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About Contact Arc Initiations

No Inductance-In-The-Loop Required!

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The Two Contact Arc Initiation Mechanisms

The Wet Power Contact Cycle (**Wet PCC**) contains two (2) distinct forms of arcing, each defined by its respective arc initiation mechanism (note that arc initiation is not the same as plasma ignition; i.e., arcs initiate before their plasmas ignite). The two types of contact arc initiation mechanisms are:

1. The **Thermionic-Emission-Initiated-Arc (T-Arc)** is born out of Current and initiates around $\mathbf{V_{(T\text{-}Arc\_init\_min)}}$, and the **T-Arc** plasma is maintained at or above the minimum-arc-current of $\mathbf{I_{(arc\_plasma\_min)}}$.
2. The **Electron Field-Emission-Initiated-Arc (F-Arc)** is born out of Voltage and initiates around $\mathbf{V_{(F\text{-}Arc\_init\_min)}}$, and the **F-Arc** plasma is maintained at or above the minimum-arc-current of $\mathbf{I_{(arc\_plasma\_min)}}$.

Both **T-Arcs** and **F-Arcs** require the combination of a minimum arc-initiation-voltage and a minimum arc-plasma-supporting-current of 300mA to 1000mA. We refer to these current and voltage combinations as the respective **T-Arc** Domain and **F-Arc** Domain (fig. I).

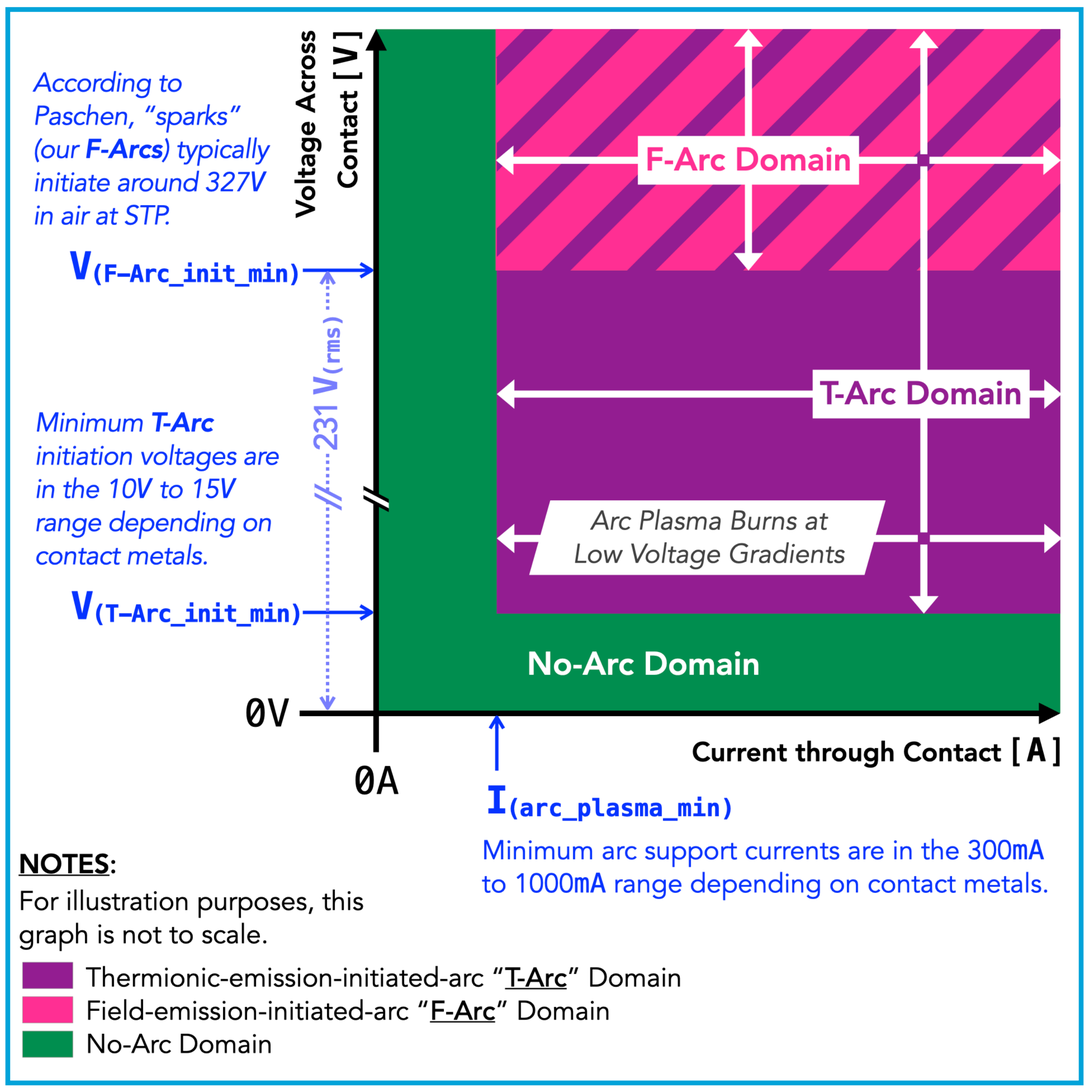

Figure I: *The Domains of Existence for T-Arcs and F-Arcs*

Arcing Initiated During Contact *MAKE*

During contact MAKE, when (in general) operating voltages are more than $231V_{RMS}$ (327V spark potential), **F-Arc** initiation occurs as the moving electrode nears the stationary electrode. Then the *MAKE* **F-Arc** plasma ignites and is promptly extinguished at the instant of contact impact.

This initial impact results in a series of plasma pressure amplified *MAKE* bounces, with each bounce yielding a **T-Arc**. These bounces continue until the contact is µ-welded in the CLOSED position (ref. 2, fig. II).

