

Incident Summary #II-1215144-2021 (#22593) (FINAL)

SUPPORTING INFORMATION	Incident Date		June 24, 2021	
	Location		Abbotsford, British Columbia	
	Regulated industry sector		Electrical - Low voltage electrical system (30V to 750V)	
	Impact	Injury	Qty injuries	1
			Injury description	First degree burns to face and blurred vision.
		Damage	Injury rating	Major
	Damage description		A six position meter stack sustained melting and smoke damage to all three phases of bussing and the walls of the cabinet. All three phase bus bars melted through over a distance of approximately 2 inches.	
	Damage rating	Moderate		
Incident rating		Major		
Incident overview		An arc flash occurred on an energized 208 volt, 3 phase meter stack in the electrical room of an apartment building while an electrician was replacing a circuit breaker that fed power to one of the units. An abnormal arcing fault resulted in the arc flash, which burned the electrician and travelled up the meter stack ultimately melting through all 3 bus bars.		
INVESTIGATION CONCLUSIONS	Site, system and components		The apartment building has a 208 volt, 600 amp, 3 phase service fed from three 50 kVA pole mounted utility transformers. The service terminates at a 600 amp, 3 phase fused main disconnect switch in a restricted access electrical room. This disconnect switch can be shut off and locked out to ensure all other equipment in the electrical room is de-energized. The fuses are of the standard 10kA interrupt rating, non-time delay type and are intended to open in the event of a fault.	
			The 600 amp main disconnect is connected to 600 amp rated feed through meter stack termination boxes. The termination boxes supply 14 side-by-side 6 position meter stacks that feed the individual apartment units and a 400 amp rated disconnect switch for the common area loads for the apartment building. This means that shutting off the main disconnect switch to de-energize the meter stacks will also turn off all common area loads in the building.	
			The meters for each individual apartment are contained in the meter stacks, which are totally enclosed by protective covers to stop persons from contacting energized equipment and to contain potential fault energy. Each meter is protected by a two pole 60 amp circuit breaker in the meter stack, which protects against overload and overcurrent conditions in the feed to the individual apartment and can be used to de-energize that feed as well as the meter enclosure.	
			There are two metal brackets that connect each circuit breaker to the bus bars in the meter stack. These result in a much smaller air gap between two of the three phases than in the rest of the equipment. There is a plastic insulating barrier installed at these locations to prevent arcing between the conductive bus bars.	

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Failure scenario(s)	A 60 amp breaker in a meter stack had been reported to be tripping frequently at loads far less than it's rated capacity and an electrician with 25 years of experience was called in to replace the breaker. The electrician did not de-energize the meter stack where the breaker was located before commencing work. The old breaker was removed, and while the new breaker was being installed the plastic insulator between the two bus bars was broken off. This allowed the metal connection tab on the breaker to make contact with two of the energized bus bars, which resulted in a 208 volt line to line abnormal arcing fault. The abnormal arcing fault was large enough to arc to the third bus in the meter stack and an arc flash occurred. As the arc flash developed, the surrounding air was ionized, and this ionized air moved up the enclosed portion of the meter stack until the energy reached a point where the short circuit was conducting between all three bus bars (2 meter spaces above the initial fault) and melted them entirely. This molten metal was sprayed throughout the inside of the meter stack. The electrician was positioned directly in front of the open section of the meter stack where the fault occurred, which resulted in him being burned by the arc flash. The arc continued until one of the fuses in the main disconnect opened and /or the space between the melting parts was too large to maintain the arc.
Facts and evidence	-Statement from the electrician that was injured that they were changing a breaker in the damaged meter stack (SEE FIGURE #1), and that they had not shut off the main disconnect. -Statement from the electrician that they had performed the same removal and replacement procedure without incident two days prior. -Statement from the electrician that they heard a boom and saw a large flash while attempting to push the breaker into the bus bars, and that no tools were being used at that moment. -Statement from WorksafeBC that the only personal protective equipment (PPE) in use by the electrician was a medical mask and standard work gloves. -Statements from witnesses on site that the electrician had char marks on his face, that the chest area of his shirt was black, and that his eyes were very red immediately after the incident. -Statements from witnesses that there was smoke in the corridor outside the electrical room and a burning odour, but no signs of fire. -The plastic insulator between breaker connection points on bus bars was broken off, and part of it was found on the floor. SEE FIGURE #4. -The bolt-on connection terminals of the breaker were visibly melted. SEE FIGURE #3. -The breaker connection points on the bus bars were significantly melted. One of them melted completely through at a bolt hole, and the remaining piece was found on the floor. SEE FIGURE #2 and #4. -All three bus bars were melted through at two meter positions above where the breaker was being replaced. SEE FIGURE #5 and #6.

