PALO VERDE
NUCLEAR GENERATING STATION

Electrical Maintenance Training Program

Classroom Lesson

Electrical Maintenance Training Program	**Date: 09/01/2011 2:50:31 PM**
LP Number: NEA04L00103	**Rev Author: MARK LACOMBE**
Title: LARGE TERMINATION: AMP	**Technical Review:** Wagley, Walter K(Z99366) Digitally signed by Wagley, Walter K(Z99366) DN: cn=Wagley, Walter K(Z99366) Date: 2011.09.12 14:09:44 -07'00'
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INITIATING DOCUMENTS

None

REQUIRED TOPICS

None

CONTENT REFERENCES

13-EN-0306: Installation Specification for Cable Splicing and Termination

LARGE TERMINATIONS: AMP
VTD-A602-00217/147, VTD-A602-00216, VTD-A602-00214/128,
VTD-A602-00318/319, VTD-A602-00240/123, VTD-A602-00242/125/126

Tyco Cold Splice CSJA 2824-APS Installation Instructions.

CRAI 3697212 Training Dept. to create the proper training and qual requirements for the use of TYCO (Cold Shrinkable) CSJA joints for medium voltage cable repairs.

CRAI 3567232 Training Dept. to implement training to support the use of TYCO (Cold Shrinkable) CSJA joints for medium voltage cable repairs.

CRDR 3616634 Startup Transformer NANX02 Winding Ground Differential Trip due to cable fault.

LESSON PLAN REVISION DATA

Sept 01 2011	Mark LaCombe	Record modified to include TYCO CSJA Cold Splice information and include Sig CRDR 3616634

TERMINAL OBJECTIVE:

1.0 Given references, materials, tools, and M&TE the student will, install Amp terminals and splices on wire sizes #8 and larger as demonstrated by the completion of a Lab Practical Evaluation (LPE).

ENABLING OBJECTIVE:

1.1 Identify factors that determine what terminations are to be used.

1.2 Identify how to determine conductor size.

1.3 Install a Plasti-Grip type terminal on a conductor using tool 59974-1 and the appropriate dies per the applicable VTD/IS.

1.4 Install Solistrand terminals and splices on a conductor using tool 59975-1 and the applicable VTD/IS.

1.5 Identify installation criteria on Ampower terminals and splices using tool 59973-1 and the appropriate dies per the applicable VTD/IS.

1.6 Install an Ampower type terminal on a conductor using crimp tool 1490749-1 and the appropriate dies per the applicable VTD/IS.

1.7 Identify installation criteria for Ampower terminals and splices using tool 69099 or 69082 and the appropriate dies per the applicable VTD/IS.

1.8 Identify installation criteria for TYCO CSJA type cold shrink splices.

TO: 1.0 Given references, materials, tools, and M&TE the student will, install Amp terminals and splices on wire sizes #8 and larger as demonstrated by the completion of a Lab Practical Evaluation (LPE).

EO: 1.1 Identify factors that determine what terminations are to be used.

LESSON PLAN	METHODS AND ACTIVITIES
• Document review: Work Order: What does the WO contain? Performance Verifications Second Party verifications Critical Attributes Cautions/Notes M&TE Acceptance criteria Retests Chemicals Contact Information References: Prints Specifications Vendor Technical Manuals (VTM's) Vendor Technical Documents (VTD's) Plant Document Management System (PDMS) Engineering Design Changes (EDC's)	TCSAI 2835512 CRDR 2790388 During the performance of WO 2697545, the 2MSIAP03 motor lead "C" phase LUG came of the lead. CRDR 2827530 On 9/1/05 during an inspection of the LPSI 1A pump motor electrical terminations being conducted under WO 2797528, broken wire strands were found on the motor leads. In addition, the motor leads use a #6 AWG conductor but the lugs used for the connection were designed for a #4 AWG conductor. A #4 AWG crimping tool was used to compress the lug.

- 13-EN-0306:

  1/2” or 5/8” stainless steel bolts and hardware shall be used to perform 15KV and 5KV bolted splices and bolted terminations

  Ampower terminals shall be used for terminations to motors/generators utilizing #6 AWG or larger conductor cable.

  When utilizing stainless steel hardware, “Never Seez”, nickel special nuclear grade, or an approved equal lubricant shall be applied to the threads of the bolt prior to installation and torquing.

  Ampower terminals requiring two single crimps may have the crimps on either the same side or opposite sides of the connector.

