so that a worker can climb up by step ladder at the pole.

Let's say a monopole is designed for 132KV. There is at least a distance of around 3 meters by design in-between the step ladders (installed in the center) and one circuit at cross arm.



Is it possible to de-energize one circuit (three phases) for maintenance work while the other circuit remains energized during corrective or preventive maintenance? In this case, the maintenance worker

will climb at the monopole, compromising the minimum safe approach distance as recommended in the NEPRA Power Safety Code Section 7.21.7.

7.21.7. Maintain an appropriate minimum distance from energized power lines at all times, while working nearby:

Line Voltage	Minimum Safe Distance
Up to 50 Kilovolts (KV)	3 Meter (10 Feet)
50 to 250 Kilovolts (KV)	6.1 Meter (20 Feet)
Over 250 Kilovolts (KV)	7.6 Meter (25 Feet)

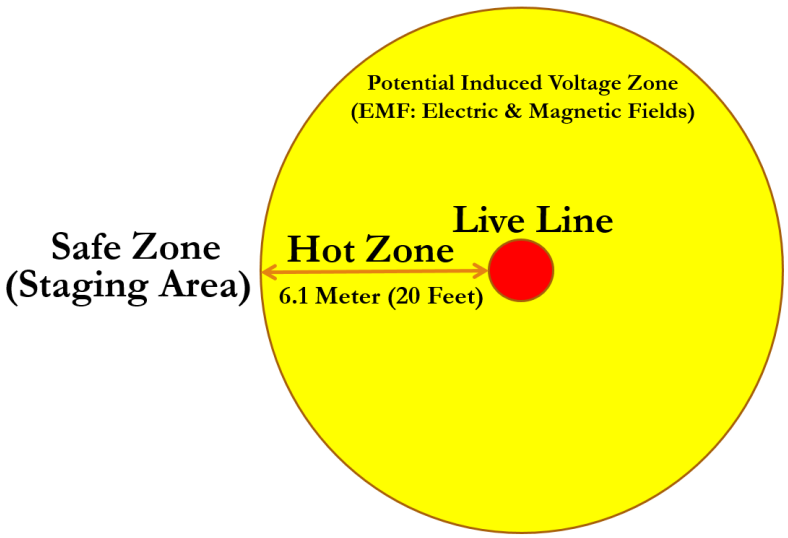
Note: Distances listed are for standard conditions, extra care must be taken, if standard conditions do not exist.

NEPRA Clarification

1. General

1.1. The limits specified in the Power Safety Code Section 7.21.7 are the appropriate safe approach distance (**safe zone**) while working on monopole/tower/structure nearby uninsulated energized power lines. Workers must maintain maximum clearance to obtain the safest work environment and adequately to protect against electrical shock or burns.

1.2. The recommended safe distance in the Power Safety Code Section 7.21.7 for 132 KV and 220 KV is 6.1 Meters (20 Feet).



1.3. When it is confirmed that there is no induced voltage exists at the maintenance worksite or where workers work at an electrically safe distance outside the boundary of induced voltage away from restricted approach boundary as specified in the NFPA 70E-2021 Table 130.4(E)(a) plus adding an additional safety factor of one meter then it is okay to follow your normal routine PPE and safety procedure/SOP to control risks and ensure safe execution of the job.

Δ Table 130.4(E)(a) Shock Protection Approach Boundaries to Exposed Energized Electrical Conductors or Circuit Parts for Alternating-Current Systems

