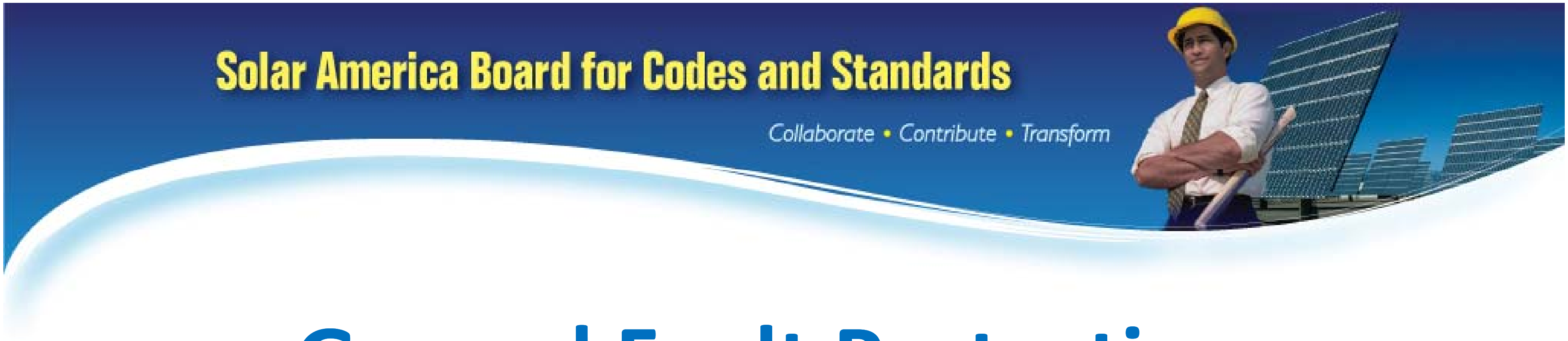


Ground Fault Protection Improvements to Prevent Fires

Description of problem and potential solutions

Presented by
Bill Brooks, Brooks Engineering

Ground-Fault Protection Blindspot

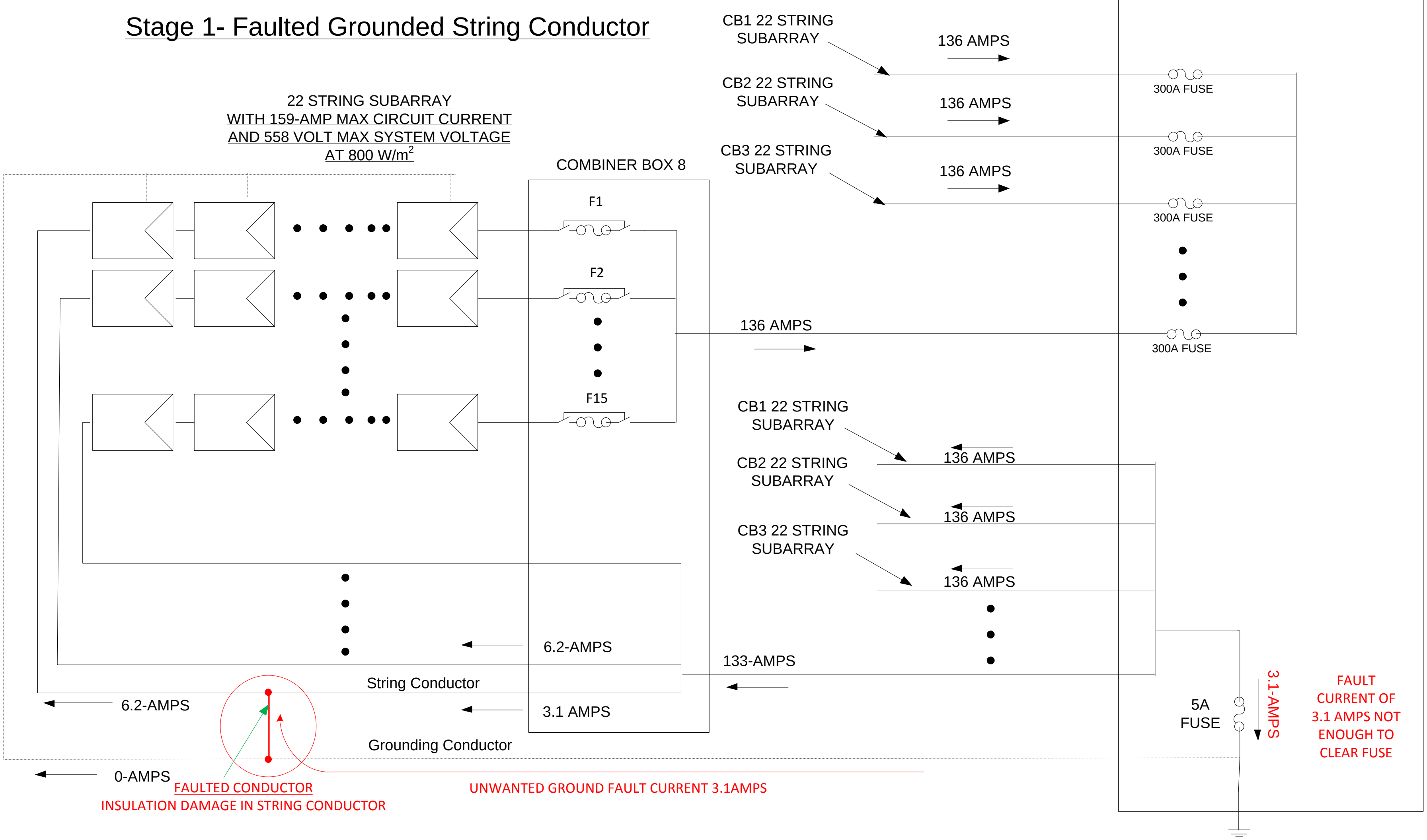
Recent fires on large PV Systems have had similar origins

