Hot Line Tags

Hot Line Tag Goal

- What are we trying to accomplish when applying a Hot Line Tag
  - Have the employee exposed to the lowest arc energy possible.
  - Keep arc flashes below Cat X to meet PPE worn.
  - Keep faults associated with employee work from faulting twice.
  - Minimize the impact of a HLT lockout on reliability.

- Utilities that change protection when an HLT applied all stated they make the trip as fast as possible.

What Is The Trained Response For Operators When a Devices Locks Out With HLT Applied?

After ensuring crew safety

1. Reclose the protective device
2. Wait X minutes for an analysis of “key” tickets then reclose if no exceptions are found.

   Looking for reports of car hit pole or cut cables
3. Patrol the line fully or a combination of patrolling and time-based analysis of “key” tickets then reclose if no exceptions are found

When a patrol is involved, the speed of the disconnection impacts how <u>often</u> outages occur and <u>where</u> the fault might be.

Pig skin hypothesis

Hypothesis

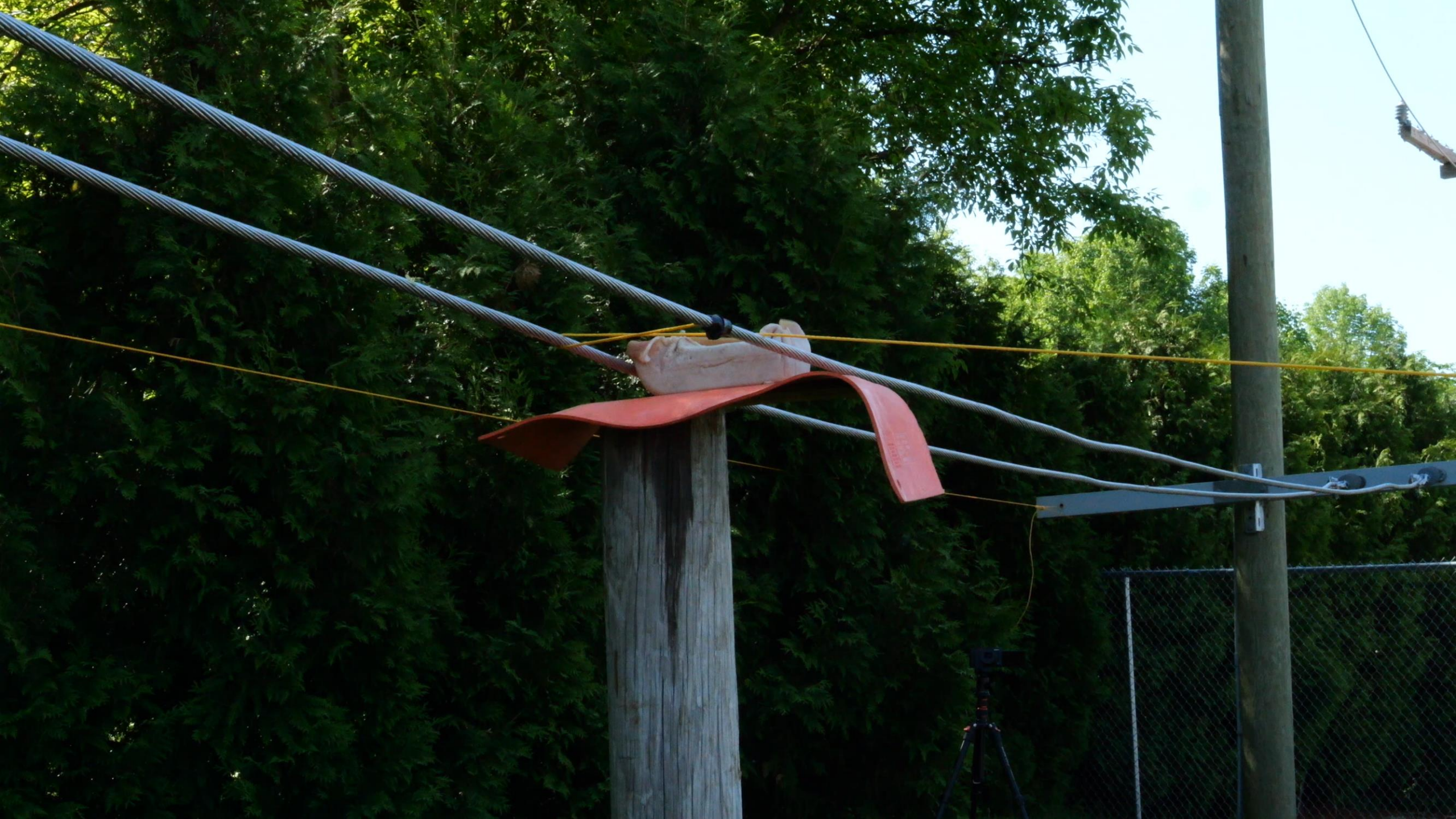
The fast settings being deployed during HLT does not provide the line worker with protection from an electrical contact event.

- Questions to answer
  - With the impedance of a human body, does the body experience a process of low current prior to faulting. (Does it fault in a similar fashion as vegetation)
  - Does the process change if the body is sweaty

Question to answer.
Limbs evolve into a fault.
Would human contact also evolve into a fault?

Planned testing

- Food grade pig skin was purchased and filled with ballistic gel.
  - The skin was to represent human skin
  - The ballistic gel represented internal organs / muscle.
- Three test were planned. All had instantaneous trip at the recloser (2 cycle)
  1. Temporary contact at 12 kV
  2. Spray the skin with Gatorade (sweat) and temporary contact with 12 kV
  3. Permanent contact with 12 kV (hold contact until arc occurs)



Testing results

- The skin was very moist / fatty. This contributed to its connectivity.
  - The food grade pig skin was previously blanched.
  - The prepared molds were wrapped in plastic wrap while kept in the refrigerator. This retained all their moisture.
- There were no burn marks on the skin after contact
  - The contact point nor the arc path had any physical damage
- Conclusion
  - This set up was not a good representation of a dry human contact.
  - The test sequence should be repeated with unblanched skin.

Can a fast setting minimize equipment damage from an arc?

Planned testing

- Create an arc at a set of line hoses with a slow trip setting
  - The line hoses prevent the arc from traveling
  - Does the arc damage the conductor.

Arc at line hoses

Testing results

- The conductor was seriously damaged but remained in the air
- Conclusion – Since arcs created within the work area will often be limited from moving by the application of cover up, a fast trip lessens equipment damage including the potential to sever the conductor.

Impact of HLT Delays to coordinate with fuses

Delay added (cycles)

	1 kA	2 kA	4 kA
25K	1.8	1.1	0.8
65K	8.9	2.7	1.3
65T	22.2	6.6	2.3
140K	103.8	15.6	3.6
140T	177.0	36.0	10.2

Per unit energy relative to no delay

	1 kA	2 kA	4 kA
25K	1.3	1.2	1.1
65K	2.5	1.5	1.2
65T	4.7	2.1	1.4
140K	18.3	3.6	1.6
140T	30.5	7.0	2.7

Is the increase in arc energy associated with coordinating with transformer fuses small enough to warrant adding trip delays so that an animal contact on fused equipment, which is assumed to be the primary cause of most HLT lockouts, does not create a lockout with an HLT applied.

- Would fewer lockouts support a more conservative response to an HLT lockout such as requiring a patrol or additional analysis.