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- Ultrinium™ sustained pressure injection method (U.S. Patent 7,615,247)
- Ultrinium™ formulation optimization injection method (U.S. Patent 7,611,748)
- Injection Adaptor (U.S. Patent 7,195,504 and 7,538,274)
- Perficio™ single switch injection (U.S. Patent 7,353,601)
- Predicting performance of Electrical Power cables (patent pending)
- Formulation of Ultrinium™ & Perficio™ components (patents pending)
- N-Rex™ submarine cable injection process (patent pending)
- N-Ter™ injection or Novinium thermally enhanced rejuvenation (patent pending)
- Reticular Flash Preventer (RFP) provides safer operation of conventional injection elbows (patent pending)

Version 20100607

Tailored Injection™

The Ultrinium™ Tailored Injection process utilizes one of two injection scenarios to rehabilitate aging cables. The most robust approach is sustained pressure rejuvenation (SPR), which is described in NRI-61. In addition to treatment benefits of sustained pressure, sustained pressure rejuvenation requires that all terminations and splices be replaced with modern components. Each component includes a stainless steel injection adaptor (IA) to avoid fluid contact with the component. Compatible [novinium certified](#) elbows and the Injection Adaptors (IAs) for 200-amp applications are listed in the Elbow Application table at the end of this document. The use of this paradigm should be maximized as it provides the highest value to capital cost ratio. In a small number of cases, pre-existing molded splices are located in positions where they are not feasible to access. In these cases, the less robust unsustained pressure rejuvenation (UPR) approach can be attempted. The unsustained rejuvenation process is described in NRI-62. Unsustained pressure rejuvenation requires that all terminations be replaced with injectable components. Compatible [novinium certified](#) injection elbows for 200-amp applications are listed in the Elbow Application table at the end of this document. The following pre-existing splice types are generally incompatible with the unsustained pressure rejuvenation method:

1. Heat-shrink splices
2. Cold-shrink splices
3. Hand-wrapped splices
4. Pin & socket splices
5. Molded splices for conductors of 250 kcmil (120 mm²) or larger
6. Modular or bolt-together splices

Note that SPR does not suffer these limitations. While not all molded splices support flow, about half of single piece EPDM splices may be injected. The use of the unsustained pressure method should be minimized for four reasons.

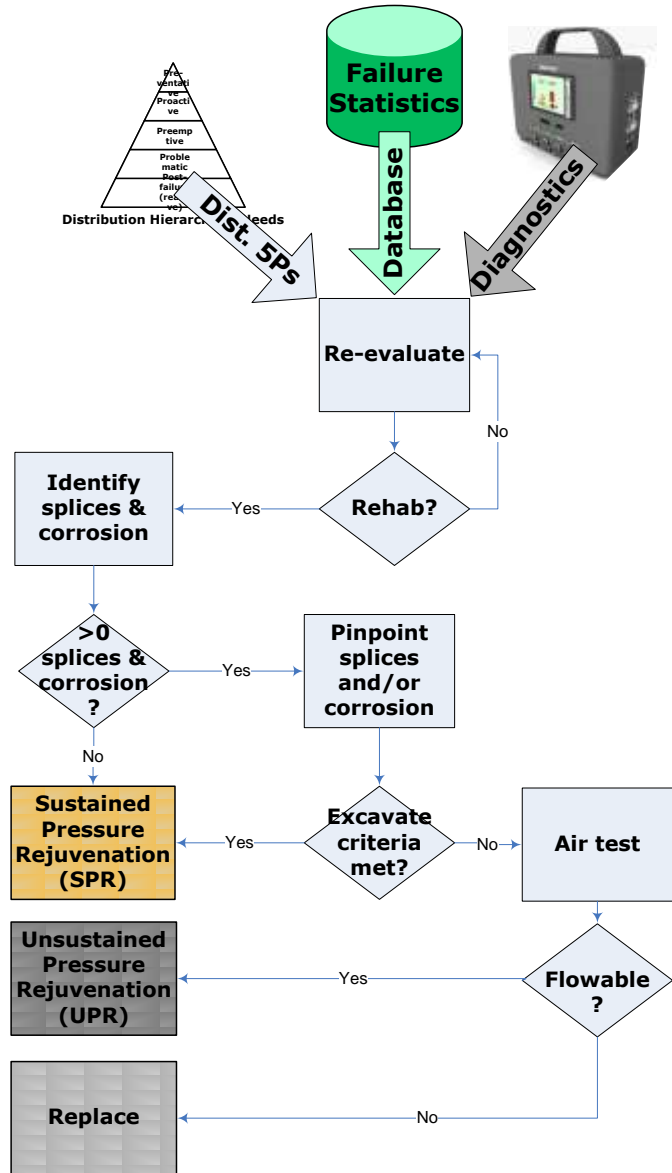
1. Some portion of the fluid injected through molded splices is absorbed in the splice and thus diverted from its target, the cable insulation.
2. At high conductor temperatures fluid absorption in the molded splice can swell the component and cause it to fail.
3. Interfacial contamination may sometimes occur. Subsequent tracking cannot be ruled out.
4. Splice components may be near the end of their reliable lifetimes and may fail independently of the treatment process.