- April 5, 2008 – Bakersfield, California
- April 16, 2011 – Mount Holly, North Carolina
- May be others (several)

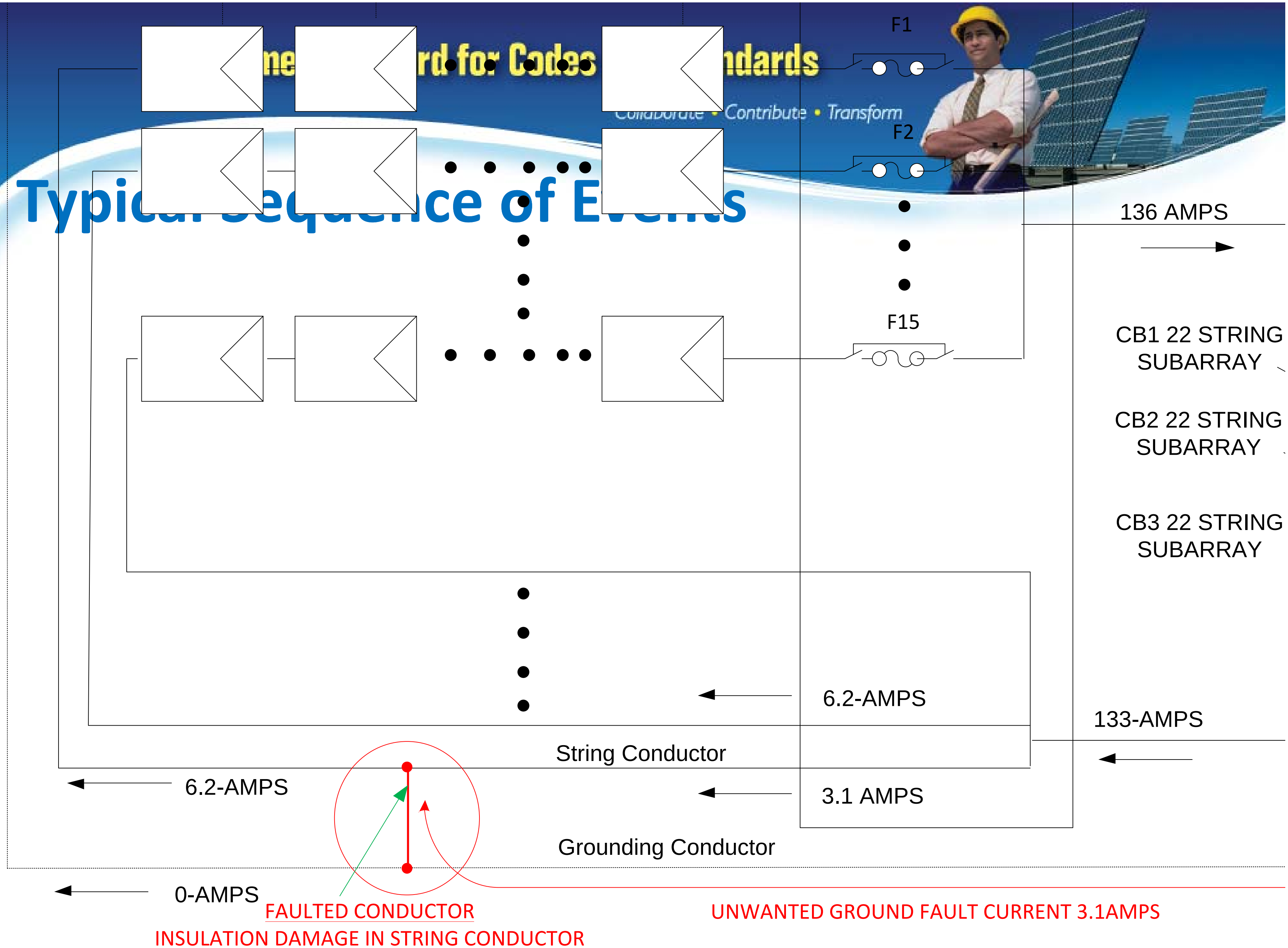
Common Elements in Fires

- Undetected fault in a grounded conductor that can continue indefinitely. Undetected fault becomes new “normal” and the ground fault fuse does not blow.
- Ungrounded conductor fault occurs some time after grounded conductor fault. This fault blows the ground fault fuse but instead of interrupting the fault, short circuit current persists in the array.

