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General Comment

Docket-2010-0202

DG-1240

The Nuclear Energy Institute (NEI) provided comments in a separate letter that recommends that DG-1240 be withdrawn. Comments received by our members on DG-1240 are in the two attached files.

Gordon Clefton
NEI, Senior Project Manager

Attachments

NRC-2010-0202-DRAFT-0006.1: Comment on FR Doc # 2010-14339
NRC-2010-0202-DRAFT-0006.2: Comment on FR Doc # 2010-14339

SUNSI Review Complete
Template = ADM-013

E-RIDS = ADM-03
Add = R.A. Jervey (RAJ)
M. Case (MJC)

DG-1240 – General Comments

ID	Section, Page, and Line #	Referenced Text	Comment
1	Section B Page 2 of 13 Paragraph 2	"The integrity of electric cables is monitored, to some extent, through periodic inservice testing of the equipment to which they are attached; however, this testing does not specifically focus on the cables and may not be sufficient to detect all of the aging and other degradation mechanisms to which a particular cable is susceptible. While these tests can demonstrate the function of the cables under test conditions, they do not verify the continued successful performance of cables when called upon to operate fully loaded for extended periods, as they would under anticipated normal service operating conditions or under design-basis conditions. Nor does inservice testing of a cable provide specific information on the status of aging degradation processes or the physical integrity and dielectric strength of its insulation and jacket materials."	This section does not credit redundancy of equipment or trains for insuring that the intended function will not be lost if a cable were to fail. Since redundant equipment is available to pick up the function, it is not likely that cables to both pieces of redundant equipment would fail simultaneously. Cable failures are random and for most failures only one of the three phases of a power cable would fail to ground. This gives a ground alarm and alerts the operators to take action.
2	Section B Page 3 of 13 Paragraph 5	"Generic Letter 2007-01 observed that cable insulation degradation as a result of continuous wetting or submergence could affect multiple underground power cable circuits at a plant site; should one of these medium-voltage cables fail, the resulting high-level fault currents and transient voltages would propagate onto the immediate power distribution system and potentially fail other systems with degraded power cable insulation."	This is an over dramatization of the consequences of a power cable failure scenario to make the case for the need to have a cable program. A cable would fail phase to ground in only one phase; it would punch a hole in the insulation and thus ground the conductor to the shield. This will give a ground alarm to alert the operators to take the associated equipment out of service. The description described would apply to the unlikely phase to phase cable failures or to a termination failure. Operating experience with cable failures shows that only the termination failures that ended up with phase to phase shorts had the fire and damage. The redundant equipment and cable routing are separated from each other, so a fire will not affect redundant equipment.

3	Section B Page 3 of 13 Paragraph 6	"While in many cases the failed cables were identified through current testing practices, some of the failures may have occurred before the failed condition was identified (i.e., on cables that are not normally energized or tested)."	Equipment with safety functions require periodic surveillance testing; thus, the cables and accessories in the circuit are energized and proven to be functional periodically. Operating experience shows that cable failures occurred in cables that were continuously energized and loaded. No failures occurred in cables that were mostly de-energized.
4	Section B Page 4 of 13 Item 1 and 2	*1. Direct Current High-Potential Test (dc High Voltage)* *2. Step Voltage Test (dc High Voltage)*	Test discussions 1 and 2 describe DC High Potential Testing. While the discussion states that EPRI research indicates that this testing could damage or cause field aged cable to fail prematurely, it does not mention that IEEE also recommends that this test only be done on new cable installations and not be performed after the cable is 5 years old. There is also no mention of the Very Low Frequency (VLF) AC Withstand Test that is recommended to replace this DC testing.
5	Section B Page 5 of 13 Item 3	*3. Illuminated Borescope*	Operating experience with the use of the borescope is successful in locating water in underground conduits; however, the borescope is limited because it could only be used in conduits that are slightly filled and could not be used in conduits that are full of cables. Also at times the geometric layout of the cables inside the conduits may become a physical obstruction and not allow the borescope to go all the way into the conduit. Another disadvantage is that on long runs it is not possible to push the borescope all the way into the conduit due to friction. Yet another disadvantage that isn't mentioned is the potential to damage the cable and/or cable jacket during insertion of the borescope.