(1)	(2)	(3)	(4)
	Limited Approach Boundary[b]		
Nominal System Voltage Range, Phase to Phase[a]	Exposed Movable Conductor[c]	Exposed Fixed Circuit Part	Restricted Approach Boundary[b]; Includes Inadvertent Movement Adder
Less than 50 V	Not specified	Not specified	Not specified
50 V–150 V[d]	3.0 m (10 ft 0 in.)	1.0 m (3 ft 6 in.)	Avoid contact
151 V–750 V	3.0 m (10 ft 0 in.)	1.0 m (3 ft 6 in.)	0.3 m (1 ft 0 in.)
751 V–15 kV	3.0 m (10 ft 0 in.)	1.5 m (5 ft 0 in.)	0.7 m (2 ft 2 in.)
15.1 kV–36 kV	3.0 m (10 ft 0 in.)	1.8 m (6 ft 0 in.)	0.8 m (2 ft 9 in.)
36.1 kV–46 kV	3.0 m (10 ft 0 in.)	2.5 m (8 ft 0 in.)	0.8 m (2 ft 9 in.)
46.1 kV–72.5 kV	3.0 m (10 ft 0 in.)	2.5 m (8 ft 0 in.)	1.0 m (3 ft 6 in.)
72.6 kV–121 kV	3.3 m (10 ft 8 in.)	2.5 m (8 ft 0 in.)	1.0 m (3 ft 6 in.)
138 kV–145 kV	3.4 m (11 ft 0 in.)	3.0 m (10 ft 0 in.)	1.2 m (3 ft 10 in.)
161 kV–169 kV	3.6 m (11 ft 8 in.)	3.6 m (11 ft 8 in.)	1.3 m (4 ft 3 in.)
230 kV–242 kV	4.0 m (13 ft 0 in.)	4.0 m (13 ft 0 in.)	1.7 m (5 ft 8 in.)
345 kV–362 kV	4.7 m (15 ft 4 in.)	4.7 m (15 ft 4 in.)	2.8 m (9 ft 2 in.)
500 kV–550 kV	5.8 m (19 ft 0 in.)	5.8 m (19 ft 0 in.)	3.6 m (11 ft 8 in.)
765 kV–800 kV	7.2 m (23 ft 9 in.)	7.2 m (23 ft 9 in.)	4.9 m (15 ft 11 in.)

Notes:
(1) For arc flash boundary, see 130.5(E).
(2) All dimensions are distance from exposed energized electrical conductors or circuit part to employee.
[a]For single-phase systems above 250 volts, select the range that is equal to the system's maximum phase-to-ground voltage multiplied by 1.732.
[b]See definition in Article 100 and text in 130.4(D)(2) and Informative Annex C for elaboration.
[c]*Exposed movable conductors* describes a condition in which the distance between the conductor and a person is not under the control of the person. The term is normally applied to overhead line conductors supported by poles.
[d]This includes circuits where the exposure does not exceed 120 volts nominal.

1.4. While working on a de-energized circuit in parallel to a live circuit or circuits, if the level of risk cannot be controlled or that induced voltage could cause an injury to worker, then the adjacent circuit or circuits must be de-energized, OFF isolated, locked, tagged, and grounded by opening circuit breakers, isolators and closing the earthing switch at all ends of the connected grids. After this confirmation from the authorized personnel, the work can be performed.

2. Guidelines

The following guidelines are for the live line work or when electrically conductive/induced environment is present.

2.1. Whenever work is to be done on or near an uninsulated energized overhead circuit, it must be identified as a **"hot zone"** if it compromises the minimum safe approach distance as given in the Power Safety Code. The hot zone is immediately dangerous to life or health

(IDLH) due to an identified risk of electrical shock, or burns in presence of high induced voltage in the hot zone.

2.2. When working on de-energized overhead lines near existing energized high voltage lines in the hot zone, there is a risk of induced voltages due to the significant electromagnetic fields present around energized overhead lines that can deliver lethal electric shocks.

2.3. The job steps shall be listed in the Method Statement/SOP/Job Plan, reviewed and confirmed by all parties with precautions, and means of communication shall be available at ground level as well as at high elevation.

2.4. Conduct risk assessment/job safety analysis for electric shock, arc flash, arc blast to assess and identify site specific safety requirements and provide recommendations for safe execution of the job.

2.5. The associated risks near energized high voltage lines, and its appropriate protection must be effectively communicated to all involved parties.

2.6. When planning the task, the worker's position in relation to the exposed circuit such that planned movements of the worker's body or conductive tools, material or vegetation should not result in any encroachment upon these limits.

2.7. When two or more circuits operating at one monopole/tower/structure with different voltages, the safe zone appropriate to each voltage must be maintained independently.

