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Investigation of Installation Practices: Field Observations

Sandia-EPRI Connector Reliability Workshop

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“Connector Reliability Across the US Solar Sector”

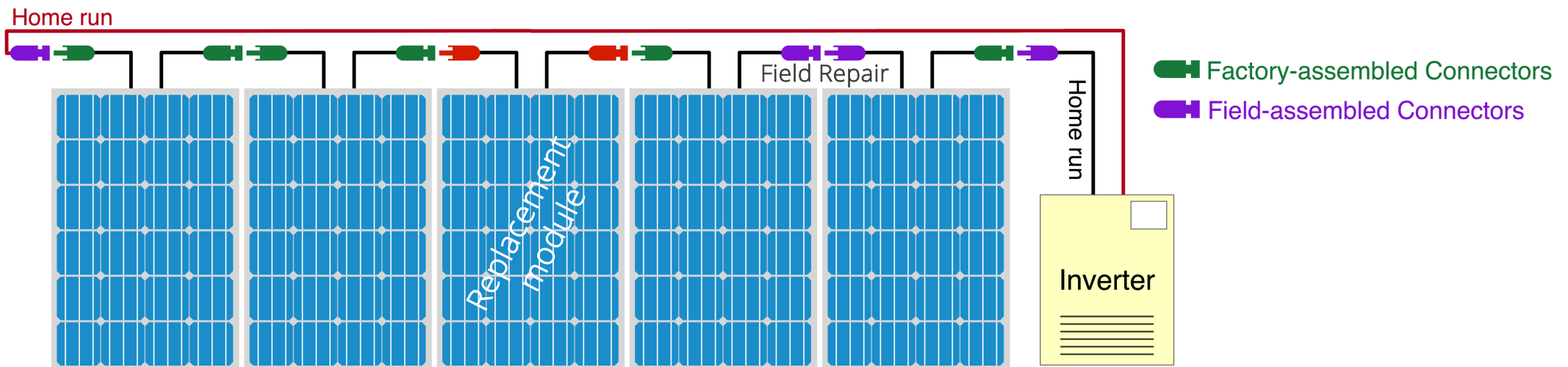
Site Visits: Utility, Commercial, Small R&D



Goals & Outcomes:

- First-hand observations of installation practices, connector brand/model diversity and field failures
- Invaluable discussions with on-site O&M crews
- Harvested connector samples returned to Sandia for evaluation
 - Beginnings of a database of field failure categories

Next few slides will provide a highlight of observations





Home-runs: Ferrules, torque and cable insulation



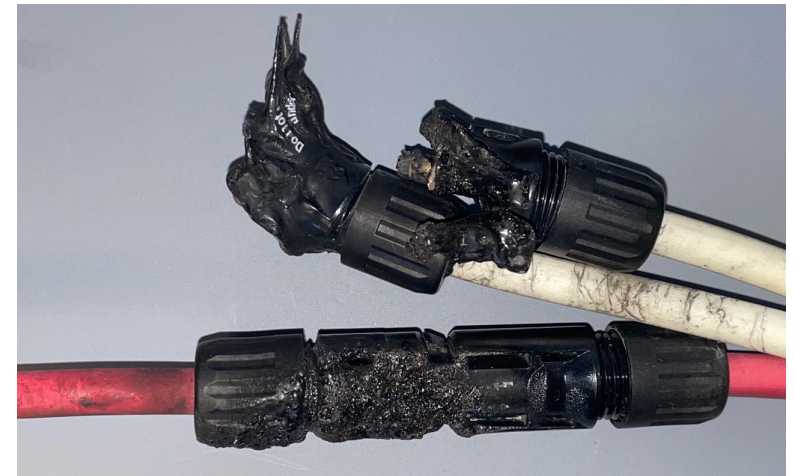
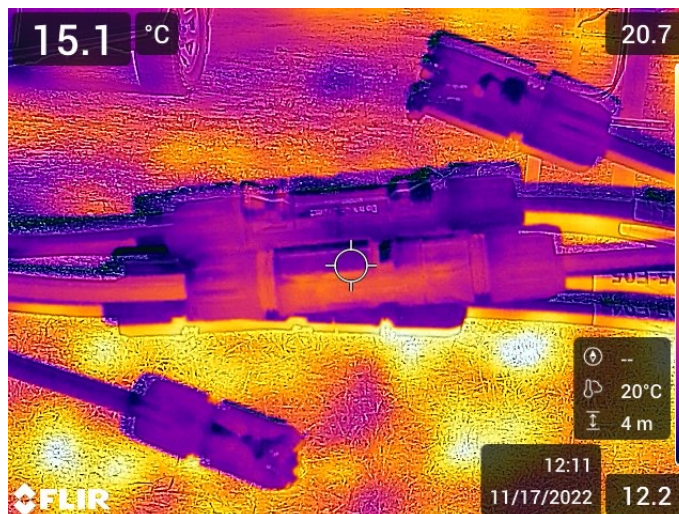
- Numerous examples of seal failures at the ferrule
- Evidence of cable insulation “pullout”.....short stripping or shrinkage?
- Incipient cable corrosion in some cases
- Almost certainly accompanied by water ingress into housing
- Not a matter of “if”....a matter of “when”



