Arc-Flash Explosion Injury Investigation

Expert Article

Workers and electricians involved in electrical upgrades or installations near live switchgear at construction sites must remain alert to the potential hazards of Electric-Arc Flash Explosion.

According to the Occupational Safety and Health Administration (OSHA) an electric arc is a type of electrical explosion. The electric arc produces a bright flash of hot gas, where temperatures can exceed 35,000 °F (19,400 °C), nearly four times the heat of the sun's surface. The energy released in the arc rapidly heats and vaporizes the metal conducting the electricity, producing an explosive arc blast resulting in deafening noises, supersonic concussive forces, and super-heated shrapnel.

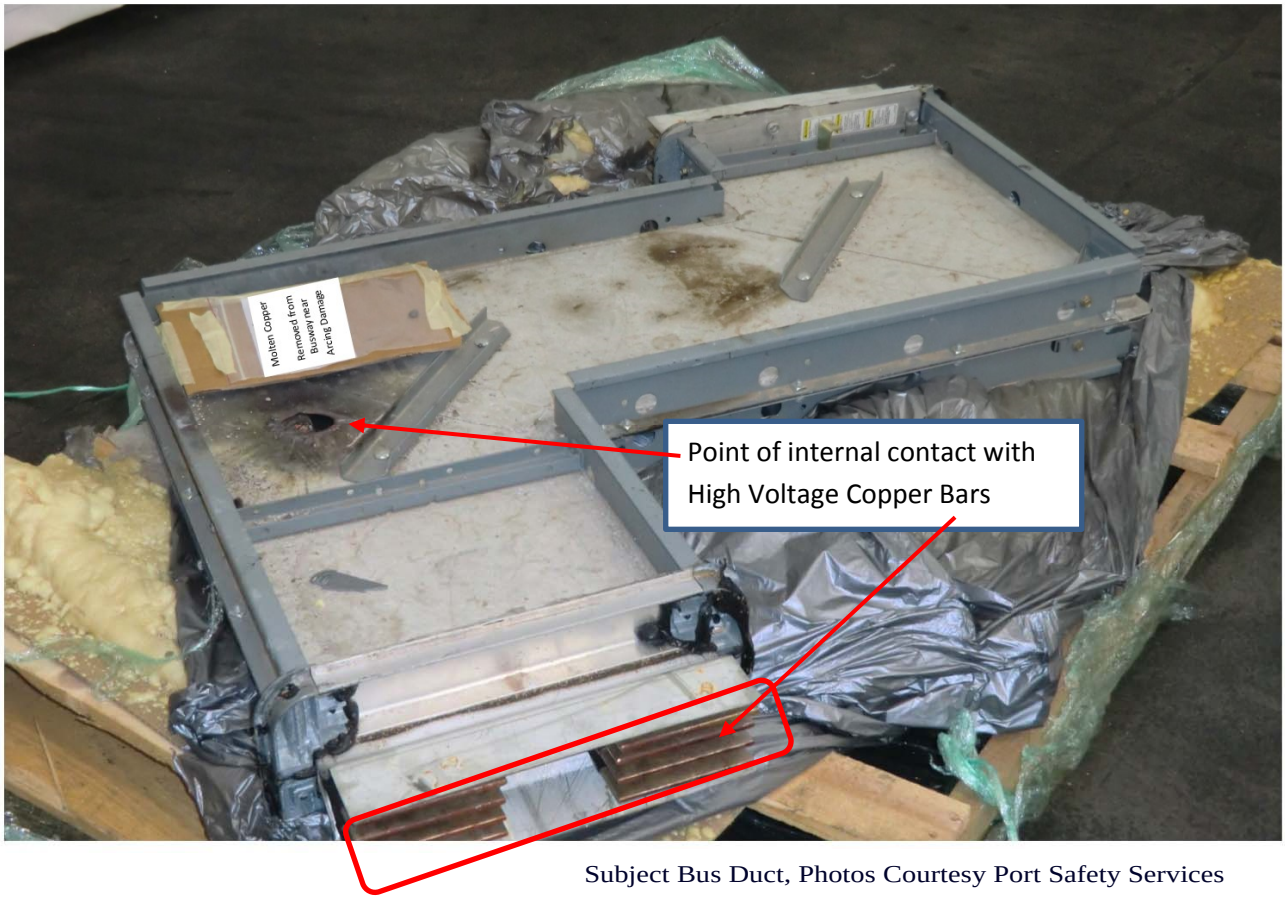
Construction Arc Flash Explosion Injury Expert Investigation