2.8. Power lines are made of metal, it expands and contracts when it is hot and cooled. The conductors may become hot from high ambient air temperatures and/or from excessive electrical load current passing through the conductors. Whatever the cause, any expansion will result in gravity causing the power lines to sag. Power lines can also swing from side to side due to wind. Due to this reason, hot zone limit must be increased either vertically or horizontally, depending on how much the conductor sags or swings.

2.9. There must be no simultaneous or overlapping of different jobs in hot zone.

2.10. Work shall not be performed in the following conditions at or near energized lines,

- At night time, (Night time work may be allowed only if the parallel circuit is de-energized and the following conditions are met, i.e. suitable weather, proper visibility, and wind speed below 32 km/h)
- In adverse weather, or rain
- A situation in which visibility is obscured.

- When wind speed above 32 km/hr. (20 mph, 17.4/knots, or 9 meters/second).
- Temperature above 45°C.
- Excessive outdoor humidity in direct sunlight (heat index more than 52°C)
  Heat index is calculated by using temperature and humidity together. There are four categories of heat index: Caution (26 to 32°C), Extreme Caution (33 to 39°C), Danger (40 to 51°C), and Extreme Danger (52°C or higher).

2.11. Only authorized, trained, experienced, and medically & physically fit employees/contractors shall enter in the hot zone with necessary level of personal protection (PPE) to perform specific maintenance task against approved "Permit to Work" under the continuous direction and supervision of the site job in-charge to monitor compliances with safe work procedures. Authorized employees/contractors shall have electrical knowledge and training to avoid electrical hazards associated with work on or near exposed energized live parts or conductor. Inexperience employees/contractors can work under the direct supervision of authorized employees/contractors, to gain the necessary training and experience.

2.12. Before working on live line or in electrically conductive/induced environment, conduct an exercise/drill with all involved parties for the job to test the preparation and to know the sequence of job steps. Execution of the actual job must be carried out by the same team.

2.13. The site job in-charge shall be available at all times to resolve differences in the work practices and opinions in order to ensure effective coordination at the work site.

2.14. Whenever live line work is performed on lines/circuit protected by automatic re-closing devices, the re-closing devices must be locked and tagged with normal locking and tagging (LOTO/Hold-Off) of the system before "Permit to Work" is issued, and they shall not be unlocked until the work is completed and "Permit to Work" is closed.

2.15. Ensure that all jobs are executed under safe and reliable condition and do not let any unauthorized worker/contractor/sub-contractor/daily wage employees to enter in the hot zone.

2.16. Identify and verify the exact location/correct circuit to be worked in the field by the site job in-charge before starting the job to avoid any contact with the energized line.

2.17. Those working on live line or near to it must give their full attention to the task in hand.

2.18. Co-workers should be informed when any employee change positions on poles/towers.

2.19. Suitable barriers shall be erected around the work area at ground level at minimum safe distance (safe zone) boundary from the monopole/tower/structure as per NEPRA Power Safety Code Section 7.21.7.

2.20. A staging area shall be established in the safe zone at upwind or crosswind direction, outside the barricaded area of hot zone for maintenance planning & operation, workers, their rest area and heavy equipment's parking.

2.21. In order to identify the safe zone boundary, warning tape and cones must be used at ground level when working near energized overhead power lines.

2.22. Employees shall not reach blindly into areas containing exposed electrical conductors or circuit parts where an electrical hazard exists.

2.23. When entering and working in hot zone, personal protective equipment must be worn.

2.24. A standby man shall be deployed in a safe zone who is trained and competent to perform his task. He must know emergency procedure and to control unauthorized visitors and vehicles into the restricted hot zone/barricaded area.

2.25. The standby man shall control and allow workers as per plan to enter the hot zone once the grounding system has been applied and all personal protective equipment has been worn.

2.26. A standby man shall have no other duties that could distract him from monitoring the work continuously.

2.27. In case of unsafe conditions, unsafe behavior of entrants, or any other situation that could endanger entrant's life, the standby man shall order them to evacuate the area.

2.28. Standby man shall remain at his post until relieved by a qualified replacement who is familiar with the job, or until all entrants have exited the hot zone. If he must leave the area and no other standby man is provided, all entrants must exit the hot zone.