6	Section B Page 5 of 13 Item 4	*4. Visual Inspection*	Visual inspection is useful for cables installed in trays that may be subjected to heat or radiation. Most cables are in mild environment and limited visual inspection will not offer any idea of the condition of the cable in the underground conduits or in inaccessible conduits in adverse thermal or radiation environments.
7	Section B Page 6 of 13 Item 6	"The dielectric loss-dissipation factor or power factor test (tan δ test) can be used to diagnose problems in low- and medium-voltage cables". "...the test should not be performed on low-voltage (600 volt) and 5,000 volt unshielded cables because of safety concerns and unreliable test results resulting from an undefined ground return path, and the amount of capacitance in the cable circuit limits the test such that standard test equipment cannot test very long and larger conductor cables."	There is conflicting information in this section about the use of tan δ test on LV cables. This tan δ test should be strictly for shielded medium voltage cables.
8	Section B Page 7 of 13 Item 9	*9. Time Domain Reflectometry*	Test discussion 9 describes Time Domain Reflectometry or TDR testing. The statement is made that this test "is able to detect aging mechanisms such as thermally induced cracking, radiation-induced cracking, and severe mechanical damage". Operating experience reveals that the induced cracking is only picked up after it is severe enough to cause cable failure.
9	Section B Page 8 of 13 Item 11	"Disadvantages are that it requires training and experience for best results, measurements made when the circuit is operating at load can lead to safety concerns, high-end imagers and analysis software are expensive, and the cables and accessories to be monitored must be visually accessible."	This is useful for termination and joint hot spots for cables and equipment, but cables and accessories to be monitored must be visually accessible. Most terminations are not accessible in the switchgear and motor termination boxes while the circuit is energized to perform thermography. Plant clearance and safety procedures do not allow opening covers.

10	Section B Page 8 of 13 Item 11	*11. Infrared Imaging Thermography*	Test discussion 11 describes thermography and states that this test "is able to detect aging mechanisms such as thermally induced embrittlement and cracking". This statement is misleading since the only thing thermography reports is the temperature. With the temperature, some knowledge of the cable, and the Arrhenius methodology, if the cable has been environmentally tested, then one may be able to estimate the remaining life in the cable, but it won't tell you if there is thermally induced embrittlement and cracking.
11	Section B	Draft Regulatory Guide DG-1240: Condition Monitoring Program for Electric Cables Used in Nuclear Power Plants	The industry feels that cables subjected to environmental stressors should be monitored, yet the NRC has indicated an expectation that even cables in a benign environment should be monitored.
12	DG-1240	Draft Regulatory Guide DG-1240: Condition Monitoring Program for Electric Cables Used in Nuclear Power Plants	Condition monitoring is not necessary for cables that are not exposed to adverse environments or operating conditions. If a cable were scoped into the aging management program, condition monitoring would not be necessary due to the fact the cable is not routed through an adverse environment. Condition monitoring for all cables in the scope of the Maintenance Rule would be an extraordinary quantity of cable and such a cost of resources would not be justified by the gain in cable failure prediction.

DG-1240 – Specific Comments

ID	Section, Page, and Line #	Comment	Proposed Resolution
1	Section B Page 2 of 13 Paragraph 2	"The integrity of electric cables is monitored, to some extent, through periodic inservice testing of the equipment to which they are attached" This sentence discusses periodic "surveillance" tests, but calls them "inservice" tests, which are generally more significant tests used to establish adequacy of components or systems, such as NDE of reactor vessel welds.	Change "inservice tests" to "surveillance tests."
2	Section B Page 2 of 13 Paragraph 2	"While these tests can demonstrate the function of the cables under test conditions, they do not verify the continued successful performance of cables when called upon to operate fully loaded for extended periods, as they would under anticipated normal service operating conditions or under design-basis conditions." This sentence infers that cables operated "fully loaded" would be expected to fail. Nuclear power plant cables are operated well below their ampacity limits such that normal and emergency loads are well within their capacity. There is no basis for stating that operating loaded will adversely affect cable function. Cables fail if they cannot withstand voltage. Current related issues are limited to only to connections that have installation errors or multi-conductor per phase cables that are not magnetically or electrically balanced.	Delete "fully loaded" from the sentence.