  Crimping of compression terminations (splices) shall be in accordance with the appropriate AMP Inspection Sheet (IS) with the exception of Ampower long barrel terminals (butt splices) being secured with two single crimps (on each end) utilizing single crimp dies, as appropriate.

Review 13-EN-0306

- Considerations for choosing termination tools and materials:
  1. The physical space (enclosure) the termination/splice must fit into.
  2. Stud sizes of terminations including hardware requirements.
  3. Will a splice need to be disconnected again.
  4. Sizes of terminal blocks or terminating devices.
  5. What is the device you are terminating to (motor, transformer, bus, ETC.)?
  6. What are the insulating requirements for the termination/splice?
  7. Does the termination need to be filed?
  8. Does the termination need to be bent?
  9. Is the wire stranded or solid?
  10. What is the size of the wire?
  11. Are you in a LOCA/HELB?
  12. What kind and size of hardware do you need?

- You will be installing either a:
  Termination (lug)
  Parallel Splice
  Butt Splice

- Types of termination materials used at PVNGS:
  A. Plasti-grip terminals on stranded wire #8 - #2.
  B. Solistrand terminals on solid wire #8 and larger and parallel/butt splices #8.
  C. Ampower terminals #6 - 1000MCM and splices 6 – 1500MCM (Motors/Generators #6 AWG and greater)

These are the typical uses at Palo Verde.

EO: 1.2 Identify how to determine conductor size.

LESSON PLAN	METHODS AND ACTIVITIES
• Determine conductor size through visual inspection: Use the nomenclature on the cable/wire to determine conductor size. Use documentation: APS paperwork that is attached to the cable/wire (APN) Vendor information attached to the cable/wire	
Determine conductor size by using a wire gauge	Have wire gauge available
Determine conductor size by measuring:	Teach students how to use dial caliper
Circular Mil: When the cross sectional area of a circular object is calculated using dimensions expressed in Mils. A. A combination of an industry standard and geometry. B. One CMA is the equivalent of a circle with a diameter of 1 Mil. C. A Mil is one thousandth of an inch. (.001”)	Example determining CMA Have students practice calculating CMA
CMA: Solid wire = D squared (D = Diameter of wire in Mils) CMA: Stranded wire = D squared x N (number of strands)	On engineering prints you may see: KCMil = 1000 Circular Mils (K = Latin prefix for 1000) MCM = 1000 Circular Mils (M = Roman numeral for 1000)

- Stripping cables and wires:

  Cables may be stripped using a variety of methods:
  Knives
  Cable strippers
  VB1 Magic Cable Stripper

  Safety: Always utilize the proper safety equipment when stripping wires or cables.
  Kevlar/cut resistance gloves
  Leather gloves
  Eye Protection

  Use safe work practices:
  Always use a sharp knife
  Always cut away from yourself
  Never cut while standing close to someone else
  Never use a knife with a part of your body in the way (leg, arm)
  Practice on a scrape cable/wire

  Stripping cables/wires:
  Do not knick, cut or damage the ground, insulation, or conductor underneath

  Do not “ring”, cut, or nick any conductor

Show slides of cable cutters

EO: 1.3 Install a Plasti-Grip type terminal on a conductor using tool 59974-1 and the appropriate dies per the applicable VTD/IS.

LESSON PLAN	METHODS AND ACTIVITIES
• AMP hydraulic hand tool 59974-1 is designed for crimping AMP terminals and splices on wires sized #8 - #2 Used for Plasti-Grip type terminations. The hand tool has a stationary lever and a movable lever. These levers are compressed to pump hydraulic fluid behind the ram, moving it forward and thereby closing the dies. After the crimping is complete, a trigger on the movable lever is squeezed to depress the release plunger. The moving die retracts to its original position, completing the crimping cycle.	See VTD-A602-00217 (IS6757) SME: Be careful which handle you are holding. The tool will fall backwards if you are holding the wrong handle.
• Tool Inspection: 1. Remove dust, moisture, and other contaminants with a clean brush, or a soft, lint-free cloth. 2. Ensure the proper retaining pins are in place and secured with the proper retaining rings. 3. When the tool is not in use, keep the handles closed to prevent objects from becoming lodged in the dies, and store the tool in a clean, dry area.	

- Dies: Terminals and dies are color coded. Dies have the terminal size stamped in the wire barrel crimp sections of both the moving and stationary dies. When crimped, the wire size will appear on both sides of the terminal wire barrel. The wire size appearing on the crimped wire barrel should always agree with the wire size stamped on the terminal tongue.