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	-Holes were melted in the sides of the meter stack cabinet (SEE FIGURE #5) at the location where the bus bars melted through, indicating that the arc flash conducted to the grounded metal enclosure as well as the bus bars. -Molten metal droplets were found throughout the meter stack. -The interior side of the protective covers above the position where the breaker was being changed were found to be black with smoke damage. The protective cover for the position where the breaker was being changed was clean, indicating it was not in position when the incident occurred. SEE FIGURE #1. -Arc flashes can occur when an electrical connection is made through the air between two phases of an electrical system. The energy involved in the arc flash is dependant on the voltage and current available as well as the time it takes the overcurrent protection to clear the fault. -The Canadian Electrical Code and regulatory requirements stipulate that no repairs or alterations should be carried out on live equipment except where disconnection of the equipment is not feasible. Technical Safety BC also has a directive and information bulletin regarding requirements to not work on energized equipment that can be found at the links below: https://www.technicalsafetybc.ca/alerts/directive-bc-electrical-code-section-2-general-rules https://www.technicalsafetybc.ca/alerts/information-bulletin-section-2-requirements-de-energize-electrical-equipment - The Technical Safety BC information bulletin also references the WorksafeBC requirements for working on energized equipment, under which the preferred method is also de-energization.
Causes and contributing factors	The cause of the incident was that an electrician attempted to remove and replace a circuit breaker in an energized meter stack without de-energizing the equipment first. The insulator between bus bars being broken off during the work is very likely a contributing factor. The fact that no shock and arc flash PPE was worn was also a contributing factor to the injuries sustained by the worker.