2.29. Standby man shall request concerned supervisor for additional standby man, if required.

3. Personal Protective Equipment (PPE)

3.1. PPE for Live Line Work.

3.1.1. When working near or on live line/circuit, wires, cables and electrical equipment, electrical rated PPE shall be used all the time in hot zone to offer protection against electrical shocks.

3.1.2. When working on live line/circuit, wear conductive PPE such as conductive shoes, conductive socks, conductive gloves, conductive trousers, and conductive shirts. It is not recommended to use foot powder with protective conductive footwear since foot powder provides insulation and reduces their conductivity.

3.1.3. When working on live line, wear PVC coated Full Body Harness for fall protection along with double lanyard for 100% tie to be attached with strong point while climbing and working on the height more than 6 feet/1.8 meter above the ground or impact level.

3.2. PPE for Electrically Conductive/Induced Environment.

3.2.1. Wear high voltage insulated electrical rubber hand gloves and sleeves for the rated voltage for protection against electrical shocks or induced voltage. Discard electrical rubber hand gloves from service whose shelf life is expired. Electrical gloves are made of natural rubber, which is derived from the latex of plants. Natural rubber has a shelf life of three (3) to five (5) years, depending on the weather and the usage conditions.

3.2.2. Conduct periodic inspection and dielectric testing of insulated electrical rubber hand gloves. Rubber insulating gloves must be tested before first issue and every six months thereafter or when showing any signs of defects upon inspection. Write the date of next re-testing on the gloves pair with permanent marker. The "first issue" mean when the new gloves are removed from their original, manufacturer's packaging.

3.2.3. Insulating sleeves shall be worn with insulating gloves in case exposing the employee elbow and upper arm to contact with other energized parts.

3.2.4. Insulated Electrical Rubber Hand Gloves and Sleeves, Class 00 (Maximum AC 500V/DC 750V), 0 (Maximum AC 1000V/DC 1500V), 1 (Maximum AC 7500V/DC 11250V), 2 (Maximum AC 17000V/DC 25500V), 3 (Maximum AC 26500V/DC 39750V), 4 (Maximum AC 36000V/DC 54000V) for involved working voltage. Leather gloves shall be worn over insulated rubber gloves to provide the required mechanical protection. The gloves shall not be used when damp.

3.2.5. In electrically conductive/induced environment, wear PVC coated Full Body Harness for fall protection along with double lanyard for 100% tie to be attached

with strong point while climbing and working on the height more than 6 feet/1.8 meter above the ground or impact level.

3.2.6. When working in an electrically conductive/induced environment, wear high voltage insulated electrical (dielectric) safety shoes (non-metallic and non-magnetic) with titanium or composite toe for the rated voltage instead of normal safety shoes (steel toe) to avoid step potential hazards.

3.2.7. Do not use muddy shoes when climbing up, there is a risk of slipping.

3.2.8. When protection against arc flash is required as per risk assessment/JSA then use arc flash kit while working on high voltage at energized/live line more than 420V.

3.2.9. Rubber protective equipment shall be stored in approved protective bags in a cool, and dry location out of the sun. The items shall not be directly placed on the ground, as they must be kept free of dirt and moisture.

3.2.10. When high voltage protective rubber has been in service for a long time (such as overnight), it must not be expected to provide appropriate protection. Such items must be removed, inspected, and cleaned before being used again. If suspected, they must be sent for electrical tests.

3.2.11. Rubber gloves must not be worn inside out. They must not be worn without approved leather gloves. Leather gloves must never be used for any other purpose.

4. Tools

Tools for live line work or when working in electrically conductive/induced environment.

4.1. Use insulated live-line tools, platforms and equipment. Live-line tools could be made of fiberglass-reinforced plastic or appropriate material.

4.2. Live line tools and telescopic hot stick must be approved and tested according to the rated voltage of the line. Test dates must be clearly marked and never exceeded.

4.3. In hot zones or up monopole/tower/structure, metal rulers, measuring tapes, or wire reinforced fabric tapes must not be used.

4.4. To raise tools or materials for workers on monopole/tower/structure, an approved tool bag must be used. Tools must not be thrown to workers under any circumstances.