In July of 2022, a plumber was working inside an outdoor mechanical

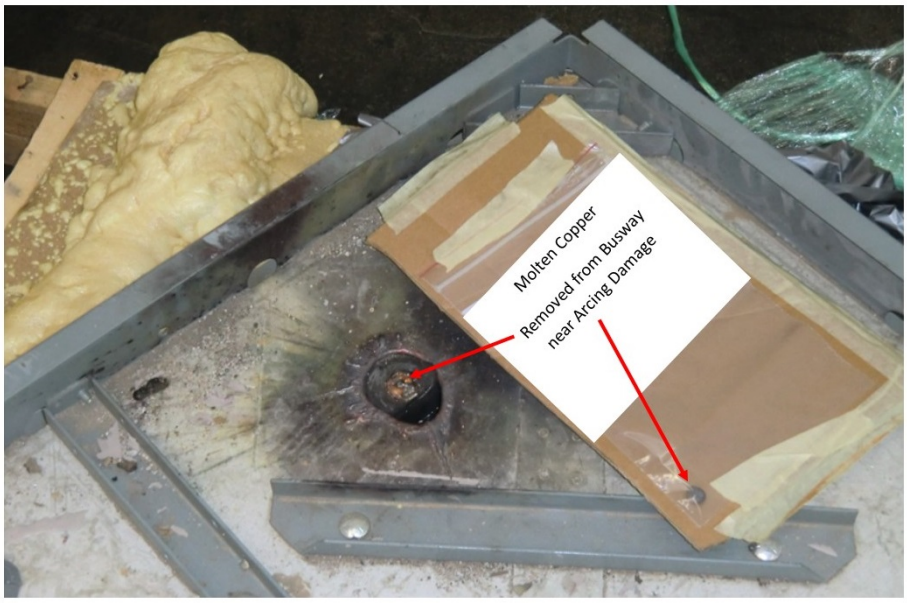
equipment yard, where high volt electrical switchgear was installed, serving a new office building and clinic, currently under construction. For security reasons, contractor tools and plumbing materials had been stored within the locked mechanical room. On the morning of the incident, a plumber was tasked with drilling holes into metal components, using a portable impact driver.

As he gathered his materials to begin work in the mechanical room, he failed to carefully survey the area for potential hazards. In searching for a suitable location to support drilling, he unknowingly placed his metal workpiece directly onto a high voltage horizontal bus duct.

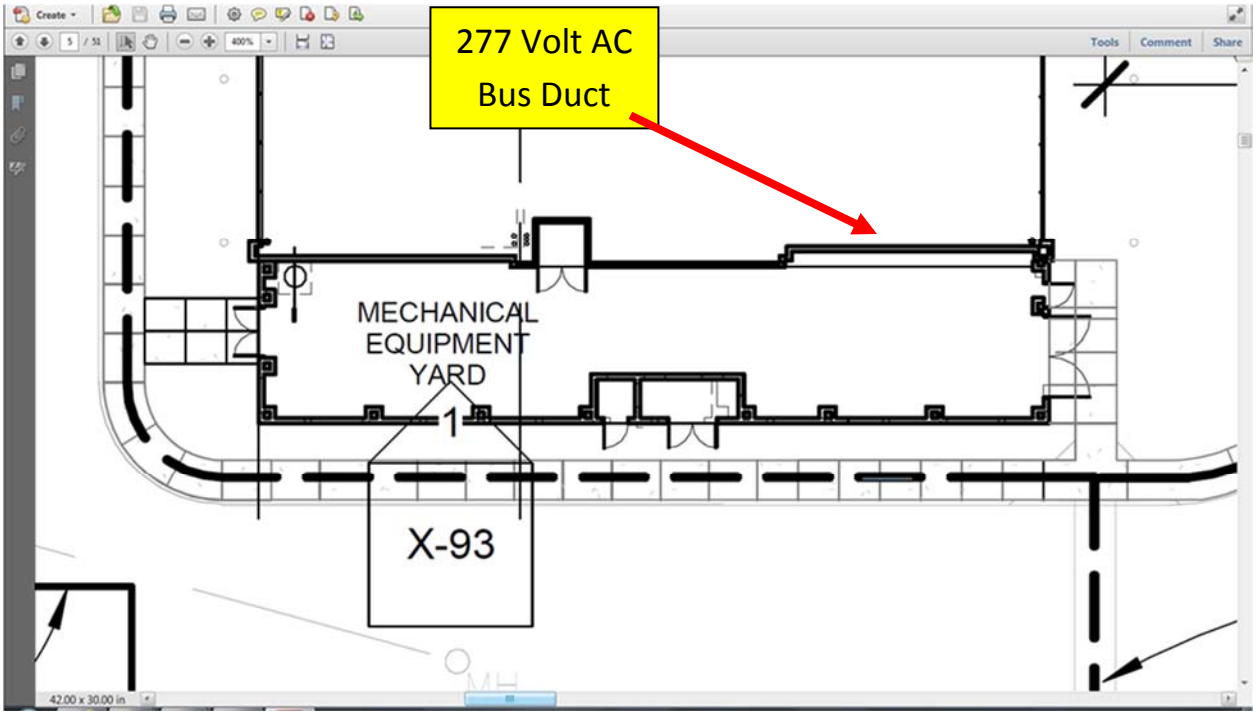
Assuming it would be ok to use the duck bus as a temporary work bench, he set up his tools and began drilling into a metal bracket. Suddenly he pierced through the aluminum sheet metal cover of the bus duct (below the workpiece), penetrating directly into 277 volt copper bars within the energized unit, as an arc flash explosion occurred.