Home Run Bundles: Thermal Damage and inspection challenges



- Runaway resistive heating at pin-sleeve contact
- Bundled home run harnesses can put adjacent connectors at risk
- Emerging thermal damage may not be easy to identify
- Blocks with failed strings are offline...no current = no heat
- Identification by maintenance crews often most reliable





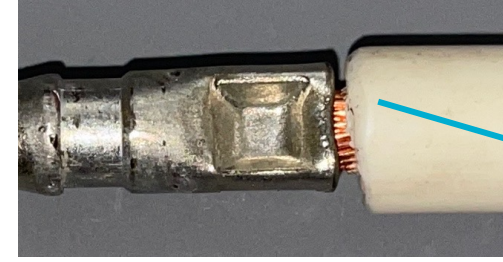
Dissecting a Failed Wiring Harness



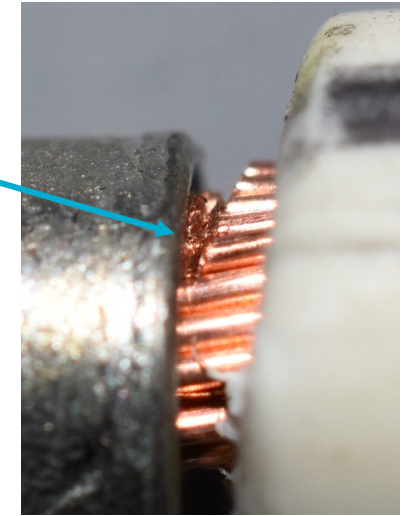
Proper torque
Collapsed strain relief
Pin secure