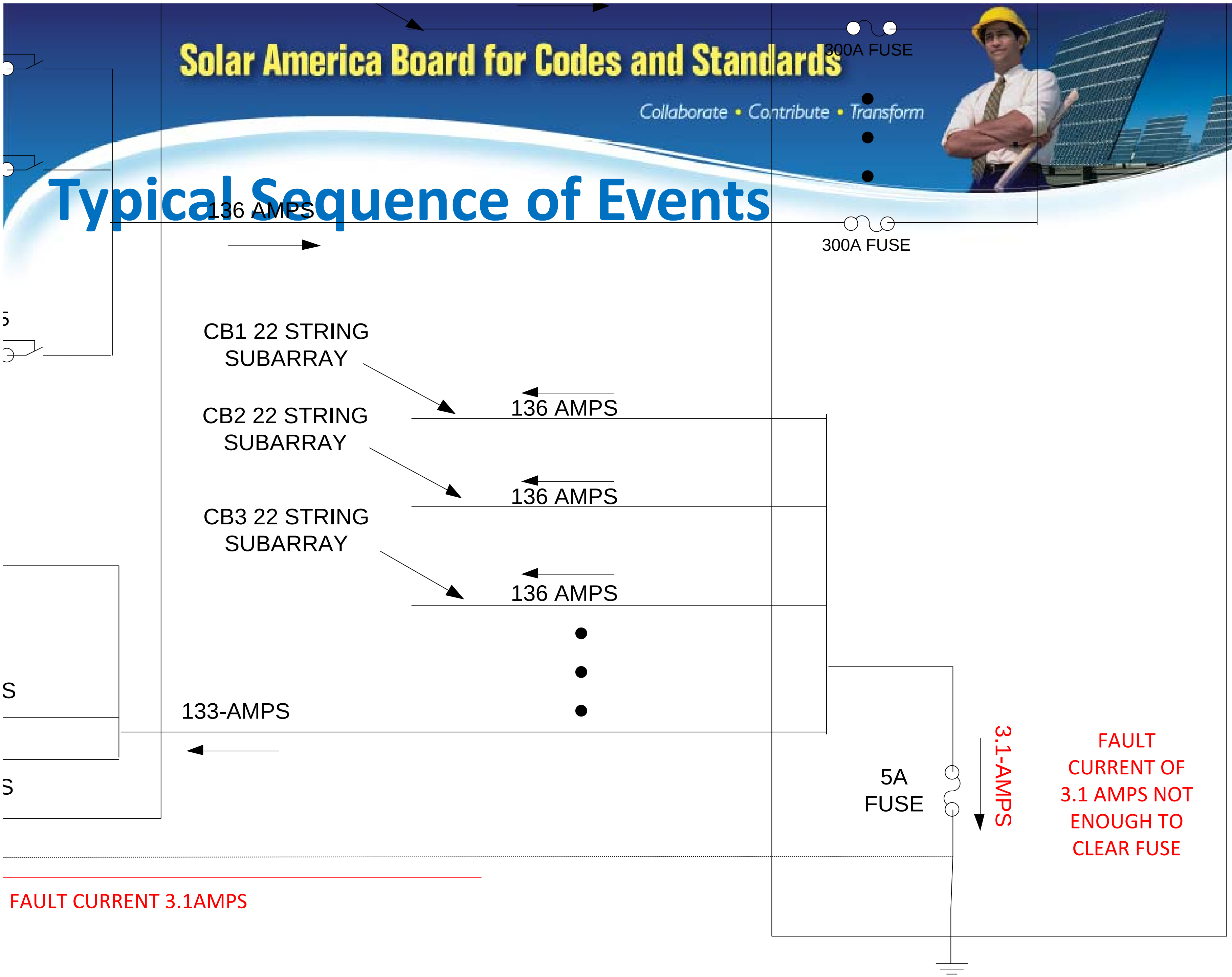
Typical Sequence of Events



Typical Sequence of Events

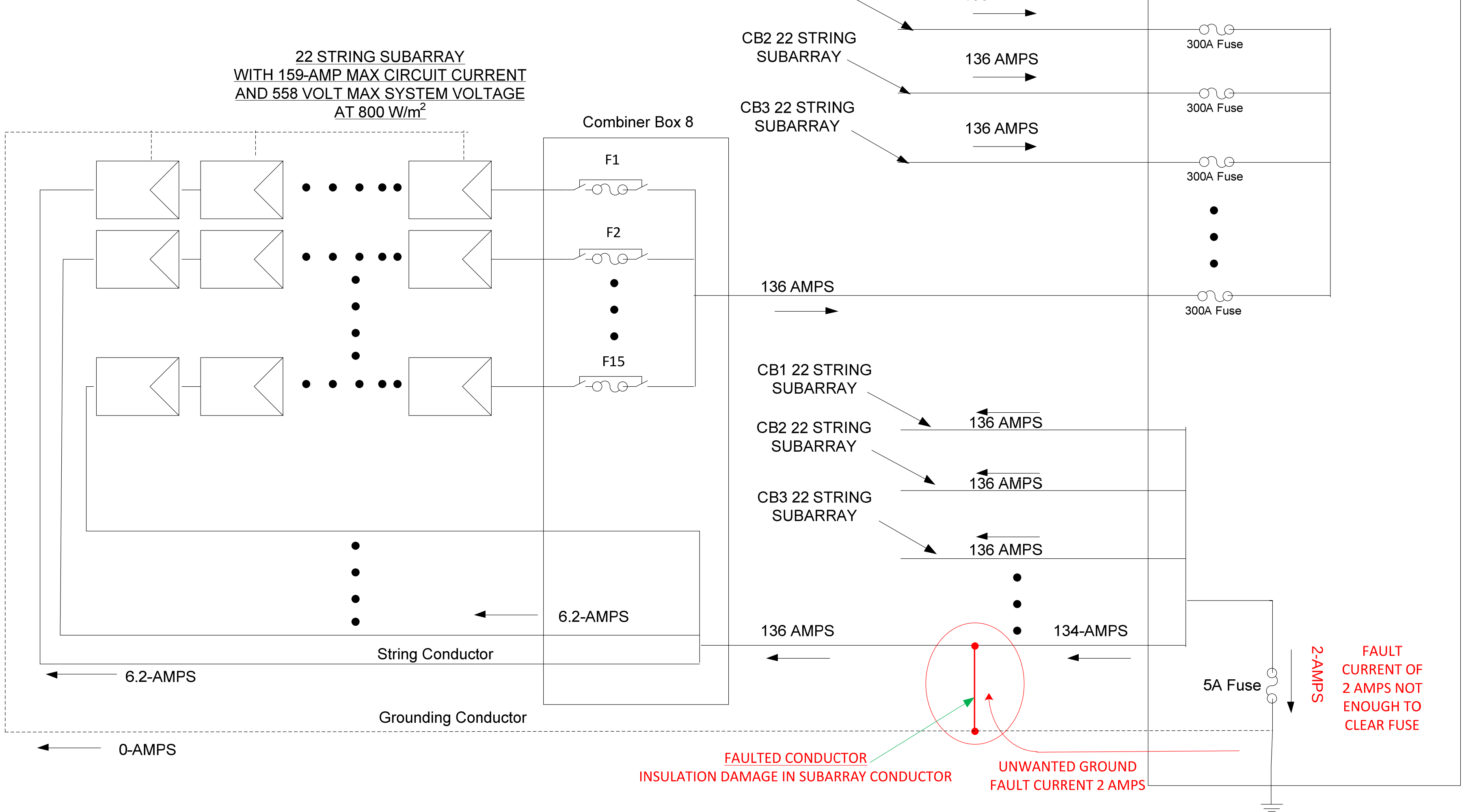


Typical Sequence of Events

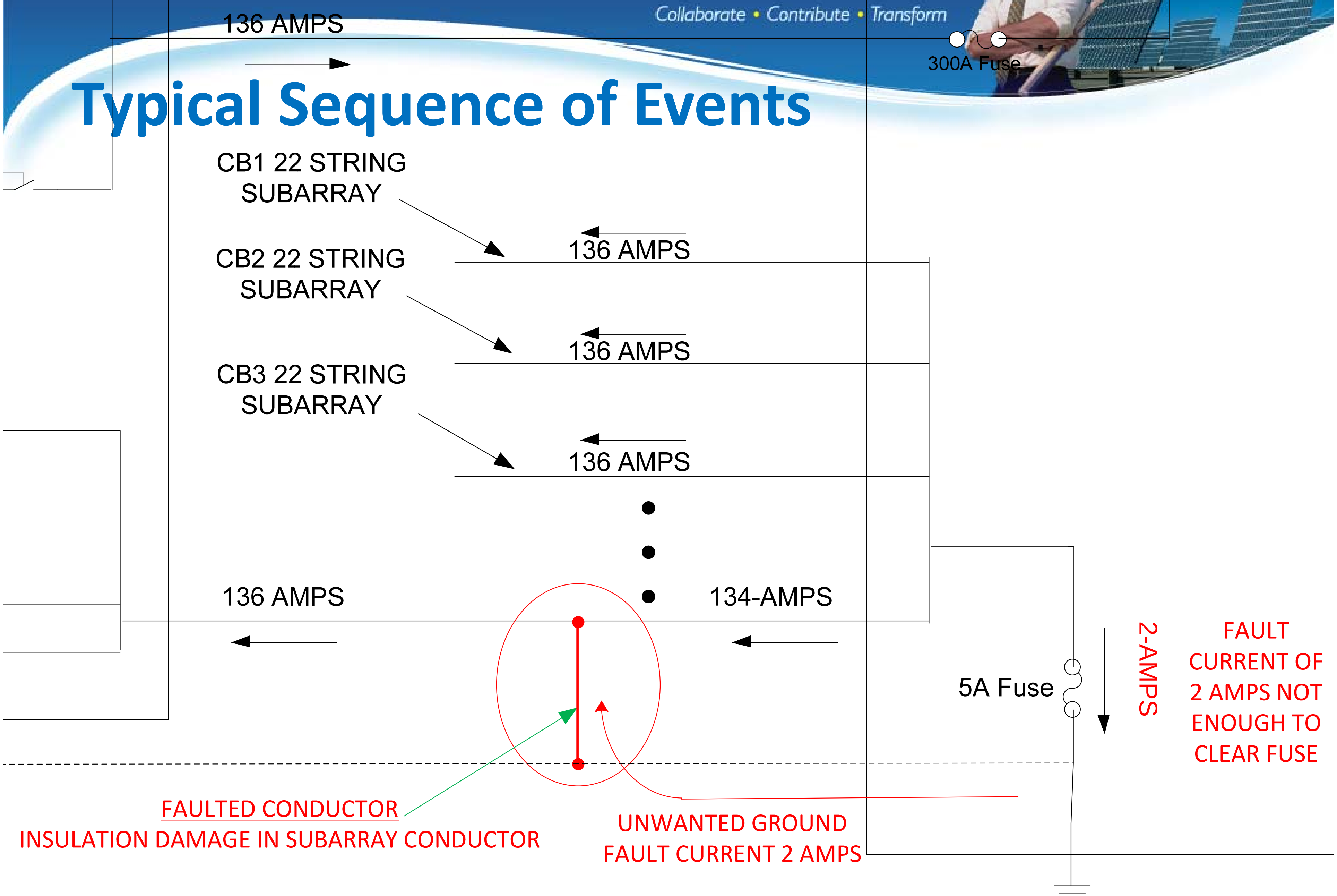


Typical Sequence of Events

Stage 1- Faulted Grounded Subarray Conductor



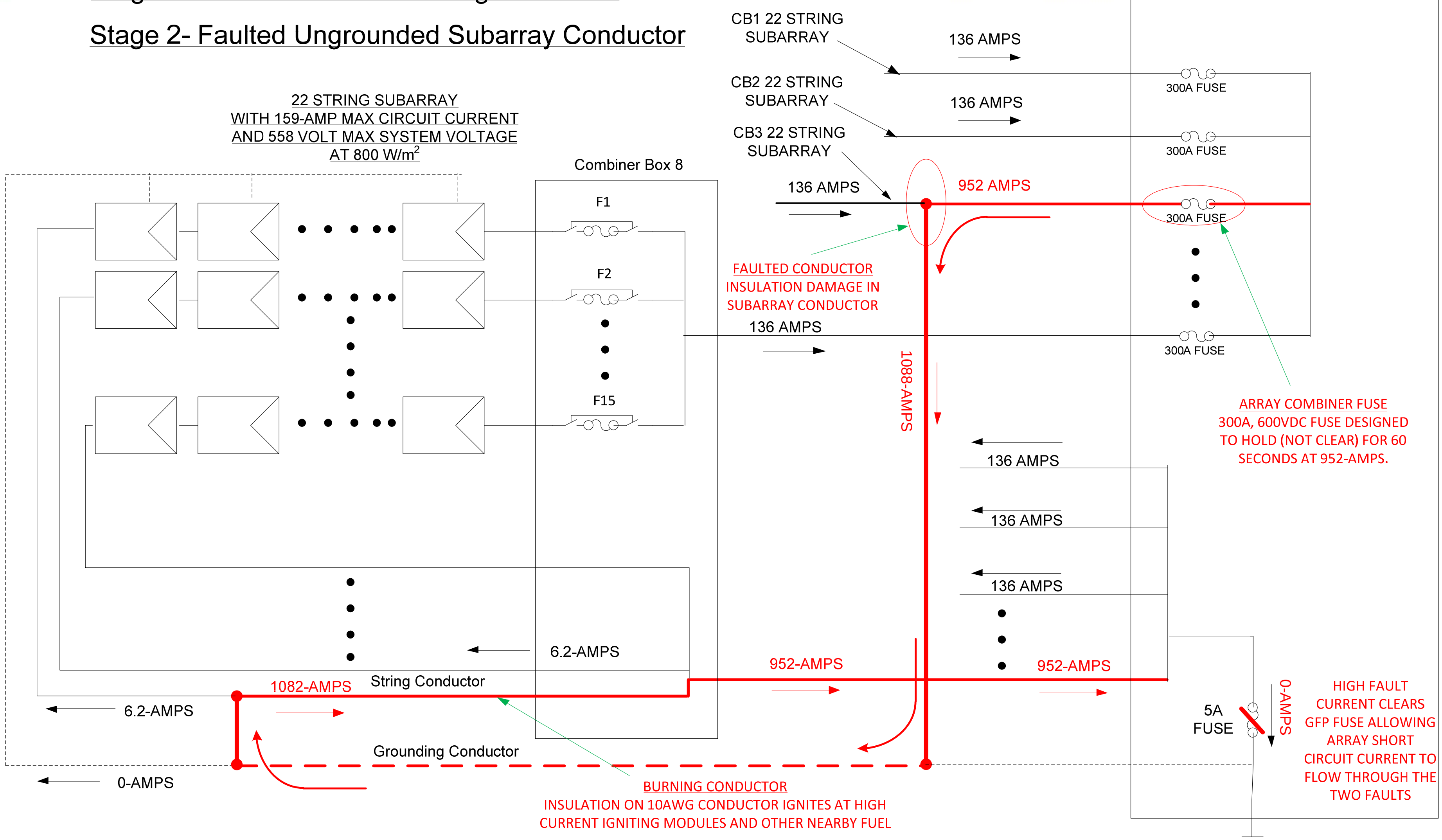
Typical Sequence of Events



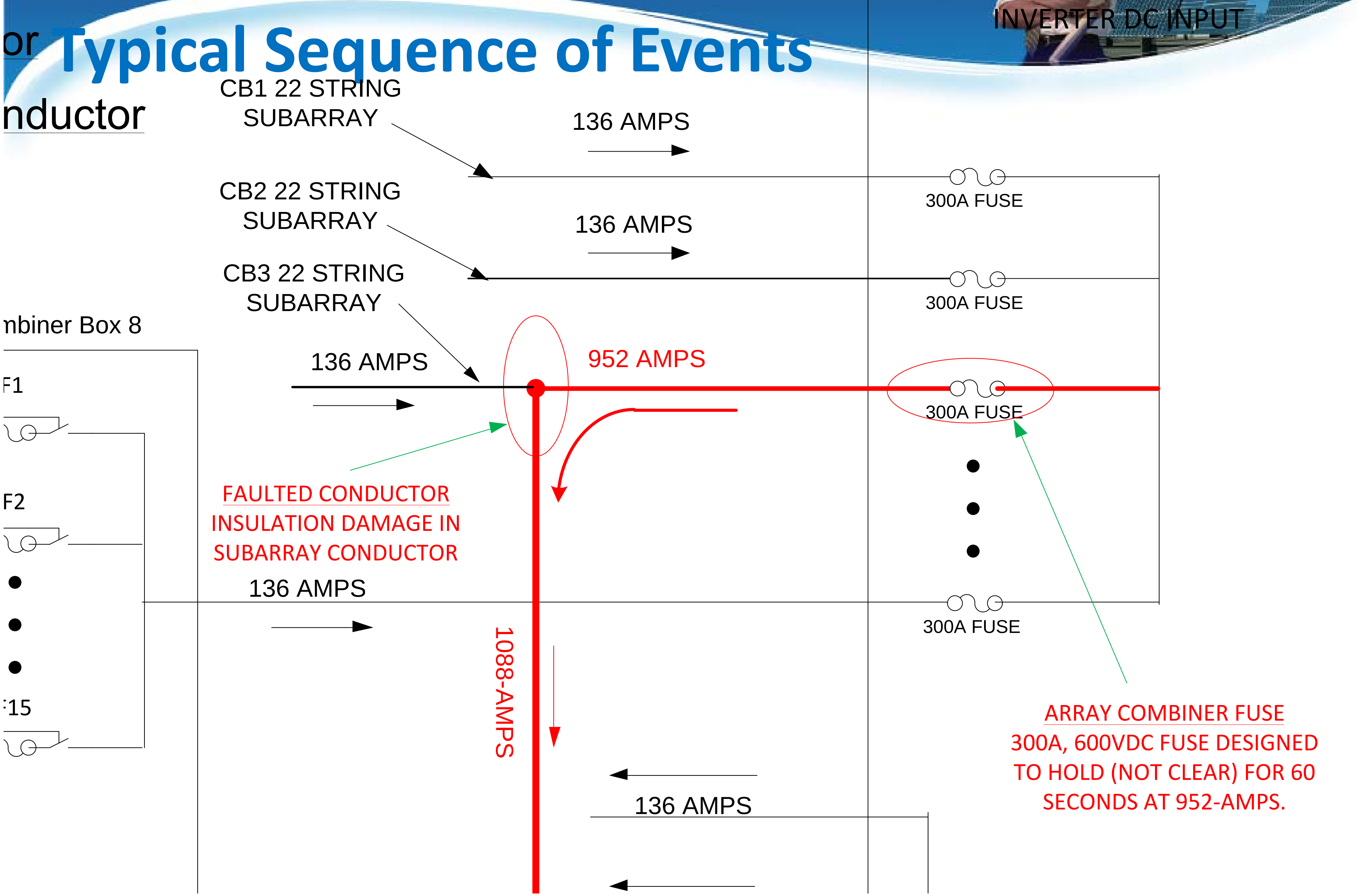
Typical Sequence of Events

Stage 1- Faulted Grounded String Conductor