Subject Bus Duct, Photos Courtesy Port Safety Services

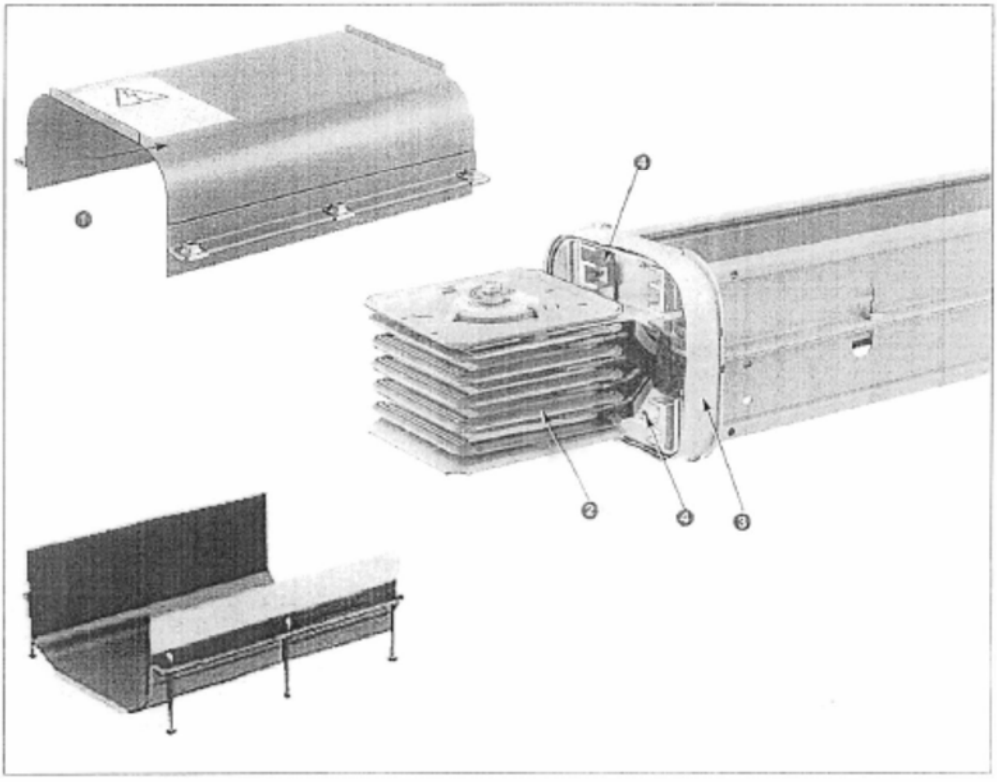


Penetration via impact drill
into a 277 Volt AC Bus Duct



Busway Systems
Construction

Outdoor Feeder Busway 800A–5000 A



Incident Investigation

Investigation revealed that the plumber failed to identify hazardous electrical energy within the subject mechanical room. In addition, the victim's burns and associated injuries were directly related to his failure to secure a legitimate and safe drilling bench.