3	Section B Page 2 of 13 Paragraph 2	"Nor does inservice testing of a cable provide specific information on the status of aging degradation processes or the physical integrity and dielectric strength of its insulation and jacket materials." The sentence states that tests do not evaluate the dielectric strength of jackets. The dielectric strength of a cable jacket is not an important factor.	Reword sentence to: "...or the dielectric strength of insulation or physical integrity of jackets and insulation."
4	Section B Page 2 of 13 Paragraph 2	The DG conflicts with the language of both paragraph (a)(1) and (a)(2) that allows either performance or condition monitoring. DG-1240 implies that cable failures are not acceptable and that performance monitoring alone is not sufficient. If the risk model demonstrates that failures of supported equipment can be tolerated, then the failures of the associated cable can also be tolerated. Performance monitoring is acceptable unless the failure of the support equipment cannot be tolerated, in those circumstances condition monitoring is recommended. Inservice testing does not detect all degradation mechanisms of the equipment being tested.	Recommend adding guidance: Condition monitoring for cables when: • Failure of equipment supported by the affected cable cannot be tolerated. • Failure history of the cable indicates that performance monitoring is not sufficient. For example, an increasing number of failures may indicate the cable has reached the backend of the aging curve and condition monitoring would be useful at this time. • Equipment is subjected to an adverse environment other than the conditions for which it was designed.

5	Section B Page 2 of 13 Paragraph 3	"There has been concern that such local adverse environmental stressors can cause excessive aging and degradation in the exposed sections of a cable that could significantly shorten its qualified life and cause unexpected early failures." This sentence states that degradation could "significantly shorten its qualified life…" The only cables that have regulated "qualified lives" are those subject to 10CFR50.49. The qualified lives are highly controlled and adverse environments are carefully considered and taken into account. Circuits in mild environments do not have "qualified lives" under NRC regulations. EQ cables must and are replaced before the end of their qualified lives. Qualified lives in nuclear power plants range from an operating cycle to more than the entire licensed period including license renewal.	Delete "There has been a concern that such". Begin sentence with "Local". Provide support for statement that local adverse environmental conditions shorten the cable life. Delete "significantly" Delete the word "qualified" from the sentence or change the sentence to read: "… in the exposed sections of a cable that could lead to failure."

6	*Section B* Page 2 of 13 Paragraph 4	*"... cable system operating environments or locally adverse* conditions that are unanticipated or more severe than original plant design may constitute a design deficiency of the cable system. A cable system must be designed to meet applicable regulations and to perform its intended function in the plant environment under all anticipated operational occurrences and design basis events." A change in the cable environment is not a failure of the cable design; corrective action is done to the environment—not the cable. If the environment cannot be returned to its design, then cable and other SSCs designed for the new environment could be used. DG-1240 refers to adverse localized environments (ALE). For cables most ALEs will occur due to temporary plant conditions such as insulation or heat shields removed for maintenance activities and not replaced in a timely manner, crushed or damaged insulation, pipe or roof leaks, hose rupture, or chemical spill. Degradation or damage to nearby cables by these events would not be due to an "original" cable design deficiency.	Remove the clause "of the cable system ". The term "anticipated operational occurrences" should be defined to account for the existence of temporary adverse localized environments (ALEs).
7	Section B Page 3 of 13 Paragraph 1	"Since most of these underground distribution systems are largely inaccessible, wetted and flooding conditions remain undetected for extended periods of time." This sentence states that flooded conditions always remain undetected. This may be true at some plants but is not the case at others.	Change to "may remain undetected for extended...."
8	Section B Page 3 of 13 Paragraph 1	"Eventually, power and control cables that are not designed to operate in a submerged state will experience early failures, often resulting in significant safety consequences" There is no proof that any significant portion of the population will experience early failures. Early failures are possible but are not a given.	Restate as "Eventually, power and control cables that operate in a submerged state may experience early failures that may result in a safety consequence." This would be a correct characterization.