Stage 2- Faulted Ungrounded Subarray Conductor



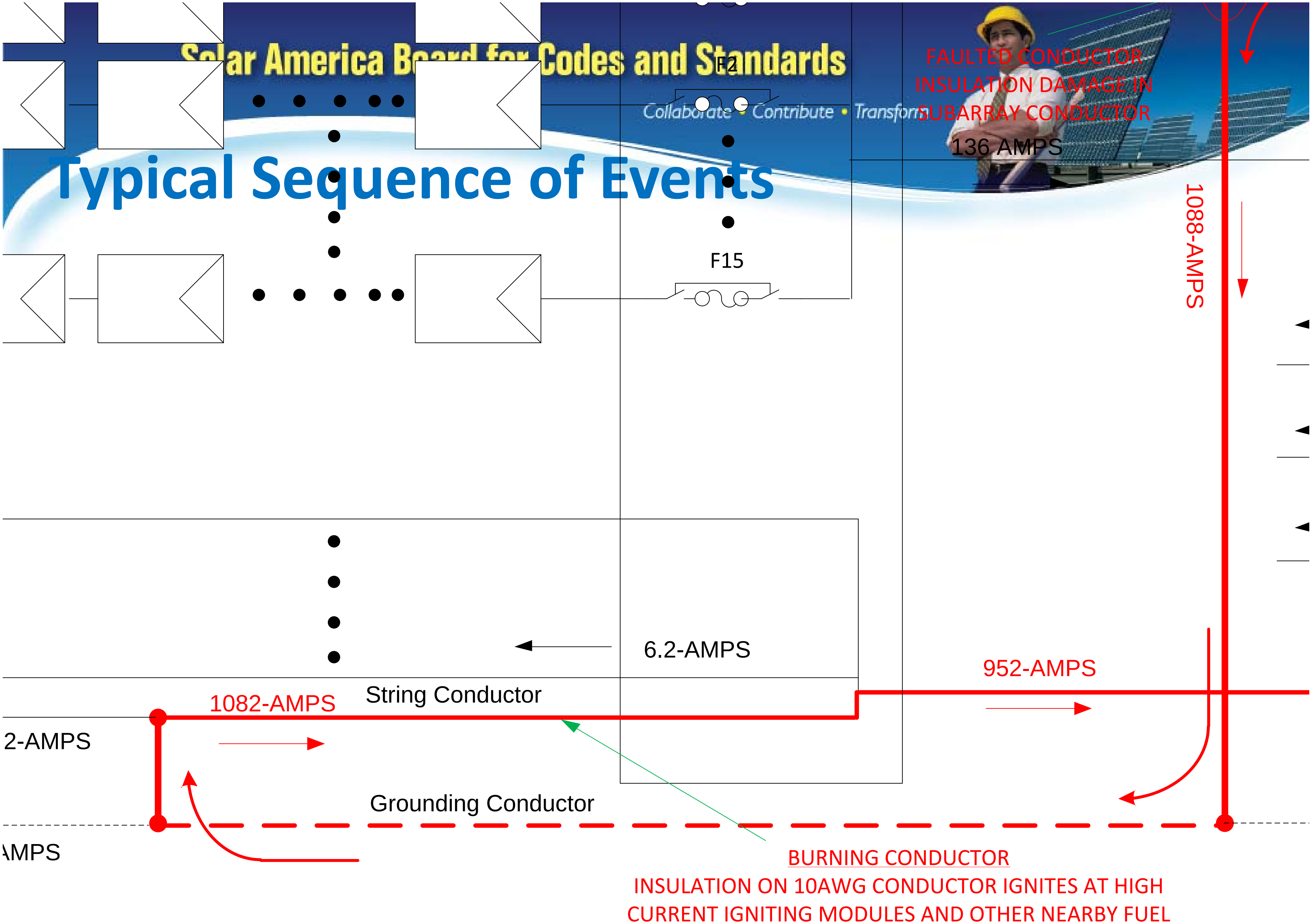
Typical Sequence of Events



Solar America Board for Codes and Standards

Collaborate • Contribute • Transform

Typical Sequence of Events

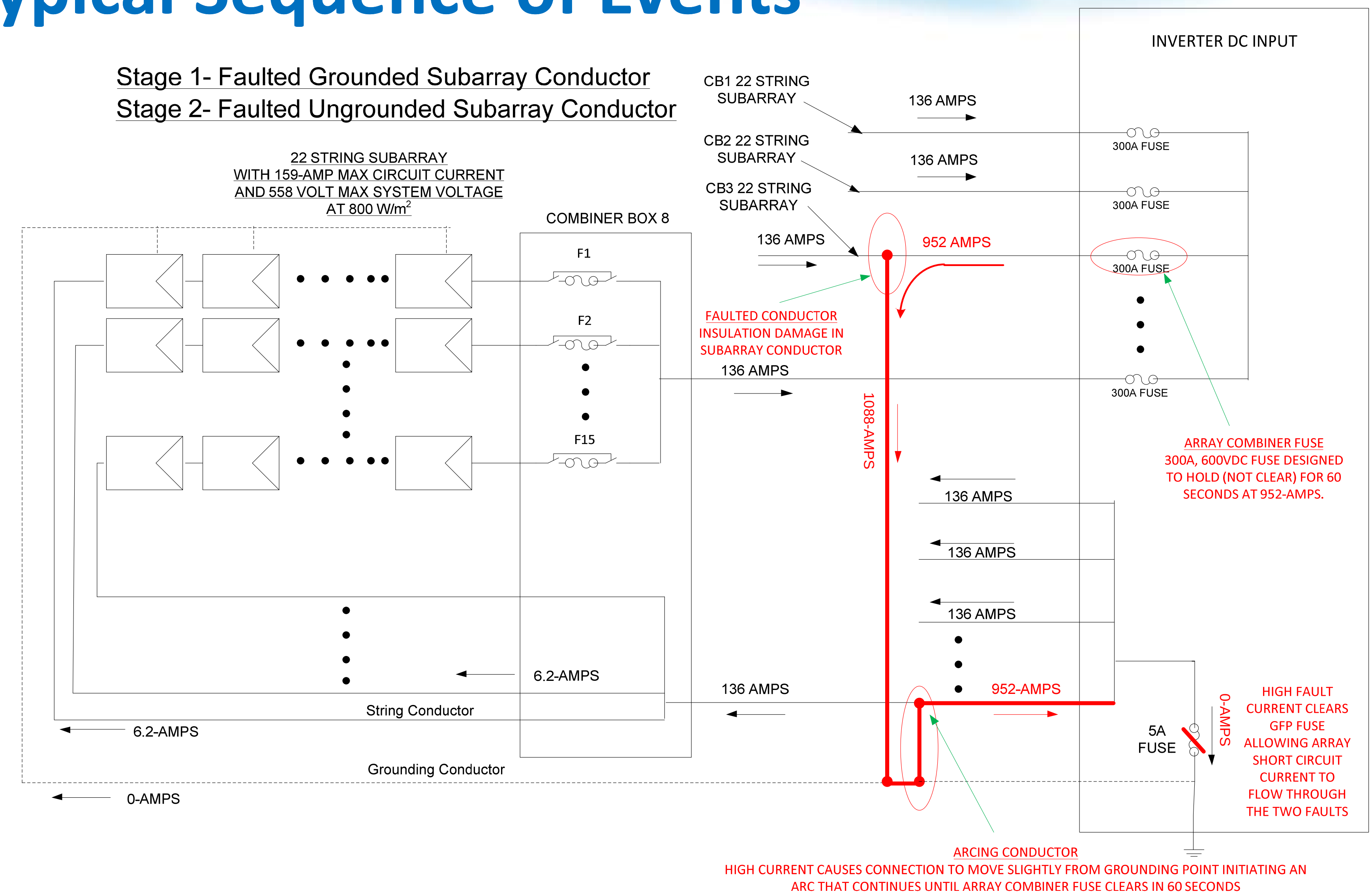


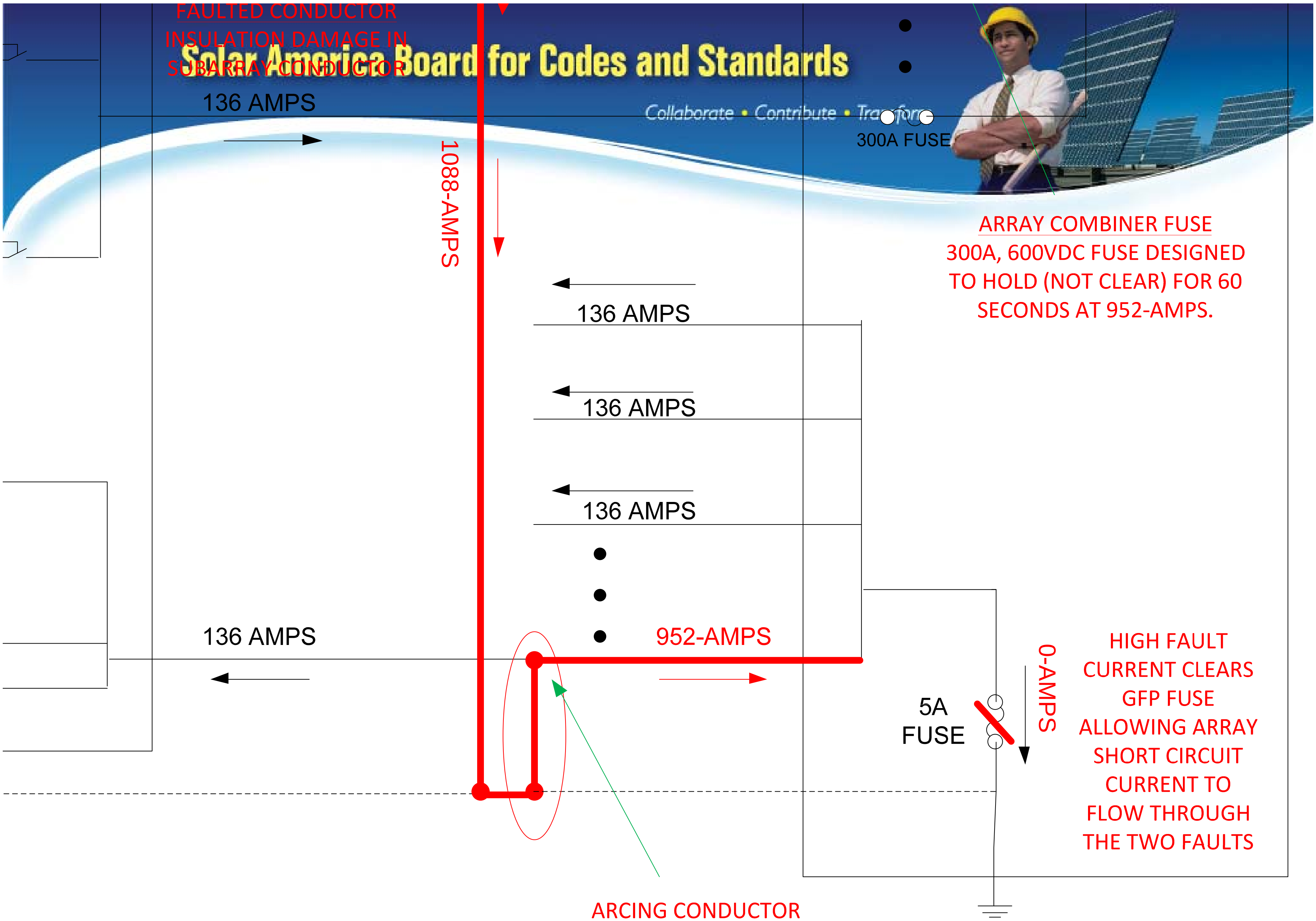
Solar America Board for Codes and Standards

Collaborate • Contribute • Transform

Typical Sequence of Events

Stage 1- Faulted Grounded Subarray Conductor
Stage 2- Faulted Ungrounded Subarray Conductor