Analysis of onsite photos of the injury incident discovered that the victim failed to locate a safe and suitable work station for drilling metal work pieces. Due to the victim's negligence the explosion injury forcefully expulsed molten copper and metal into the air surrounding the victim, impacting the worker causing serious third degree burns to his face, arms, and hands. The worker's unsafe action was a violation of established safety rules, and deemed to be the principal cause of injury.

Findings from our Expert Witness Investigation

In summary, this arc-flash incident was caused by work being performed on top of the subject bus duct. The arc-flash was caused by penetration of the bus duct (aluminum sheet metal cover, and the bus bar insulation) by a metal object, such as a drill bit or a tech screw, that made electrical contact between the grounded cover and the subject bus bar at 277V. Fault current melted the penetrating metal, which caused the short circuit and arcing current in excess of 10,000 A. Both the aluminum cover and copper bus were melted and vaporized by the heat of the arcing current. The impact driver socket and chuck were both melted by the intense heat of the arcing current because they were immediately above and centered over it when the arcing started. Damage to the body of the impact driver was less because it was further away from the point of arcing.

Copper was expulsed from the region of arcing and entered the spinning impact driver socket causing it to solidify on the outer surfaces of the internal socket walls. The victim sustained burns and the severity of the sustained burns also varied as a function of distance from the point of arcing.

Signature and PE / CSP Stamp

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Forensic Casework Involving Construction at Maritime Ports

Port Safety Services by SAFETRAN has the professionals and experience of in-house expertise to investigate a broad range of issues involving workplace injury and wrongful death. Our experts have investigated cases involving mechanical equipment explosion, toxic and hazardous materials, material handling, forklift and trucking injury that impact the lives and safety of workers involved in maritime shipping operations.

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Featured Expert Witness

Daniel J. O'Connell, CSP, CHMM is a Board Certified Safety Professional approved in state and federal court as a testifying expert witness. O'Connell served previously as a longshoreman, crane operator, and teamster. His extensive firsthand experience as a safety consultant to industry, and instructor of workers and employees for over three decades.

Date
April 5, 2025

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References

Cal/OSHA Guide to Electrical Safety
https://www.dir.ca.gov/dosh/dosh_publications/Electrical_Safety.pdf

Cal/OSHA's Electric Power Interruptions and Employee Safety
http://www.dir.ca.gov/dosh/dosh_publications/epies.pdf

Center of Excellence for Electrical Safety
http://www.lanl.gov/safety/electrical/resources.shtml

NIOSH, Arc Flash Awareness http://www.cdc.gov/niosh/mining/products/pdfs/afa.pdf

NIOSH, "Preventing Worker Deaths from Uncontrolled Release of Electrical, Mechanical, and Other Types of Hazardous Energy" http://www.cdc.gov/niosh/docs/99-110/pdfs/99-110.pdf

OSHA Quick Cards - Electrical Safety http://www.osha.gov/Publications/electrical_safety.html

OSHA Construction eTool – Electrical Incidents
http://www.osha.gov/SLTC/etools/construction/electrical_incidents/mainpage.html

OSHA Health and Safety Topics – Electrical http://www.osha.gov/SLTC/electrical/index.html

NFPA 70E REFERENCES
https://www.nfpa.org/codes-and-standards/nfpa-70e-standard-development/70e

§110.5(A)(1)(a) Host Employer Responsibilities.

Article 100, Qualified and Unqualified Person Definition.

Article 350, Safety-Related Work Requirements, Competent Person Definition

§110.6(A), 110.6(D). Safety Training Requirements

§110.7(A) Electrical Safety Program

§110.8(A) Working While Exposed to Electrical Hazards.

§110.8(B) Working Within the Limited Approach Boundary

§130.1(A) Justification for Work.

§130.3, Arc Flash Hazard Analysis

§130.2(D) Approach by Unqualified Persons.

§100, Definitions, Electrically Safe Work Condition.

§130.3(A)(2)(B), Voltage Levels Above 600 Volts, Protective Clothing and PPE

§130.6(E)(1) Other Precautions

§130.6(E)(2) Approach to Energized Electrical Conductors and Circuit

§130.7(5) Body Protection

§130.7(6)(B) Arc Flash Protection

§130.7(16)(D)(e) Other Protective Equipment

§130.7(E)(3) Attendants to warn and protect employees

§130.7(16)(D)(f) Protective Shields

§130.7(16)(E)(1) Alerting Techniques

§130.7(16)(E)(2) Barricades

§210.1 Enclosures

§210.2 Area Enclosures

(Annex J) Energized Electrical Work Permit

(Annex O) Safety-Related Design Requirements