About Paschen's Law

Friedrich Paschen's research was conducted using non-moving metal-plate electrodes. Therefore, our reference to this "law" for $\mathbf{V_{(F\text{-}Arc\_init\_min)}}$*, aka "spark potential," serves only as a general guideline as Power Contacts are neither isotropic nor homogeneous after first use.*

Arcing Initiated During Contact *BREAK*

The *"BREAK* Arc" is comprised of an initial *BREAK* **T-Arc** that may be extended by a series of *BREAK* **F-arcs**. The initial *BREAK* **T-Arc** is created after the explosion of the super-heated molten-metal bridge that had been carrying current as the contact begins to open. As the *BREAK* **T-Arc** plasma extinguishes and current is interrupted, inductance in the loop extends the duration of the "*BREAK* Arc" by initiating a series of *BREAK* **F-Arcs** which continue until the contact gap widens beyond the thermodynamic ability to support the burning plasma (ref. 2, fig. III).

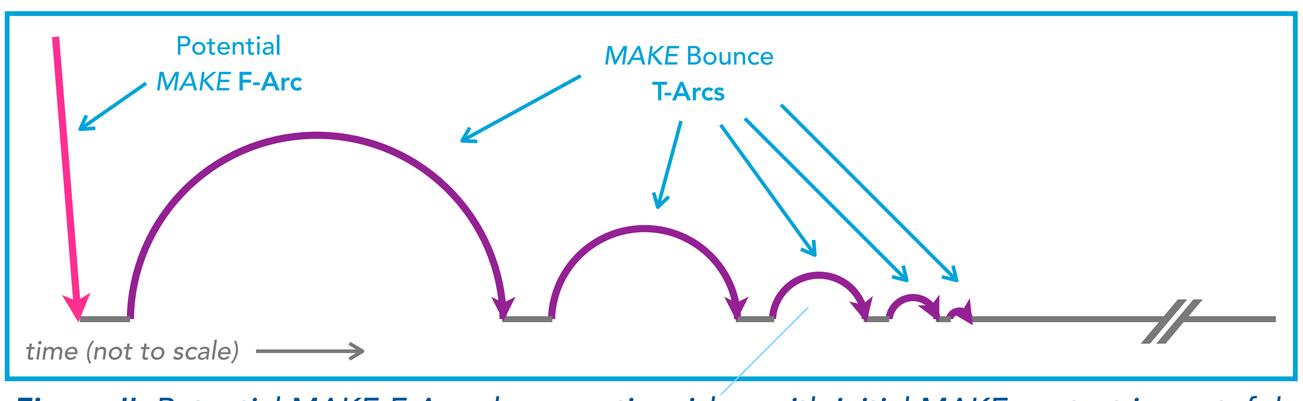

Figure II: *Potential MAKE F-Arc plasma extinguishes with initial MAKE contact impact, followed by a series of MAKE-bounce-T-Arcs.*

No Inductance In The Loop Required

Note that *BREAK* **F-Arcs** are the *ONLY* electrical power contact arc *REQUIRING* inductance for initiation. Inductance in the loop causes a response of high EMF counter potential $(EMF = -L * (dI/dt))$.

A "Suppression" Opportunity for MOVs

While an MOV (or other over-voltage limiter) is not an actual Electronic Power Contact Arc Suppressor (EPCAS) (ref.3), it can play a role in extinguishing BREAK **F-Arcs***. Over-voltage limiters clamp the inductive EMF counter potential to a maximum limit, thus limiting the tail-end of the "BREAK Arc.*

"BREAK Arc" = "BREAK **T-Arc**" + "BREAK **F-Arcs**"

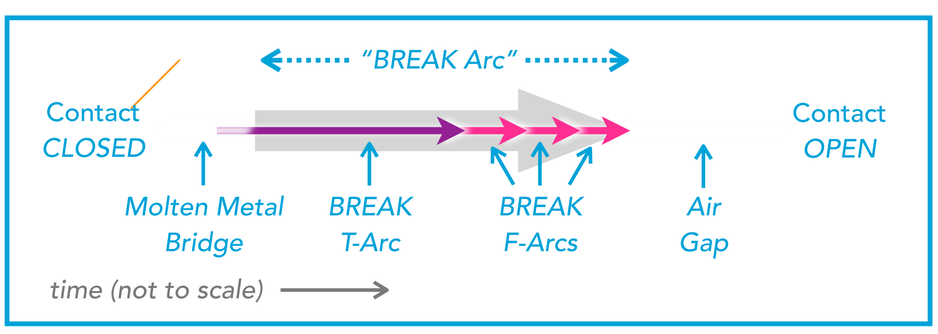

Figure III: *"BREAK Arc" is initially comprised of the BREAK T-Arc, and then extended by from one to possibly thousands of BREAK F-Arcs until contact comes to rest in* OPEN *state.*

Why Arc Initiation Mechanisms Matter

It is important to realize and account for whether a contact arc is initiated by thermionic-emission (**T-Arc**) or by electron field-emission (**F-Arc**). This insight yields the ability to appreciate the difference and value of the two plasma phases (metallic & gaseous) for Electronic Power Contact Arc Suppression (**EPCAS**), as well as contact cleaning and restoration (ref. 4).

References:
1. M.Atalla, Mechanisms of the initiation of the short Arc, 1954
2. R.Henke and R.P.Thorbus, "The Wet Power Contact Cycle," 2021
3. R.Henke and R.P.Thorbus, "The EPCAS Cycle," 2021
4. R.Henke and R.P.Thorbus, "Power Contact Cleaning and Restoration," 2021