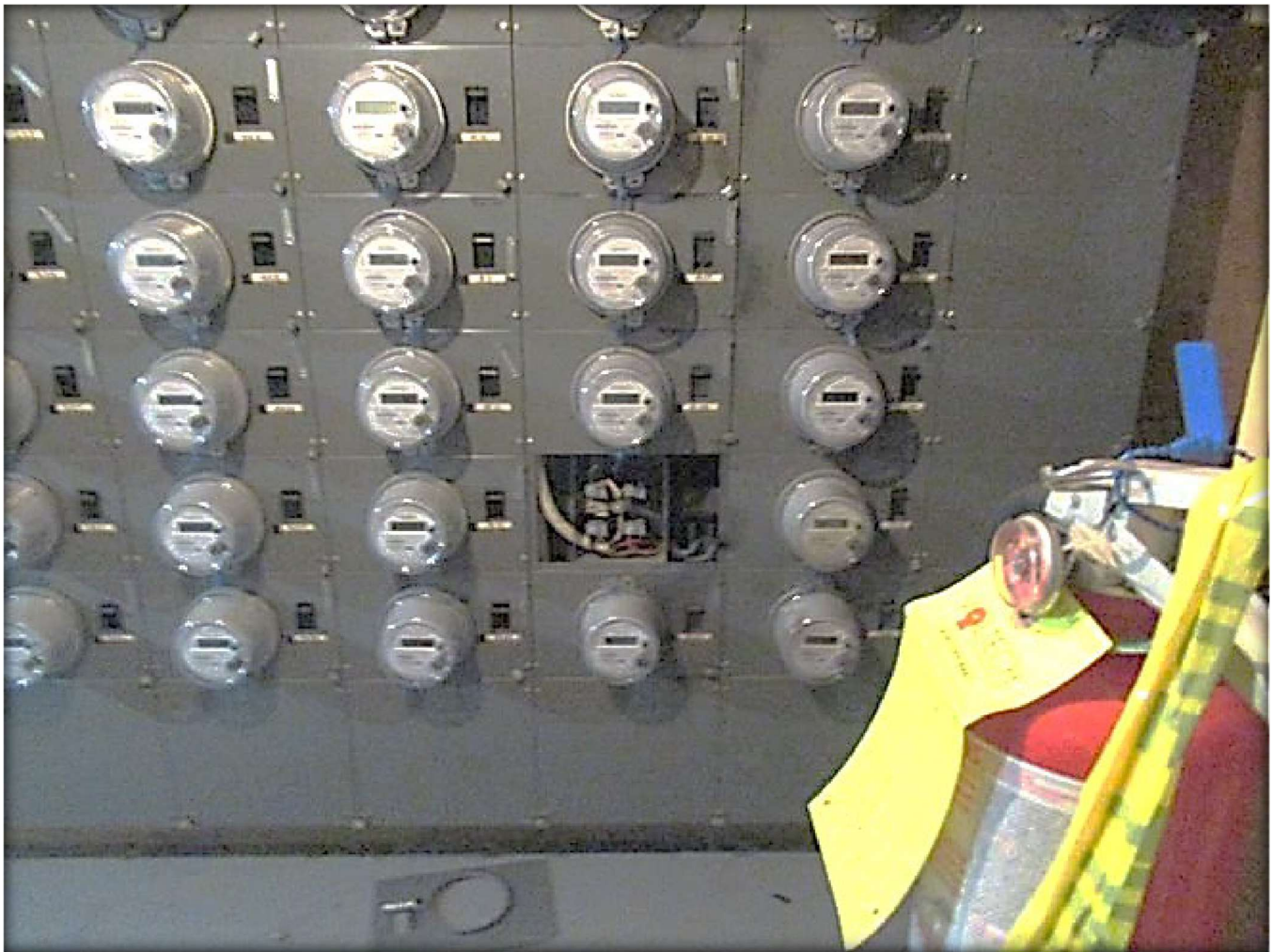


Figure 1 - Meter stack post incident with open cover where breaker was being changed while energized.