Finally, if the cable cannot be treated with either of the two injection paradigms, it should be rehabilitated with the least capital effective (i.e. the lowest benefit to capital cost ratio) alternative, namely replacement.



Caution: Working around energized high-voltage systems may cause serious injury or death. The procedures in these instructions should be performed by personnel familiar with good safety practices in handling high-voltage electrical equipment. De-energize, test and ground all electrical systems before proceeding.

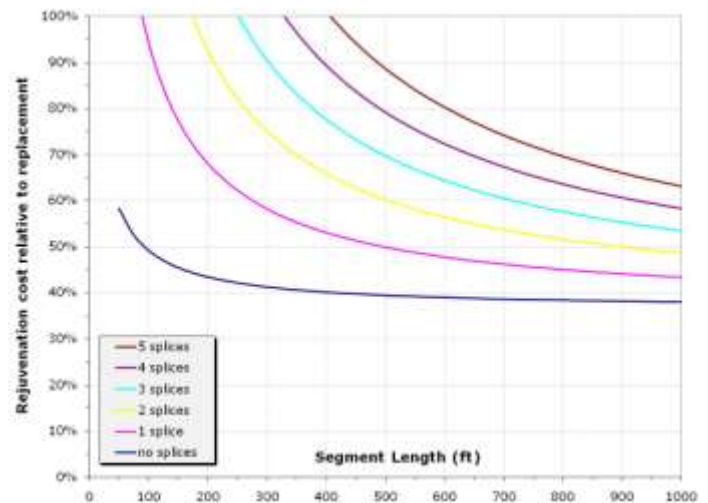
1. Rehabilitation efforts should be the result of a continual re-evaluation of the population of at-risk cables using all available historical reliability data. Rehabilitation proceeds as shown in the rehabilitation flow chart. Sustained pressure rejuvenation (SPR) enjoys the highest benefit to capital ratio and is applied whenever possible. See steps 2 and 3. Unsustained pressure rejuvenation (UPR) has the second best benefit to capital ratio and is applied to the majority of the untreated balance. See step 4. The residual portion of the population is replaced with the least capital efficient process. See Step 5.



2. If there are no splices and no significant neutral corrosion, execute the instructions in NRI 61.



3. If there are splices and/or significant corrosion sites, refer to the guidelines published in Exhibit F of the Novinium rehabilitation proposal. Excavate and repair up to the number of splices (See NRI 31 and NRI 32) and corrosion (See NRI 80) sites indicated in Exhibit F for the cable length being considered.



Typical Exhibit F excavation guidelines

4. If the number of splices and/or corrosion sites exceeds the Step 3 guidelines or if special circumstances make one or more excavations impractical, execute NRI 62.



5. As a last resort, replace those cables that have not been rejuvenated. Cables with multiple splices are likely the least reliable.