See VTD-A602-00147 (IS1758)

- Inspection: Visually inspect the die closure surfaces for flattened, pitted, broken or chipped conditions. Do not allow deposits of dirt, grease and foreign matter to accumulate in the die closure surfaces of the dies.

- Insertion:
  1. Remove latch pin on head, then open yoke.
  2. Loosen set screw in yoke.
  3. Before inserting dies in head, loosen socket head cap screws holding insulation crimping section of dies in place. If screws are not loosened, dies may not fit into head of tool because of close clearance.
  4. Insert stationary die (with large shank) into yoke. Tighten set screw.
  5. Activate tool to advance ram until set screw is visible.
  6. Loosen set screw in ram and insert moving die (with small shank) into well of ram. Tighten set screw. Ensure that moving die is properly oriented to mate with stationary die.
  7. Retighten cap screws holding insulation crimp section of dies.
  8. Return ram to the “Down” position.

SME: These dies can be inserted with one die backwards. This will damage the die.

- Removal:
  1. Remove latch pin and open yoke.
  2. Loosen set screw in yoke and remove stationary die.
  3. Raise ram to “Full up” position. Loosen set screw and remove moving die.

- Insulation Crimp Adjustment:
  The insulation crimp adjustment is made to both stationary and moving dies after they have been placed in head.

  The dies have 3 insulation crimp positions. The adjustment is made by moving a pin-key.

  When the pin-key is pushed all the way in, the insulation crimping section of die is in the loose position.

  When the pin-key is half way out, the insulation crimping section of die is in the medium position.

  When the pin-key is all the way out, the insulation crimping section of die is in the tight position.

  To make the insulation crimp adjustment, loosen socket head cap screws and push pin-key all the way in so that insulation section of die is in the loose position. Make certain that the pin-keys in both the stationary and moving dies are place in the same position.

  Press and hold the insulation die down against the pin-key. This will prevent the spring-loaded pin-key from popping back.

  Tighten socket head cap crews. Be certain insulation crimp portion of moving and stationary dies are both adjusted to the same position.

  Make a test crimp.

- Insulation Crimp Adjustment: Cont

  Plasti-Grip terminals provide only a “support” for the wire; terminal insulation will not always touch wire insulation, but will provide “support” when wire is flexed.

  Remove crimped terminal from dies and visually inspect the insulation crimp portion of terminal. The insulation crimp should provide “support” for wire.

  If the insulation crimp does not support wire insulation loosen socket head cap screws and set pin-key in the medium position. Repeat adjustment as necessary until desired insulation crimp is obtained.

  Do not use a tighter setting than required.

- Crimping procedure:
  Select the proper die for the terminal and wire size being used.

  Strip wire to the dimensions listed in the applicable VTD. Do not nick or cut conductor strands.

  Insert stripped wire in terminal. End of wire conductor must be flush with or extend beyond edge of terminal wire barrel.

  Open yoke and place terminal in dies. Bottom of terminal tongue should face stationary die and terminal barrel should rest against spring-loaded locator.

  Close yoke and insert latch pin. Be sure latch pin is fully inserted or damage to dies and head will occur.

  Hold terminal and wire in place and activate power unit until crimp is complete.

  Open yoke and remove crimped terminal. If terminal sticks in die after crimping, apply a rocking motion to remove the die.

- Crimp Inspection:

  Wire is fully inserted.

  Crimp is centered on wire barrel.

  Correct color code and die combination (Terminal insulation color matches color dots on dies).

  AWG wire size being used is same as wire size embossed on terminal insulation and stamped on terminal tongue.

  End of conductor is flush with, or extends beyond end of wire barrel of terminal.

  Insulation barrel is in contact with wire insulation. Plasti-Grip terminals provide only a “support” for the wire; terminal insulation will not always touch wire insulation, but will provide “support” when wire is flexed.

EO: 1.4 Install Solistrand terminals and splices on a conductor using tool 59975-1 and the applicable VTD/IS.

LESSON PLAN	METHODS AND ACTIVITIES
• AMP hydraulic hand tool 59975-1 is designed for crimping AMP Solistrand terminals and splices on wire sizes #8 - #2. The hand tool has a stationary lever and a movable lever. These levers are compressed to pump hydraulic fluid behind the ram, moving it forward and thereby closing the dies. After the crimping is complete, a trigger on the movable lever is squeezed to depress the release plunger. The moving die retracts to its original position, completing the crimping cycle.	See VTD-A602-00216 (IS6758)
• Tool Inspection: 1. Remove dust, moisture, and other contaminants with a clean brush, or a soft, lint-free cloth. 2. Ensure the proper retaining pins are in place and secured with the proper retaining rings. 3. When the tool is not in use, keep the handles closed to prevent objects from becoming lodged in the dies, and store the tool in a clean, dry area.	