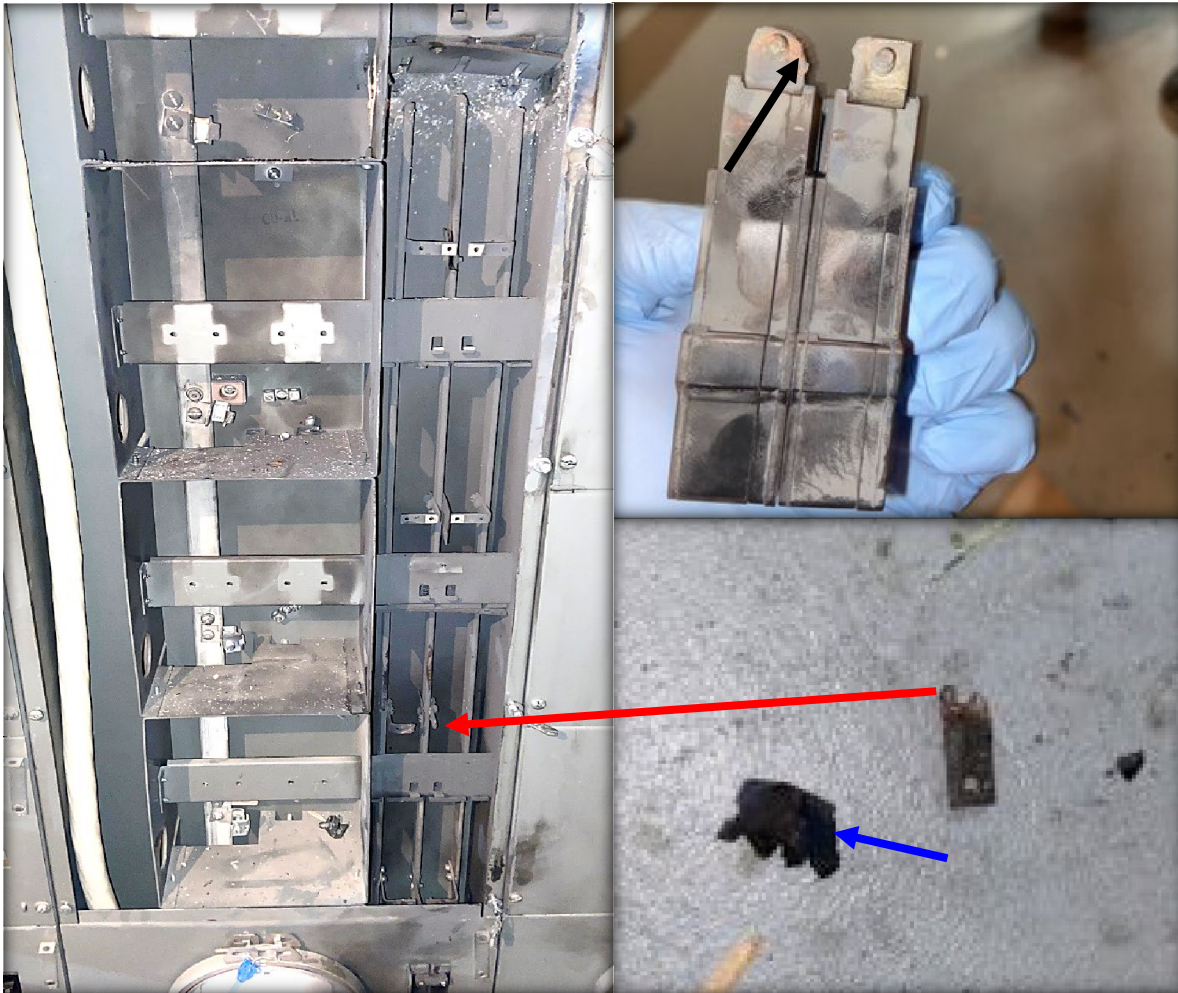


Figure 2 (left side) - Meter stack with metal breaker attachment bracket broken off and on the ground. (red arrow)

Figure 3 (top right) - Metal tabs of the circuit breaker melted (black arrow)

Figure 4 (bottom right) - Piece of broken breaker insulation (blue arrow), piece of melted bus bar connection tab (red arrow)

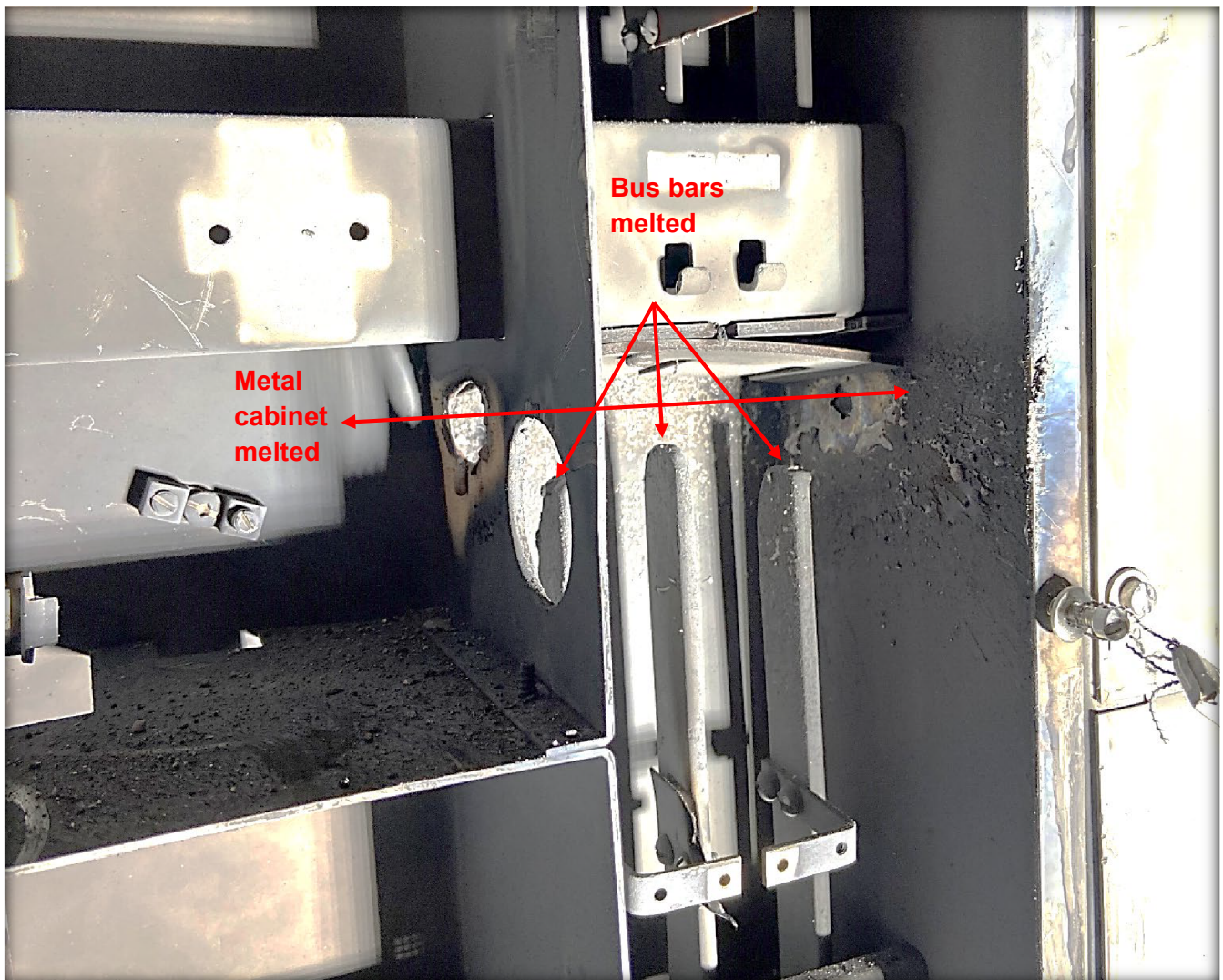


Figure 5 - Bus bars and metal cabinet melted from the arc flash event.