Novinium Certified Elbow Application Table ¹				200 Amp Elbow Connector ^{5,6}								
Voltage & Type	Conductor AWG-Ins. Thickness Cable Table # ²	Conductor/Insulation Nominal Diam. (in) ³	Injection Adapters	Manufacturer ⁴	Standard Elbows			Injection Elbows ^{7,8}				
					Standard Length ⁸	Recommended Connectors	Repair Length	Standard Length	Novinium Part Number	Repair Length with Test Point	Novinium Part Number	
15kV load-break	#2-175 1	0.282 / 0.734	2-2	Cooper	LE215A-04	Richards	P2ALCU-7	167ELR-6689 5 220	167ALR -F	1-EB-15kV064-082-S	168AELR 6689	1-EB-15kV066-089-L
				Hubbell	9U01ABD623							
				Elastimold	165LR-A							
	#2-220 16	0.282 / 0.792	3-2	Cooper	LE215A-04	Richards	P2ALCU-7	167ELR-7495 5 220	167ALR -F	1-EB-15kV064-082-S	168AELR 7495	1-EB-15kV074-095-L
				Hubbell	9U01ABD633							
				Elastimold	165LR-B							
	1/0-175 3	0.373 / 0.777	3-2	Cooper	LE215B-06	Richards	P2ALCU-9	167ELR-7495 5 240	167ALR -F	1-EB-15kV064-082-S	168AELR 7495	1-EB-15kV074-095-L
				Hubbell	9U01ABD635							
				Elastimold	165LR-B							
1/0-220 18	0.373 / 0.877	4-2	Cooper	LE215B-06	Richards	P2ALCU-9	167ELR-7495 5 240	167ALR -G	1-EB-15kV076-095-S	168AELR 7495	1-EB-15kV074-095-L	
			Hubbell	9U01ABD645								
			Elastimold	165LR-B								
2/0-175 4	0.418 / 0.824	4-2	Cooper	LE215B-07	Richards	P2ALCU-10	167ELR-7495 5 250	167ALR -G	1-EB-15kV076-095-S	168AELR 7495	1-EB-15kV074-095-L	
			Hubbell	9U01ABD646								
			Elastimold	165LR-B								
2/0-220 19	0.418 / 0.924	5-3	Cooper	LE215C-07	Richards	P2ALCU-10	167ELR-88110 5 250	167ALR -H	1-EB-15kV085-105-S	168AELR 88110	1-EB-15kV088-110-L	
			Hubbell	9U01ABD646								
			Elastimold	165LR-C								
3/0-175 5	0.470 / 0.878	5-4S	Cooper	LE215B-08	Richards	P2ALCU-11	167ELR-7495 5 260	167ALR -G	1-EB-15kV076-095-S	168AELR 7495	1-EB-15kV074-095-L	
			Hubbell	9U01ABD647								
			Elastimold	165LR-C								
4/0-175 6	0.528 / 0.938	5-3	Cooper	LE215C-09	Richards	P2ALCU-12	167ELR-88110 5 270	167ALR -H	1-EB-15kV085-105-S	168AELR 88110	1-EB-15kV088-110-L	
			Hubbell	9U01ABD648								
			Elastimold	165LR-C								
4/0-220 21	0.528 / 1.038	6-3	Cooper	LE215C-09	Richards	P2ALCU-12	167ELR-88110 5 270	167ALR -J	1-EB-15kV098-118-S	168AELR 88110	1-EB-15kV088-110-L	
			Hubbell	9U01ABD658								
			Elastimold	165LR-D								
25kV load-break	#2-260 273	0.292 / 0.852	4-2	Cooper	LE225MB-04	Richards	P2ALCU-7	273ELR-6689 5 240	273ALR -G	1-EB-25kV076-095-S	274AELR 7495	1-EB-25kV074-095-L
				Hubbell	9U01BBD623							
				Elastimold	275LR-CC							
	#1-260 88	0.322 / 0.888	4-2	Cooper	LE225MB-05	Richards	P2ALCU-8	273ELR-7495 5 230	273ALR -G	1-EB-25kV076-095-S	274AELR 7495	1-EB-25kV074-095-L
				Hubbell	9U01BBD633							
1/0-260 32	0.373 / 0.941	5-2	Cooper	LE225MB-06	Richards	P2ALCU-9	273ELR-88110 5 240	273ALR -CC	1-EB-25kV080-106-S	274AELR 88110	1-EB-25kV088-110-L	
			Hubbell	9U01BBD645								
			Elastimold	275LR-CC								
2/0-260 33	0.418 / 0.988	6-2	Cooper	LE225MD-07	Richards	P2ALCU-10	273ELR-88110 5 250	273ALR -CC	1-EB-25kV080-106-S	274AELR 88110	1-EB-25kV088-110-L	
			Hubbell	9U01BBD646								
4/0-260 35	0.528 / 1.102	7-3	Cooper	LE225MD-09	Richards	P2ALCU-12	273ELR-K 5 270	273ALR -DD	1-EB-25kV094-117-S	274AELR K	1-EB-25kV109-131-L	
			Hubbell	9U01BBD658								
				Elastimold	275LR-DD							