4.5. Under-rated tools or apparatus must not be used in the hot zone.

4.6. Use Ground-Fault Circuit Interrupters (GFCIs) in wet areas to prevent shocks at sites or while using portable electrical tools.

4.7. Employees/contractors must not touch live line tools or any conductive materials with bare hands in hot zone due to the presence of induced voltage in the area.

4.8. Drop toolkits shall be used to prevent tools from falling from a height. The standby man shall monitor and ensure that no one is underneath the worksite.

4.9. Each live line tool and piece of equipment must be inspected for mechanical and electrical strength and wiped clean before use.

4.10. All parties involved in working must understand the risks of falling/touching tools on live circuits and shall take appropriate precautions.

4.11. Live line tools shall not be used on energized lines or near energized lines, or on energized equipment unless workers have been properly trained to use such tools.

4.12. Workers in the basket must be protected from induced voltage by bonding those conductive platforms and associated equipment to the grounding conductors.

4.13. All rubber protective equipment, live line tools, and equipment shall be thoroughly inspected before each use and whenever damage is suspected. If any tools or equipment show signs of damage, they must be taken out from service and disposed of immediately.

4.14. In the hot zone, conductive items such as metallic coins, metal-framed glasses, jewelry, watches, watchbands, bracelets, rings, key chains, necklaces, metal headgear, metalized aprons, or cloth stitched with conductive thread shall not be worn or carried.

4.15. Ropes, slings, taglines, hand-lines and other tackle shall be of non-conductive material used at or near energized lines and equipment, and must not be used for any other purpose. It must be kept clean, dry, and free of foreign substances.

4.16. Rope conducts electricity when moist, which makes it extremely dangerous for live line work. If live line rope becomes damp, it must be uncoiled and allowed to dry for at least 48 hours.

4.17. Crane Lift Plan shall be prepared by an experienced, trained and authorized Crane Rigger and crane operation activity shall be supervised by the Crane Rigger against an approved Permit to Work. Warning signs shall be posted on cranes and heavy equipment regarding the minimum clearance.

4.18. In the hot zone, only authorized operators shall enter and operate certified insulated heavy equipment's, cranes, and aerial devices.

4.19. When a boom or load is within 20 feet of an energized circuit, the heavy equipment's, cranes, man lift and aerial devices must be grounded.

4.20. Ground workers must stay away from cranes, heavy equipment, and aerial devices that have booms or buckets in the vicinity of lines, or apparatus that could be energized due to induced voltage.

4.21. The ground workers who are required to approach heavy equipment, cranes, or aerial devices must use insulated electrical (dielectric) overshoes because they could be subjected to step potential during a fault.

4.22. Ground workers must communicate effectively with those in the bucket to ensure that ground workers are clear when work is performed in the hot zone.

5. Grounding and Bonding for De-energized Circuit/Lines

5.1. Electrical conductors which normally carry high voltage must not be touched unless they are rendered safe for work to be done on them.

5.2. The working circuit must be de-energized, OFF isolated, locked, tagged, and grounded by opening circuit breakers, isolators and closing the earthing switch at all ends of the connected grids. After this confirmation from the authorized personnel, the work can be performed.

5.3. The grounding or bonding will be placed at such locations so that each worker is protected from hazardous voltages.

5.4. Portable grounding leads, and clamps must be capable of conducting the maximum fault current possible at the work location for the duration needed to clear the fault.

5.5. De-energized lines and equipment must be treated as live in the absence of proper grounding.

5.6. The protective grounding system, which includes conductor ground and bonding leads, must be engineered to protect workers from hazardous voltages that can be created by line reenergizing, lightning, or induced voltage.

5.7. If more than one crew is working independently on the same de-energized line or circuit, each crew must have single-point protective grounds installed to create an equipotential zone at each work location.

5.8. Single-point grounding shall be applied because it generally yields the lowest potential difference in the work zone and because it usually requires less grounding equipment and effort to install. Single-point grounding involves installing one set of grounds at the work location between the conductors, the system neutral (if one exists), and the ground (which may be a tower or pole ground) to create a bonded work zone that will remain at a near identical state of electrical potential, hence the term "equipotential zone."