9	Section B Page 3 of 13 Paragraph 1	"...should one of these medium-voltage cables fail, the resulting high-level fault currents and transient voltages would propagate onto the immediate power distribution system and potentially fail other systems with degraded power cable insulation." This concept has no physical basis and is an unsupported hypothesis. There are no phenomena that would lead to this condition. If the statement is meant to mean that over trips are possible, that should be stated. There is no basis to say that it is likely that additional cable failures will result. There is no history of such events.	Delete the referenced sentence.
10	Section B Page 3 of 13 Paragraph 2	"Operating experience reveals that the number of cable failures is increasing with plant age, and that cable failures are occurring within the plants' 40-year licensing periods." This sentence states that operating experience indicates an increasing trend in failures. This statement is based on an inadequate review of the data. Failure trends are stable and have not increased significantly. Failures are occurring, but not with an increasing rate, nor at a particularly high rate. In the GL 2007-01 results, NRC Staff recorded only 269 failures at 104 plants over a twenty-two year period; roughly 1 failure per plant per decade.	Delete the referenced sentence or provide a statistically sound assessment of the data. See EPRI 1019160 for a statistical analysis of medium voltage cable failures.
11	Section B Page 3 of 13 Paragraph 2	"While in many cases the failed cables were identified through current testing practices, some of the failures may have occurred before the failed condition was identified (i.e., on cables that are not normally energized or tested)." The second half of the sentence is confusing. It should directly indicate that some events were in-service failures and not detected prior to failure. There have been very few failures that have occurred the instant a non-energized cable was energized. Failures most often occur some period after energization.	Change the sentence to read "While in many cases cable degradation was detected by current testing practices, some degradation led to failures during service and sometimes shortly after energization of a normally de-energized cable."

12	Section B Page 3 of 13 Paragraph 2	"Therefore, it is necessary to monitor the condition of electric cables throughout their installed life through the implementation of a cable condition monitoring program." There is no need to assess all cables, especially those in benign conditions. There is no need to evaluate cables through their entire lives given that there are long inception periods for all of the aging concerns.	The sentence should be revised to incorporate "cables subject to adverse conditions should be monitored for condition at or before the point of susceptibility to the adverse condition"
13	Section B Page 3 of 13 Paragraph 2	DG-1240 omission. Regulatory Guide should characterize the length of time that cables may be in wetted or flooded conditions without an adverse affect.	The industry consensus as documented in EPRI-1020805 – "Aging Management Program Guidance for Medium-Voltage Cable Systems for Nuclear Power Plants", is that water migration through the cable jacket and insulation may take months to years to occur.
14	Section B Page 3 of 13 Paragraph 2	"Eventually, power and control cables that are not designed to operate in a submerged state will experience early failures, often resulting in significant safety consequences." There is no scientific basis for considering a wet aging stressor for low-voltage cable insulation (rated ≤ 2kV, nominal system voltages ≤ 600V). DG-1240's Reference [8] SAND-0344 (its Table 4-18 and elsewhere) clearly establishes the wet-aging stressor for MV power cables and NOT LV cables. IEEE has NOT found necessary the development of any equivalent LV cable testing guidance as in the IEEE 400 series for MV power cables.	Reword to: 'Eventually, medium voltage power and control cables that are not designed to operate in a submerged state may experience early failures.'

15	Section B Page 3 of 13 Paragraph 3	This paragraph presents a list of "ideal" characteristics. Almost no condition monitoring test exists that meets all of these conditions. Useful tests are rarely non-intrusive. Medium voltage testing especially is likely to demand that cables be disconnected and subjected to elevated voltages. Some tests such as withstand tests, are purposely destructive to deteriorated cables. Some tests provide an indication of current acceptability and a reasonable expectation of a period of acceptable performance, but cannot provide a quantifiable remaining life. Some of the most useful tests will not provide a location of the degradation.	Providing the list of ideal attributes serves no useful purpose; delete it.
16	Section B Page 3 of 13 Paragraph 3	This paragraph implies that cable failure in unacceptable. The last sentence indicates that all cables should be condition monitored. This is inconsistent with the risk informed principles of the Maintenance Rule. Cables are considered to "Inherently reliable" as defined by and have been monitored under paragraph (a)(2) without preventive maintenance. As stated in the NUMARC 93-01, section 9.3.3, line 29, "The need to place an SSC under (a)(1) and establish goals may arise the inherently reliable SSC has experience a failure."	Recommend adding guidance: Condition monitoring for cables when: • Failure of equipment supported by the affected cable cannot be tolerated. • Failure history of the cable indicates that performance monitoring is not sufficient. For example, an increasing number of failures may indicate the cable has reached the backend of the aging curve and condition monitoring would be useful at this time. • Equipment is subjected to an adverse environment other than the conditions for which it was designed.