- Die selection:
  1. Press head latch and open crimping head.
  2. Pull back the die latch and turn thumb knob until desired die size appears. Embossed wire size appears on side of each die position.
  3. Rotate thumb knob left or right until die latch locks die wheel in desired position. In order to close head, die latch must snap into locked position.

- Crimping Procedure:
  Strip wires to dimensions listed in the applicable VTD.

  Insert terminal or splice in upper die.

  Pump movable lever until moving (lower) die grips terminal or splice. Do not deform wire barrel of terminal or splice.

  Insert stripped wire into wire barrel of terminal or splice.

  Continue pumping movable lever. When dies have bottomed, an audible pop will be heard. This indicates that the crimp is complete.

  Retract movable die by pulling movable lever slightly outward. Then, while squeezing trigger (to actuate striker arm) compress levers to depress plunger. Movable die will now retract.

  Remove crimp.

- Crimp Inspection:

  Centering of crimp - crimp may be off center but not off end of wire barrel.

  Wire size being used matches wire range stamped on die position and terminal.

  End of wire is flush with or extends slightly beyond end of wire barrel.

  There are no nicked or missing strands.

EO: 1.5 Identify installation criteria on Ampower terminals and splices using tool 59973-1 and the appropriate dies per the applicable VTD/IS.

LESSON PLAN	METHODS AND ACTIVITIES
• Amp hydraulic hand tool 59973-1 is designed for crimping Amp terminals and spices in wire sizes #8-4/0 AWG. This tool can be used for Ampower or Solistrand type terminations. The hand tool has a stationary lever and a movable lever. These levers are compressed to pump hydraulic fluid behind the ram, moving it forward and thereby closing the dies. After the crimping is complete, the movable lever is turned to depress the plunger. The moving die retracts to its original position, completing the crimping cycle.	See VTD-A602-00214 (IS6803) Used for Ampower only at PVNGS
• Tool Inspection: 1. Remove all foreign particles with a clean, soft brush or clean, soft lint-free cloth. 2. Ensure the proper retaining pins are in place and secured with the proper retaining rings. 3. When the tool is not in use, keep the handles closed to prevent objects from becoming lodged in the dies, and store the tool in a clean, dry area.	

- Dies: Each die assembly consists of a nest and indenter which are retained in the crimping tool by setscrews or by internal retainers. The nest is positioned in the yoke of the crimping tool and the indenter is positioned in the ram of the tool in all applications.

See VTD-A602-00128 (IS1565)

- Inspection:
  1. Check all bearing surfaces for wear. Remove and replace worn components.
  2. Inspect the crimp area for flattened, chipped, cracked, worn, or broken areas. If damage is evident the die must be replaced.

- Insertion:
  1. Pull out latch pin and open yoke
  2. Push nest into yoke until nest snaps into position.
  3. Advance ram. Push indenter into ram until indenter snaps into position.
  4. Close yoke and secure latch pin.

- Removal:
  1. Remove latch pin and open yoke.
  2. Insert blade of screw driver under nest and pry nest out of yoke.
  3. Raise ram to full up position.
  4. Insert blade of screwdriver under indenter and pry indenter out of ram.

- Crimping procedure:
  Strip wires to dimensions specified in the instruction sheet for the applicable die.

  Insert terminal or splice in stationary die.

  Ensure latch pin is fully inserted before operating tool.

  Pump movable lever until the moving die grips the terminal or spice.

  Do not deform wire barrel of terminal or splice.

  Insert the stripped wire into the wire barrel of the terminal or splice.

  Continue pumping movable lever. When dies have bottomed, an audible “pop” will be heard. This indicates that the crimp is complete.

  Retract movable die by pulling movable lever slightly outward. When turning movable lever (to actuate striker), compress levers to depress plunger. Movable die will now retract.

  Remove latch pin, open yoke, and remove crimped terminal or splice.

  If terminal or splice sticks in die after crimping, apply a rocking action to remove it from the die.

- Crimp Inspection:

  Crimps centered. Crimps may be off center but not off end of wire barrel.

  Embossed wire size matches size of wire being used and wire size stamped on terminal or splice.

  Insulation does not enter wire barrel.

  Wire is visible through inspection hole of terminal or butt splice.

  On parallel splices, bare wire ends must be flush with or extended beyond end of barrel.

EO: 1.6 Install an Ampower type terminal on a conductor using crimp tool 1490749-1 and the appropriate dies per the applicable VTD/IS.