ARCING CONDUCTOR

HIGH CURRENT CAUSES CONNECTION TO MOVE SLIGHTLY FROM GROUNDING POINT INITIATING AN ARC THAT CONTINUES UNTIL ARRAY COMBINER FUSE CLEARS IN 60 SECONDS

Blindspot

- Established GFDI limits are larger for larger PV systems
- Evidence suggests faults on the grounded array conductor can exist without tripping the ground fault fuse
- Higher ground-fault trip threshold also yields a larger blind-spot

Solar ABCs Project

- White Paper
- Research
- Report with Recommendations

White Paper

- Describe Problem
- Identify tests to determine if a specific installation is safe
- Identify possible solution

Research

- Determine the conditions where the existing ground-fault protection is inadequate
- Develop a mitigation proposal
  - Implement through changes to NEC and UL Standards
  - Current proposal is a combination of a morning check and measurement of differential current.

What about Existing PV Systems with Blindspot?

- Several Important Steps Should Be Taken Soon

  1. proper installation techniques with close attention to wire management,
  2. annual preventative maintenance actions to identify and resolve progressive system damage,
  3. detailed data acquisition to monitor the operation of all PV systems at a level sufficient to determine if unscheduled maintenance is required, and,

What about Existing PV Systems with Blindspot?

4. additional ground fault and PV array isolation sensing devices

- Options likely to be recommended by research.
  - Retrofit large systems with more sensitive Residual Current Monitors (300mA or less)
  - Where possible, apply daily array insulation test before starting the inverter.

Design Recommendations for Future PV Systems

- Possible options based on future research:
  - Employ retrofit recommendations up front for grounded PV arrays.
  - UNGROUND the array
  - Employ segmenting contactors to reduce current during faults.
  - Arc Fault Detectors (2011 NEC)
  - Module level control to react to faults