17	Section B Page 4 of 13 Paragraph 1	"....which are recommended for use, when appropriate", Items 1 and 2 repeat the erroneous listing in Ref. [6] NUREG/CR-7000. The IEEE 400 series, especially IEEE 400.1 [Ref. 10] establishes high-voltage DC testing as recommended for cables with laminated insulation (like covered paper) and NOT to the extruded solid insulations as used at nuclear power plants. EPRI research confirms the potential harm in applying the DC high-potential tests and adds a cautionary recommendation precluding their use.	Delete items 1 and 2: *1. Direct Current High-Potential Test (dc High Voltage)* *2. Step Voltage Test (dc High Voltage)*
18	Section B Page 4 of 13 Paragraph 1	"Many condition monitoring techniques (e.g., elongation at break, compressive modulus, density) are localized indicators of the condition at the specific place along a cable circuit where the measurement is made; cable properties measured at multiple points may show the cable to be in sound condition, but a measurement made only inches away at a more severely stressed section could show otherwise" The statement seems to be trying to prove the impossibility of assessment rather than that assessment is possible. Assessment of worst case stress points along a cable allows the condition of the rest of the cable to be determined.	Practical means of assessing cables should be described rather than inferring that assessment with existing practices are not possible. One must look at the highly stressed portion of a cable. If that section is in good condition, the rest of the cable is acceptable. If it is deteriorated, that section must be repair or replaced or the entire cable must be replaced.

19	Section B *Page 4 of 13* Paragraph 1	"Furthermore, the criteria used to define cable functional *condition or accident survivability for a particular circuit are* application specific. Consequently, the use of absolute acceptance criteria for a single specific condition monitoring technique is neither meaningful nor practical." These statements are not helpful data and criteria exist that are useful for certain conditions and cable types. These statements are negative and not supportive of the desire to implement condition monitoring efforts.	Deletion of the entire paragraph is probably best. Characterizing CM in a positive light and describing what is currently possible would be much more useful. I do not suggest overstating the usefulness or state of the art in CM, but the statements given indicate that there is no hope. The reality is that CM processes will provide significant insights into condition of cable and allow decisions on which ones are satisfactory and which ones need corrective action.
20	Section B Page 4 of 13 Paragraph 1	"Consequently, the use of absolute acceptance criteria for a single specific condition monitoring technique is <u>neither</u> meaningful nor practical." A change is needed because for 600V power cable, which has no shield, there is only one diagnostic test that can be performed in the field, Insulation Resistance/Polarization Index (PI). Partial discharge is for medium voltage only, LIRA while very promising for low voltage cables will not be commercially available for several years. For low voltage power cable that has been in service 30+ years TDR can detect connector corrosion, water intrusion and associated conductor corrosion, and strand breakage. It cannot pick up the small changes in dielectric properties of the insulation due to normal aging.	Delete the word "neither "and insert "may not be".

21	Section B *Page 4 of 13* Paragraph 1	"It would be more effective to set administrative quantitative *or qualitative acceptance criteria for screening-type cable* condition monitoring inspections and tests (e.g., visual inspection, bulk electrical properties tests, or functional tests) that, when exceeded, could then administratively trigger more detailed inspection and retesting, or further testing using additional condition monitoring techniques to provide an expanded characterization of cable condition and degree of insulation degradation. The results of the expanded inspection and testing could then provide sufficient information to conduct a formal assessment of the cable's condition and initiate appropriate corrective actions." This concept is not based on any practical experience and provides no useful information on actual implementation of a program.	Delete the paragraph. Once plants begin implementation of aging management programs, the insights gained will drive the need for further actions.
22	Section B Page 4 of 13 Paragraph 2	NUREG/CR-7000 contains numerous technical errors, does not discriminate between medium and low voltage cable applications, or wet and dry applications. The operating voltages and environments and the associated degradation mechanisms drive applicability and selection of appropriate test methods. The NUREG could cause plant personnel to implement methods that provide no useful information and could lead to incorrect conclusions (e.g., that deteriorated cables are in acceptable condition). Useful guidance would provide indications of the direct applicability of methods for specific conditions and concerns. Generalized information and incorrect information is not useful to the industry.	This document should not reference NUREG/CR-7000.
23	Section B Page 4 of 13 List of Individual Condition Monitoring Methods	The degradation mechanisms of cables are different for medium and low voltage cables and for wet and dry conditions. These differences drive the test and evaluation methodology that would be selected.	Divide the discussion of test techniques into applicability to medium and low voltage cables and further divide each into applicability to cables in wet and dry service conditions.