5.9. When applying single-point temporary grounding, first connect the ground clamp of grounding lead to monopole/tower/structure/stub, and then connect the contact clamp to isolated/de-energized line. While for removing temporary grounding, first remove the contact clamp from isolated/de-energized line and then remove the ground clamp from the monopole/tower/structure/stub.

5.10. Provide training to its employees and contractors on how to correctly install conductor grounds and bonding for the involved voltage rating to mitigate the electrical shocks.

5.11. When working on the de-energized lines near the energized line, test the line with a voltage detector and provide grounding sets of same voltage level.

5.12. Workers shall not start work until conductor grounding and bonding have been applied to protect the worker from energization of the line or monopole/tower/structure from induced voltage.

5.13. Grounding cables shall meet the requirements of the IEC 61230 Standard.

5.14. Hazardous induced voltage is present all the time around the de-energized line, monopole/tower/structure and at worker worksite even after installation of conductor grounds and bonding therefore the conductor grounding and bonding must be effective and intact while work is being performed to provide maximum protection to workers.

5.15. In any case, temporary grounding clamps must be secured and cannot be detached.

5.16. The temporary grounding must be short circuit proof and electrically connected to the work object.

5.17. Whenever two lines need to be connected to each other, temporary grounds shall be installed on each line section to drain inductions.

5.18. When equipment and conductors are grounded, currents related to induce voltage will circulate to ground. Installed grounding sets at different locations can create a hazardous condition, therefore they shall be barricaded to prevent step or touch potential.

6. Housekeeping

6.1. In the hot zone, employees/contractors shall not perform housekeeping near energized electrical conductors and circuit parts or where induced voltage can cause injury unless adequate safeguards are provided to prevent electrical shock.

6.2. In the hot zone, conductive cleaning products, such as steel wool, metalized cloth, and silicon carbide, as well as conductive liquid solutions shall not be used unless adequate safeguards are provided to prevent electrical shock.

7. Emergency Action Plan

Emergency Action Plan for live line work or when working in electrically conductive/induced environment.

7.1. Develop an emergency action plan based on risks identified in the risk assessment study/job safety analysis.

7.2. Trained First Aider(s) with first aid kit shall be available at all times in the safe zone to assist rescue efforts in the safe zone, when required.

7.3. No one shall respond to any incident unless he is trained and he has appropriate PPE for the incident.

7.4. If an abnormal condition is noticed or an emergency is announced, stop the assigned jobs in a safe manner and evacuate the hot zone. All employees and contractors in the hot zone shall report to a temporary assembly point and wait for further instructions.

7.5. When an overhead line falls or is contacted, take the following precautions,

7.5.1. Make sure everyone is at least 6.1 meters (20 feet) away from the fallen line.

7.5.2. Use flag man to protect motorists, spectators, and other individuals from fallen or low wires.

7.5.3. Place barriers around the emergency area.

7.5.4. Do not attempt to move the fallen line.

7.5.5. Do not touch anything that touches the fallen line.

7.5.6. Be alert to water or other conductors present.

7.6. If an individual becomes energized or receives an electrical shock, dedicated emergency responders shall use insulated electrical rescue hook to separate the victim from the electrical source and provide CPR, rescue breathing, or first aid immediately.

7.7. If an overhead conductor is contacted while operating vehicles or heavy equipment, stop the equipment immediately, it can cause an arc, smoke, or even a fire. Occupants shall remain in the vehicle or heavy equipment cab until the emergency responder breaks the electrical connection.

7.8. If it becomes necessary to exit the vehicle or heavy equipment, leap with both feet as far away from the vehicle as possible without touching it, maintain your balance, keep your feet together, and either shuffle or bunny hop away from the vehicle to 6.1 m (20 ft) or more.

7.9. Do not return to the vehicles or heavy equipment until the emergency responders have removed the conductor from the vehicles or equipment and confirmed the vehicle is no longer in contact with overhead lines or has no charge.

Note:

All of the above precautions are applicable when a new monopole/tower/structure is to be erected in hot zone along with an existing transmission line with in same corridor.

Communicate this clarification to all interested parties, including contractors and work permit issuers for their uniform understanding and implementation.