LESSON PLAN	METHODS AND ACTIVITIES
• Amp hydraulic hand tool 1490749-1 is designed for crimping Amp terminals and spices in wire sizes #8 - 4/0 AWG for Solistrand products and #6 - 4/0 for Ampower products. This tool can be used for Ampower or Solistrand type terminations. The hand tool has a stationary lever and a movable lever. These levers are compressed to pump hydraulic fluid behind the ram, moving it forward and thereby closing the dies. After the crimping is complete, the movable lever is turned to depress the plunger. The moving die retracts to its original position, completing the crimping cycle.	See VTD-A602-00318 (IS408-8718) Used for Ampower only at PVNGS
• Tool Inspection: 1. Remove all foreign particles with a clean, soft brush or clean, soft lint-free cloth. 2. Ensure the proper retaining pins are in place and secured with the proper retaining rings. 3. When the tool is not in use, keep the levers closed to prevent objects from becoming lodged in the dies, and store the tool in a clean, dry area. 4. Inspect for worn, cracked, or broken areas.	

- Dies: The die assemblies are single position sets, each consisting of an anvil subassembly and an indenter subassembly.

See VTD-A602-00128 (IS1565)

- Inspection:
  Visually inspect die closure surfaces for broken, pitted, or chipped areas.

- Insertion:
  1. Depress the upper release button located in the C-head and slide the nest into place.
  2. Release the button and rock the die back and forth until the nest snaps in place.
  3. Activate the power unit until the lower die release button located in the ram is exposed.
  4. Depress the release button and slide the indenter into place.
  5. Release the button and rock the indenter back and forth until the die snaps in place.
  6. Return the ram to the down position.

- Removal:
  1. Depress the upper release button located in the C-head and slide the nest out of the head.
  2. Activate the power unit until the lower die release button in the ram is exposed.
  3. Depress the release button and slide the indenter out of the ram.

- Crimping procedure:
  Select proper size terminal or splice for wire size being used.

  Determine correct terminal or splice wire loading by referring to CMA range listed in the table.

  Strip wires to dimensions specified in the instruction sheet for the applicable die. Take care not to nick or cut the wire strands.

  Ensure the wire size stamped on the terminal or splice corresponds to the wire size stamped on the stationary die.

  Center the terminal or splice in the stationary die.

  Pump movable lever until the moving die grips the terminal or spice without deforming the wire barrel of terminal or splice.

  Insert the stripped wire until it bottoms in the terminal or butt splice. The end of the wire must be visible through the sight hole.

  Sight holes of butt splices must always face either the upper or lower die.

  When inserting the stripped wires into a parallel splice, the ends of the wires must be at least flush with, or extend slightly beyond the end of the wire barrel.

- Crimping procedure cont:

  Continue pumping movable lever. A slight click may be heard, indicating the pump has shifted into the high pressure stage. Continue pumping movable lever and completely crimp the connector. This tool has a built in by pass cartridge that will automatically activate when full pressure is reached. There sill be a noticeable decrease in handle pressure when the by pass is reached.

  Turning movable lever (to actuate striker), compresses lever to depress plunger. Movable die will now retract.

  Remove the crimped terminal or splice.

  If terminal or splice sticks in die after crimping, apply a rocking action to remove it from the die.

- Crimp Inspection:

  Crimps centered. Crimps may be off center but not off end of wire barrel.

  Embossed wire size matches CMA of wire being used and wire size stamped on terminal or splice.

  Insulation does not enter wire barrel.

  Wire is visible through inspection hole of terminal or butt splice.

  On parallel splices, bare wire ends must be flush with or extended beyond end of barrel.

EO: 1.7 Identify installation criteria for Ampower terminals and splices using tool 69099 or 69082 and the appropriate dies per the applicable VTD/IS.

LESSON PLAN	METHODS AND ACTIVITIES
• AMP hydraulic head 69099 is designed for crimping Ampower terminals and splices on wire sizes 6 – 350MCM and Solistrand terminals and splices wire sizes #8 - #4/0.	See VTD-A602-00240 (IS2458)
AMP hydraulic head 69082 is designed for crimping Ampower terminals and splices on wire sizes 350MCM – 1000MCM and Solistrand terminals and splices wire sizes 250 – 600MCM.	See VTD-A602-00242 (IS2456) We do not use this tool for Solistrand terminals and splices at PV.
• AMP hydraulic heads 69099 and 69082 are used with AMP hydraulic foot pump #69325.	
• Tool Inspection: For both 69099 and 69082 heads. Remove accumulations of dirt and grease on the crimping head, especially in the area where dies are inserted. Inspect assembled head for nicks, scratches and cracks especially at corners of C-frame and around the top of cylinder.	