Novinium Certified Elbow Application Table ¹				200 Amp Elbow Connector ^{5,6}							
Voltage & Type	Conductor AWG-Ins. Thickness Cable Table # ²	Conductor/Insulation Nominal Diam. (in) ³	Injection Adapters	Manufacturer ⁴	Standard Elbows			Injection Elbows ^{7,8}			
					Standard Length ⁸	Recommended Connectors	Repair Length	Standard Length	Novinium Part Number	Repair Length with Test Point	Novinium Part Number
35kV load-break	1/0-345 45	0.373 / 1.111	7-2 or 8-2	Cooper Hubbell Elastimold	LE235D-06 9U01DBD655 375LR-J	Richards P2ALCU-9		LEIN235D-06 ⁷	1-EB-35kV099-118-06 ⁷		
	2/0-345 46	0.418 / 1.158	8-2S	Cooper Elastimold	LE235D-07 375LR-K	Richards P2ALCU-10		LEIN235D-07 ⁷	1-EB-35kV099-118-07 ⁷		
	4/0-345 47	0.528 / 1.272	9-3	Cooper Elastimold	LE235F-09 375LR-K	Richards P2ALCU-12		LEIN235F-09 ⁷	1-EB-35kV099-118-09 ⁷		
15kV/ 25kV dead-break	#2-175 1	0.282 / 0.734	2-2	Cooper Elastimold	DE225 DA 04 T 156LR-F	Richards P2ALCU-7		156ALR- F	1-EB-15-25kV064-082		
	#2-220 16	0.282 / 0.792	3-2	Cooper Elastimold	DE225 DA 04 T 156LR-F	Richards P2ALCU-7		156ALR- F	1-EB-15-25kV064-082		
	1/0-175 3	0.373 / 0.777	3-2	Cooper Elastimold	DE225 DA 06 T 156LR-F	Richards P2ALCU-9		156ALR- F	1-EB-15-25kV064-082		
	1/0-220 18	0.373 / 0.877	4-2	Cooper Elastimold	DE225 FA 06 T 156LR-G	Richards P2ALCU-9		156ALR- G	1-EB-15-25kV076-095		
	1/0-260 32	0.373 / 0.941	5-2	Cooper Elastimold	DE225 HA 06 T 156LR-H	Richards P2ALCU-9		156ALR- H	1-EB-15-25kV085-105		
	2/0-175 4	0.418 / 0.824	4-2	Cooper Elastimold	DE225 FA 07 T 156LR-G	Richards P2ALCU-10		156ALR- G	1-EB-15-25kV076-095		
	2/0-220 19	0.418 / 0.924	5-3	Cooper Elastimold	DE225 FA 07 T 156LR-H	Richards P2ALCU-10		156ALR- H	1-EB-15-25kV085-105		
	2/0-260 33	0.418 / 0.988	6-2	Cooper Elastimold	DE225 HA 07 T 156LR-H	Richards P2ALCU-10		156ALR- H	1-EB-15-25kV085-105		
	3/0-175 5	0.470 / 0.878	5-4S	Cooper Elastimold	DE225 FA 08 T 156LR-G	Richards P2ALCU-11		156ALR- G	1-EB-15-25kV076-095		
	4/0-175 6	0.528 / 0.938	5-3	Cooper Elastimold	DE225 HA 09 T 156LR-H	Richards P2ALCU-12		156ALR- H	1-EB-15-25kV085-105		
	4/0-220 21	0.528 / 1.038	6-3	Cooper Elastimold	DE225 HA 09 T 156LR-J	Richards P2ALCU-12		156ALR- J	1-EB-15-25kV098-118		
	4/0-260 35	0.528 / 1.102	7-3	Cooper Elastimold	DE225 HA 09 T 156LR-J	Richards P2ALCU-12		156ALR- J	1-EB-15-25kV098-118		

Notes

- For 200 amp standard elbows apply the Novinium prefix "1-EB-" to the manufacturer's part number to identify the Novinium part.
- The Cable Table # is the "Cable Number" (first column) in the NRI-21 Cable Table.
- Conductor diameter, insulation O.D., elbow and connector size are based on uncompressed stranded conductor. Cables with compressed or compact conductor will have different conductor and insulation diameters and may require a different size elbow or connector. See the manufacturer's catalogs.
- Cooper is a registered trademark of Cooper Power Systems. Hubbell is a registered trademark of Hubbell. Elastimold is a registered trademark of Thomas & Betts. Richards is a trademark of Richards Manufacturing, Inc.
- Except for standard length injection elbows, many elbows may be purchased with capacitive test points. For Elastimold elbows add 1 to the 3 digit part number. The 3 digit part numbers for standard elbows for non-test point and test point elbows respectively are 165 & 166 for 15kV, 275 & 276 for 25kV, and 375 & 376 for 35kV. The 3 digit part numbers for injection elbows for non-test point and test point elbows respectively are 167 & 168 for 15kV and 273 & 274 for 25kV. For other part numbers see the manufacturer's catalogs.
- A blank indicates that a Novinium Certified Elbow is not available. Please contact Novinium engineering for options.
- Each Cooper® brand 35kV large interface injection elbow requires a sealed probe kit. Specify Novinium part number 1-UP-PKI235BP for 3Φ sealed probe and 1-UP-PKISS235CKBP for 1Φ sealed probe.
- Each standard length Elastimold® brand and Richards brand standard elbow requires a compression connector from the adjacent "Recommended Connectors" column.