24	Section B Page 4 of 13 Item 1	"The direct current (dc) high-potential test (HPT) is a pass/fail test applicable to medium-voltage power cables and all insulation and jacket materials." DC high potential testing is only applicable to lead covered, paper insulated cable (PILC). IEEE Std 400 and 400.1, the standards that govern elevated voltage tests state that the DC test should not be used on extruded polymer cable. The first concern is that DC high-pot could cause additional degradation to XLPE without causing failure in the test or indicating a problem exists. Equally as important, IEEE Std 400 states that DC testing will miss very significant defects for any polymer insulated cable. DC high potential tests are only recommended for PILC where they have been proven to be useful. The "recent" EPRI research that is alluded to in the draft Regulatory Guide is from 1995 and is well accepted across the industry.	The only statement about DC high-pot testing that should be made is that it is not recommended for polymer insulated cable, the dominant type of insulation in the nuclear industry, but is useful for PILC. Delete this entire section.
25	Section B Page 5 of 13 Item 1	"Among the conclusions reached in the EPRI study are that dc HPTs of field-aged cables can reduce cable life, dc HPTs of field-aged cables generally increases water tree growth, and pre-energization dc HPTs of new medium-voltage cable does not significantly reduce in cable life."	Insert a period after "growth" and delete everything past the period. Insert a new last sentence that says, "Initial DC HPTs of newly installed medium voltage cable does not significantly reduce cable life."
26	Section B Page 5 of 13 Item 1	Since the cable must be disconnected to perform the DC high-potential test (HPT), the HPT should not be considered as a "relatively easy to perform" test. The test itself is easy to perform; however, test preparation, cable termination and post testing/re-test would add significant work. The DC HPT is not a trendable test.	Remove the wording "it is relatively easy to perform". Add a sentence on the disadvantages to say that the DC HPT does not provide trendable information.

27	Section B Page 5 of 13 Item 2	All of the comments in Item 1 apply here. The same problem exists with the step voltage test as the DC high pot test. It applies to PILC not polymer cable.	Delete this section or make it specific to PILC.
28	Section B Page 5 of 13 Item 2	Like the DC HPT, the cable must also be disconnected to perform the step voltage test (SVT). This test should not be considered as "relatively easy to perform" test. The test itself is easy to perform; however, test preparation, cable termination, and post testing/re-test would add significant amount of work.	Remove the wording "it is relatively easy to perform".
29	Section B Page 5 of 13 Item 2	Regulatory Guide discussion concerning DC high voltage step test should be very clear that this test should only be used as an acceptance test prior to field energization. IEEE-400 discusses the latent failure potential for aged cables which are DC high potential tested.	State: DC high voltage step test should only be used as an acceptance test prior to field energization.
30	Section B Page 5 of 13 Item 3	While a boroscope may be a useful tool for identifying wet conditions or damage to ducts, the method is unlikely to provide useful condition monitoring information concerning the ability of either low or medium voltage cable to continue to function. The method could never provide a clean bill of health for any cable and is unlikely to provide even an accurate picture of the physical health of the cable. It remains a useful troubleshooting tool for resolution of specific questions such as whether mid run wetting exists.	Boroscopic inspection should be listed as a troubleshooting or specialty information gathering tool rather than a cable condition monitoring tool.
31	Section B Page 5 of 13 Item 4	Visual inspection should be placed in context. It is a useful tool in evaluating thermal, radiation, chemical and oil related degradation for both low and medium voltage cable where access is possible (If tactile assessment is included, medium voltage cable should only be evaluated in a de-energized state.) Visual inspection may find surface corona damage of non-shielded medium voltage cable; however, it will not provide any indication of electrical deterioration in wetted or dry medium voltage cable.	The applicability of visual/tactile tests for low and medium voltage cable should be discussed.