- AMP hydraulic foot pump #69325:

  Do not operate foot pump without having hose and crimping head attached.

  Protective caps are put on crimping heads and hosed fittings to prevent dirt from entering into the hydraulic system. Never store foot pump without having head or protective cap attached to the hose fittings.

- Fluid Check:

  Use a clean cloth to remove all dust and grit from area around filler plug.

  Remove filler plug, and check fluid level. Fluid level should be approximately 1” to 1.5” from top of filler hole.

  If fluid level is satisfactory, replace filler cap. If fluid level is too low, add fluid.

- Bleeding Air from the Hydraulic System:
  Foot pump should always be elevated above crimping head when bleeding air from hydraulic system.

  1. Depress return pedal.

  2. Pump pedal several times to fill hydraulic pump.

  3. Release return pedal.

  4. Pump pedal until ram advances.

  5. Depress return pedal to remove air from the hydraulic system.

  6. Repeat steps 4 and 5 about three times to ensure that all air is removed from hydraulic system.

  7. Check hydraulic fluid supply after bleeding the system. Fill if necessary.

- Attaching crimping head to hose and hose to foot pump:

  Always depress the “Return” pedal when connecting or removing hose couplings or crimping head.

  Thoroughly clean coupling area of hose assembly and crimping head/foot pump.

  Remove protective caps.

  Mate coupling halves and tighten collar.

- Dies: Dies may be either single or dual position.
  Single position dies can be inserted into the head in only one configuration.
  Dual position dies may be inserted into the head in two different configurations.

  See VTD-A602-00123 (IS1606) and VTD-A602-00126 (IS1602)

- Die Inspection:
  Wipe dies frequently with a clean cloth and store them in a clean, dry area when not in use.

  Visually inspect die closure surfaces for broken, pitted, or chipped areas.

- Die insertion:
  Back off set screw in head.

  Insert shank of stationary die properly into top of crimping head and tighten lock screw.

  Advance the ram until lock screw on ram is fully visible, loosen lock screw on ram and insert shank of moving die properly into ram fully. Tighten lock screw.

  Ensure that dies are inserted fully in the head and ram ensuring the flats on die shanks are facing set screws.

  Activate power unit to complete cycle and allow ram to return to “Down” position.

- Removal:
  Back off set screw in head and remove stationary die.

  Raise ram enough to expose set screw and remove moving die.

- Wire preparation:
  Select proper size terminal or splice for wire size being used.

  Determine correct terminal or splice wire loading by referring to CMA range listed in the applicable VTD. Total CMA of wires being used must be within CMA range of terminal or splice.

  Strip wire to dimensions indicated in the applicable VTD taking care not to nick or cut wire strands.

See VTD-A602-00123 (IS1606) and VTD-A602-00126 (IS1602)

- Operating Procedure: Single crimp

  Ensure crimping dies are properly installed in head.

  Ensure the wire size stamped on the terminal or splice corresponds to the wire size stamped on the stationary die.

  Center terminal or splice in crimping dies.

  Pump pedal to activate unit. Continue pumping pedal until ram moves up and holds terminal or splice firmly in place without deforming the wire barrel. A sudden decrease in effort required to push pedal down will be observed during the initial buildup of pressure.

  Insert stripped wire until it bottoms in terminal or butt splice. End of wire must be visible through sight hole. Sight holes of butt splice must always face either upper or lower die.

  Insert stripped wires into parallel splice. Ends of wires must be at least flush with, or extend slightly beyond, end of wire barrel.

- Operating Procedure cont:

  Continue pumping until pressure relief valve is activated. A slight decrease in effort required to push pedal down accompanied by a snapping sound, indicates that maximum required crimping pressure has been reached and that crimp is now complete.

  Press and hold return pedal. Ram in crimping head will return to down position, and crimped terminal or splice can be removed.

  Do not allow foot pump to remain under pressure for extended periods of time.

- Crimp Inspection:

  Crimps centered. Crimps may be off center but not off end of wire barrel.

  Embossed wire size matches CMA of wire being used and wire size stamped on terminal or splice.

  Insulation does not enter wire barrel.

  Wire is visible through inspection hole of terminal or butt splice.

  On parallel splices, bare wire ends must be flush with or extend beyond end of barrel.

- Operating Procedure: Dual crimp

  Verify that crimping dies are properly installed in head.