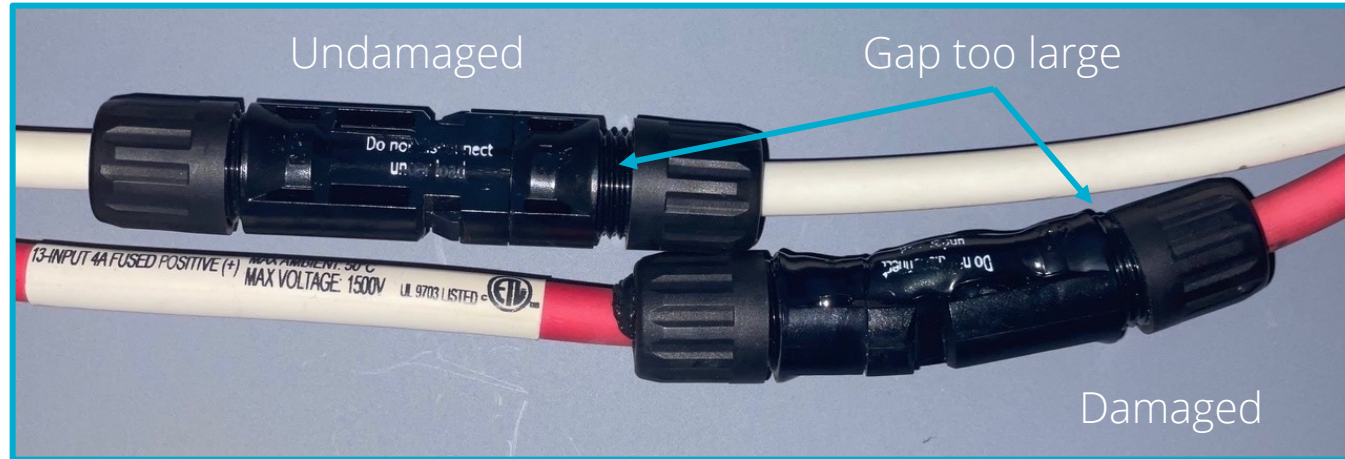
Improper torque, poor insertion



Wrong Crimp Tool



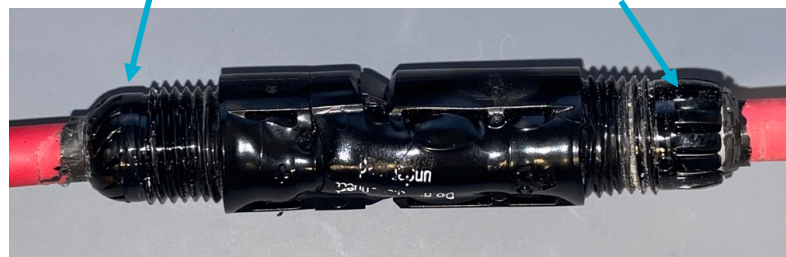
Cut Strands
Wrong strip tool?



Bad crimp



Proper torque

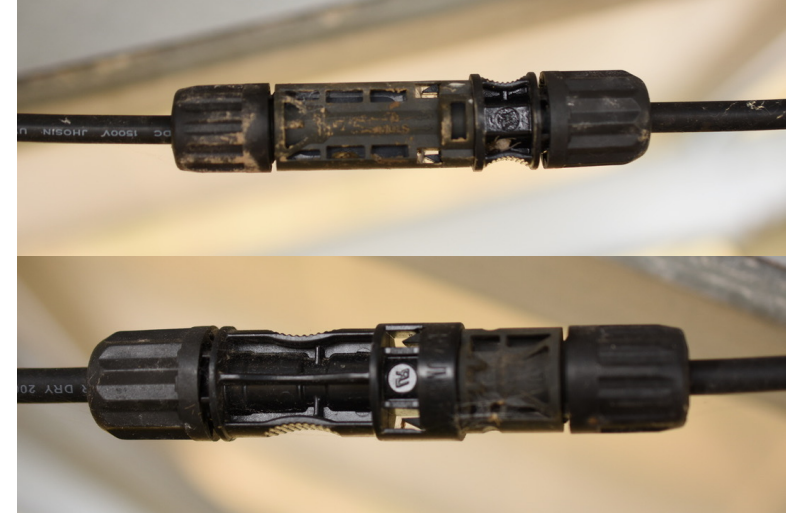


Improper torque





Module Replacements/Cable Management



- Field-made jumper to accommodate a module replacement
- Cable routing left connectors laying in trays where they could be submerged
 - connectors are IP68, but....only if they're assembled correctly
- Electrical arc to racking



- Cross-mating between replacement modules
- Single module model, two j-box & connector assemblies
- In total, four different connectors observed on site
 - Original module – high #'s
 - Replacement module – low #'s
 - Home runs & harnesses – med #'s
 - Field repair – very low #'s



Summary

- Utility field inspections to date have revealed failures only in wiring harnesses or field made jumpers/replacements
 - Considerable inconsistency in installation practices even within the same site
- Use of improper tools combined with improper assembly almost guarantees failure
 - moisture ingress, corrosion and arcing
 - high resistance points
- Cable management practices can exacerbate problems due to improper connector assembly
 - routing through metallic cable trays provides an easy arc path to ground
 - bundling in wiring harnesses can lead to collateral damage
- Installation of replacement modules can lead to inadvertent connector cross-mating