32	Section B Page 6 of 13 Item 5	The DG states that an advantage of the Compressive Modulus technique is that it provides trendable data. In order to provide valid trendable data, the compressive modulus test would have to be performed in the same area. This technique would only apply to a small portion of a cable (i.e., the portion that is tested). It is not a global test for the entire cable. The cable must be accessible to perform such a test and if the cable is accessible, then the environment will be clean. Based on this fact, the inaccessible submerged portion of the cable would not have valid test data.	Remove the wording "it provides trendable data on commonly used cable insulation materials" or acknowledge the limitations of the data for trending purposes.
33	Section B Page 6 of 13 Item 5	"The compressive modulus technique is most effective at detecting thermally induced embrittlement and radiation-induced embrittlement." "...and the test is not effective for XLPE cables that do not have a polyethylene jacket." Most cables have neoprene or CSPE jackets. The indenter can evaluate these and would give an early indication of thermal stress to an XLPE cable. A limited number of plants have some XLPE jackets on these cables. While degradation to the point of interest would take a long time, the indenter would likely be useful. On the 3rd line, please delete "used for low-voltage cables" as the scope should not necessarily be limited by voltage rating.	In the 4th line, clarify by adding to the sentence end". . . because it correlates to the destructive elongation-at-break material test". Delete "used for low-voltage cables" While the indenter has limited usefulness for XLPE itself, please indicate that the indenter could be used on the neoprene or CSPE jackets of XLPE cables, which would give leading indication of damage.

34	Section B Page 6 of 13 Item 6	The DG states that the dielectric loss-dissipation factor or power factor test (tan delta test) can be used to diagnose problems in low- and medium-voltage cables; however, the tan delta test is ineffective in low voltage cables. The DG states that this test is "relatively easy to perform". For the same reasons as discussed in comments 1 and 3 above, the test is not relatively easy to perform because the cable must be disconnected to run this test and a re-test is required afterwards.	Remove the wording "low-" in regards to using the test to diagnose problems in "low- and medium-voltage cables". Remove the wording "relatively easy to perform".
35	Section B Page 6 of 13 Item 6	"The dielectric loss-dissipation factor or power factor test (tan δ test) can be used to diagnose problems in low- and medium-voltage cables." This sentence should be changed so that it agrees with the true statement in the 2nd paragraph that, "… the test should not be performed on low voltage (600 volt) and 5,000 volt unshielded cables …."	Change the referenced sentence to read: "The dielectric loss-dissipation factor or power factor test (tan δ test) can be used to diagnose problems in shielded medium voltage cables."
36	Section B Page 6 of 13 Item 6	While test via tan δ methodology may have been applied to low voltage cable in NRC research, there are no industry standards or acceptance criteria that exist for low voltage cable. Accordingly, the test method should not be suggested for low voltage cable. In addition, tan δ is considered a medium voltage condition monitoring test not a test for diagnosing problems. It applies only to shielded MV cable and currently cannot be used for non-shielded cable. The test does not relate conditions exterior to the insulation shield such as jacket damage or contamination unless they have affected the shield or insulation system. The second paragraph of this section states that tan δ should not be applied to low voltage cable having no shield. The majority of low voltage cables have no shield. Placing a high voltage test on shielded instrument cable is also unwise.	State that tan δ is a useful condition monitoring test for medium voltage shielded cables. State that it is not recommended for low voltage cable, whether shielded or not. It should also be noted that very low frequency test sets are available that allow use of smaller more portable test sets for medium voltage cable.

37	Section B Page 6 of 13 Item 7	IR and polarization index tests are not recommended for condition monitoring of medium voltage cable because of limited sensitivity to aging of wet medium voltage cable until very severe degradation has occurred. Insulation resistance has little use for dry medium or low voltage cable because insulation resistance does not change even if severe thermal or radiation damage has occurred. Insulation resistance change would only occur after cracking of the insulation, which is past the point of failure (Under dry conditions, electrical function is possible even with through cracking). However, waiting for through cracking would defeat the concept of condition monitoring. Polarization index applies to motor windings and is not useful for medium voltage or low voltage cable. While a low insulation resistance would be indicative of a highly deteriorated (near failed) medium voltage cable, relatively high insulations resistances (100s of megohms) are likely to occur if just a thin layer of good insulation is in series with a significant degradation site. Use of IR testing is applicable and recommended for wet low voltage cable to determine if significant degradation has occurred.	Describe the limitations and usefulness of insulation resistance testing appropriately. Leave polarization index testing out of the discussion of applicable cable tests.
38	Section B Page 7 of 13 Item 7	"The disadvantages are that the end terminations of the cable must be disconnected to perform the test, the test is not as sensitive to insulation degradation as other electrical properties techniques, and leakage currents are very small and sensitive to surrounding environmental conditions, making it difficult to measure accurately."	Insert "polarization index" between "the" and "test".
39	Section B Page 7 of 13 Item 8	"Aging mechanisms detected by the PDT include thermally induced embrittlement and cracking, mechanical damage, radiation-induced embrittlement and cracking, and water treeing." The partial discharge test cannot detect water trees.	Delete everything past "cracking" and insert a period.