  Ensure the wire size stamped on the terminal or splice corresponds to the wire size stamped on the stationary die.

  To make the first crimp, place the terminal or splice in the stationary die. Ensure the crimp area of the dies is centered between the crimp marks of the terminal or splice.

  Pump pedal to activate unit. Continue pumping pedal until ram moves up and holds terminal or splice firmly in place without deforming the wire barrel. A sudden decrease in effort required to push pedal down will be observed during the initial buildup of pressure.

  Insert stripped wire until it bottoms in terminal or butt splice. End of wire must be visible through sight hole. Sight holes of butt splice must always face either upper or lower die.

  Insert stripped wires into parallel splice. Ends of wires must be at least flush with, or extend slightly beyond, end of wire barrel.

  Continue pumping until pressure relief valve is activated. A slight decrease in effort required to push pedal down accompanied by a snapping sound, indicates that maximum required crimping pressure has been reached and that crimp is now complete.

- Operating Procedure: Dual crimp Continued

  Press and hold return pedal. Ram in crimping head will return to down position, and crimped terminal or splice can be removed.

  To make the second crimp on terminals it will be necessary to either:
  Turn the terminal around
  Turn the crimping head around
  Turn the die set around

  For the second crimp, position the terminal or splice in the dies between the crimp marks on the lug.

  Operate the foot pump to complete the second crimp.

  Do not allow foot pump to remain under pressure for extended periods of time.

- Crimp Inspection:

  Crimps centered within crimp marks. Crimps may be off center but not overlapped or off end of wire barrel.

  Embossed wire size matches CMA of wire being used and wire size stamped on terminal or splice.

  Insulation does not enter wire barrel.

  Wire is visible through inspection hole of terminal or butt splice.

  On parallel splices, bare wire ends must be flush with or extend beyond end of barrel.

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- **CRDR 3616634 Splice Failure**

Description:

On 02/21/2011 at 8:01 p.m., a 13.8 kV cable splice (2ENA02NCIAA/AG), providing power from the Start-up Transformer A-E-NAN-X02 to 2E-NAN-S05B Switchgear Bus failed (went to ground), resulting in Units 1 and 3 Control Room alarms for Start-up Transformer NANX02, Winding Ground Differential Trip.

Supply power was lost to Unit 1 NANS06 and Unit 3 NANS05 Intermediate Buss along with Unit 1 safety bus 1-E-PBB-S04 and the Unit 3 safety bus 3-E-PBA-S03 respectively.

This resulted in actuation of the Unit 1 train “B” Emergency Diesel Generator (EDG) and Unit 3 train “A” Emergency Diesel Generator, Unplanned entry into a shut down Limiting Condition of Operations of 72 hours or less, a Licensee Event Report and the second site equipment reliability (ER) Clock Reset of 2011.

Direct Cause (DC)

The “Direct Cause” of failure for the 13.8 kV cable splice (2ENA02NCIAA/AG), is marginal Insulation build was not able to withstand localized electrical stresses cause by flared end of crimp connector.

Root Cause (RC-01)

The “Root Cause” of failure for the 13.8 kV cable splice (2ENA02NCIAA/AG), is the insulation system specified by Engineering was not robust and of marginal design. **(Could Craftsmanship be considered an issue?)**

EO: 1.8 Identify installation criteria for TYCO CSJA type cold shrink splices.

LESSON PLAN	METHODS AND ACTIVITIES
TYCO CSJA cold shrinkable joints are designed to splice tape shield, wire shield, LC shield, Unishield, flat strap, jacketed concentric neutral (JCN) and concentric neutral (CN) cables. **Features**: Pre-expanded, single piece silicone rubber joint body with high mechanical expansion capability. Total length of the splice body on the holdout is determined by the part number selected. The silicone rubber body provides high dielectric strength, high tear strength, low tension set and excellent low temperature recovery. Excellent electrical stress control by factory molded stress cones and Faraday cage. The joint accepts both mechanical and compression connectors.	Review APS video for features, preparation and buildup of the TYCO CSJA Cold Splice. If necessary, have the class build a splice.

- **Installation Requirements / Instructions**:

  Cable preparation:

  - The cable needs to be clean, degreased with the Primary insulation, Semicon, Shield (flatstrap, round or film/foil) and Cable Jacket trimmed to the required lengths as specified by the individual installation instructions used.

    Proper tools should be used to promote high levels of Craftsmanship

    Reference APN #114084 28Kv splice kit installation instructions.