Figure 6 – Close up of bus bars and metal enclosure melted from the arc flash event.

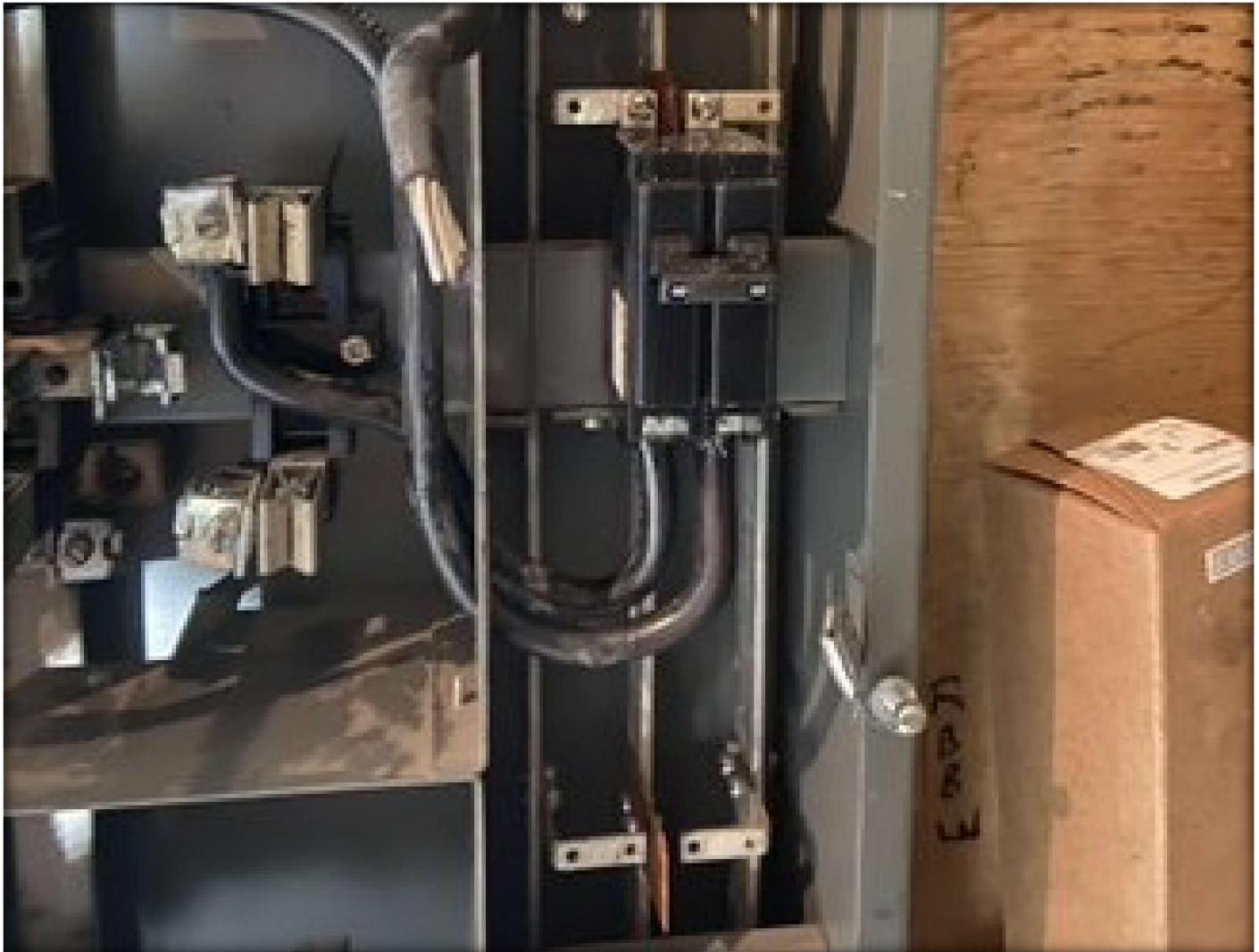


Figure 7 – Normal breaker installation with all components intact.