    - Note: Trimmed shield ends should be taped to prevent sharp edges

  - The cable jacket will need to be slightly abraded a minimum of 6" back from the cutback of the shield wire. This will provide for a good sealing surface when the insulating mastic is applied. (water tight seal)

    Ref. APS Tyco Cold Splice Video.

    - On the side where the splice body will be parked, ensure the cable is cleaned approximately 40" to ensure no contamination is transferred to the inside of the body. Use an APS approved cleaning agent for the cable.

  Silicon Rubber Spiral Wound Holdout Body:

  - 2 markers which indicate: (1) the direction to pull the spiral wound sleeve and (2) the direction of the body in relation to the actual splice.

    Ref. APS Tyco Cold Splice Video.

Shear Bolt Connector installation:

- The Insert that is internal to the connector may need to be removed based on the cable size to be terminated.
- The Shear Bolt to primary insulation will have NO gap because no growth of the shear bolt is expected when compression is made.
- The Torque on the Shear Bolt should be done as follows
    - Hand tighten all bolts and then verify the semicon cutback to semicon cutback dimensions are within the spec of the splice you are installing.
    - Tighten the bolts using a 7/8" socket using ½ turn increments from the outside in. Continue on with ½ turn increments until all of the bolts shear.

  Note: Shearing may occur out of sequence.

- The connection must be abraided using the supplied sanding strip to remove any type of burrs associated with the shearing.

- Clean the connector and primary insulation with a clean rag.
    - Take extra care when cleaning the primary insulation.

Ref. APS Tyco Cold Splice Video or demonstrate with the kit

Ref. APS Tyco Cold Splice Video or demonstrate with kit.

Splice Body Installation:

- Mark the semiconductor areas with tape to ensure that the body stays centered to the splice. Use the dimensions provided in the instruction kit for the splice you are using.

  Ref. APS Tyco Cold Splice Video or demonstrate with the kit

- Lubricate the surfaces in which the splice body will be installed (Primary Insulation, Connector and Semicon) with the Silicon VCC grease.
  - Allows for adjustment of position of Splice Body when installing.
  - Use the protective rubber glove when spreading the grease.

- The splice can now be installed by simultaneously pulling the cord and spinning the body until it begins to “bite” onto the cable or by simply pulling and unwinding the cord.

  Ref. APS Tyco Cold Splice Video or demonstrate with the kit
  - When the body grips the cable, verify the positioning to the marking tape installed earlier at regular intervals.
  - Remove the spiral wound holdout cord when the splice is completely mated to the cable splice.
  - Ensure both ends of the splice body land on the simicon portions of the splice.

- Cut and remove the black tape holding the tinned copper shield on both sides of the splice.

Ref. APS Tyco Cold Splice Video or demonstrate with the kit

- Apply 4 turns of the supplied 2” tinned copper mesh onto the cable shield areas and tie off when done.
    - This mesh will bridge high contact points to minimize electrical stress.
    - .
- Extend the tinned copper shield from the splice over the previously installed mesh on the side which the ground braid will not be extended from. The spring clamp will now be installed with 2 layers to hold it in place.
    - Fold back any extruding tinned copper shield and clamp with the remaining spring clamp.

- On the opposite side, install the external grounding conductor by flaring the end of the grounding braid (near solder block) and lay it down onto the installed mesh.
    - Use some plastic tape to hold it in place.

- Extend the tinned copper shield over the braid and the mesh and install the spring clamp as done on the other side.
    - Ensure to fold back any extruding braid and strap and keep them under the remaining spring clamp.

- Apply 3 ½ lapped layers of plastic tape over the installed tinned copper shield and spring clamp back to the red mesh on both sides of the splice.
    - This aids in unfolding the main splice jacketing.

- Install the gray sealing mastic provided onto the insulation cutbacks on both ends of the cable near the splice.
    - The solder block of the ground braid will need to be lifted in order to facilitate mastic installation on the side the braid is on. The solder block should be positioned so that it will lay back over the installed mastic. This will provide the necessary seal when the final strip of mastic is installed over this solder block.
    - Install the last piece of provided mastic over the solder block and press into place to provide a good seal. No stretching of the mastic is necessary

Ref. APS Tyco Cold Splice Video or demonstrate with the kit

- Extend the rejacketing sleeve (black) by pulling and twisting back over the cable jacket on each side.
    - Cut off the remaining red mesh and Be careful not to touch the red mesh which has silicon on it and will smear on your gloves.
    - Clean any remaining silicon lubricant with a clean rag.

- Install a tie wrap ½' out from the installed spice to hold the ground braid in place.

- Installation is now complete.