40	Section B Page 7 of 13 Item 8	"Aging mechanisms detected by the PDT include thermally induced embrittlement and cracking, mechanical damage, radiation-induced embrittlement and cracking, and water treeing." Partial discharge testing identifies points where there is a gap between insulation and the conductor or shield, or a void exists that is discharging under electrical stress. It does not detect water trees until they have converted to an electrical tree. It will likely detect a crack if the electrical stress is high enough. It will not detect embrittlement (there is no electrical phenomenon). Water treeing is a slow long term degradation taking 25 years or more to become significant in nuclear plant cable. During this period there is no partial discharging. If the water tree converts to an electrical tree (not an assured phenomenon), the electrical tree may go to failure in a period of weeks to months. Accordingly, only a short window for detection of the PD may be available. In addition, the dominant shield type in nuclear cables is a helical copper tape shield. When subjected to long-term wet aging, a slight surface corrosion is likely on the tape. This does not affect operation but is likely to cause attenuation of high frequency partial discharge signals, making them undetectable from cable terminations. Partial discharge is a useful tool for concentric neutral cables as may be used in offsite feeds for determining if splice degradation has occurred.	The abilities of PD testing should be characterized correctly. The practical constraints and useful applications should be described properly. In addition, PD test voltages would not adversely affect healthy cable and would only have a potential to damage severely aged cable, the type that should be replaced. This test is not applicable to non-shielded cables. A shield is necessary to have a ground plane for testing.
41	Section B Page 7 of 13 Item 8	Partial discharge may not be effective for tape shield cable systems due to attenuation of the signal from shield corrosion.	Regulatory Guide should identify this issue with respect to medium voltage cable with a tape shield.

42	Section B Page 7 of 13 Item 9	The DG states that the TDR test can identify the presence of water and its location along a cable run and severity of electrical faults, and the location and severity of insulation damage. While the TDR can be used to find the cable fault, the TDR will not identify the presence of water and its location along a cable run if there is no insulation damage. TDR can be used together with other tests to locate the problem.	Clarify that the TDR test will not identify the presence of water and its location along a cable run if there is no insulation damage.
43	Section B Page 7 of 13 Item 9	TDR is an excellent trouble shooting tool once failure has occurred. It can identify through wall insulation failure, if the damaged insulation is wet or contaminated. It may identify the presence of water in insulation, but cannot assess the degree of degradation, unless failure has occurred. It should not be characterized as a condition monitoring tool.	Correctly characterize TDR as a troubleshooting tool rather than as an aging monitoring tool.
44	Section B Page 7 of 13 Item 9	Time Domain Reflectometry may not be effective for tape shield cable systems due to attenuation of the signal from shield corrosion.	Regulatory Guide should identify this issue with respect to medium voltage cable with a tape shield.
45	Section B Page 7 of 13 Item 10	LIRA is a useful technique that is under development. Research has shown that it is a useful condition monitoring test for identification of thermal and radiation damage and providing a reasonable indication of the degree of damage. It has been proven to identify failure locations in medium voltage cable and for use in detection of failure of lead jackets with water ingress on paper insulated lead covered cable. To date the ability of LIRA to assess water treeing or any other degradation in medium voltage cable has not been proven. In addition, the cable must be disconnected at one end to allow testing. The load end may be either open or shorted without affecting test results.	The LIRA system should be correctly categorized as a low voltage cable assessment tool at its current state of development for the detection of thermal and radiation damage and identification of the location of the degradation. The need for disconnecting one end of the cable to allow connection should be stated. The test is simple to perform; however, interpretation will likely take training and experience.

46	Section B Page 8 of 13 Item 11	"The infrared imaging test is able to detect aging mechanisms such as thermally induced embrittlement and cracking." Infrared thermograph can identify and assess hot spots to identify elevated temperature locations on cables and their connections. It can identify the actual operating temperatures that would allow analysis of the expected results of the condition with time. It gives no direct information concerning the effect of the elevated temperature on the degradation of polymers; it does not assess embrittlement or cracking	Delete the statement that infrared thermography can assess embrittlement and cracking.
47	Section B	The term "surface contamination" has been used throughout the DG and should be clarified in the guide. What is meant by surface contamination (i.e. mud, chemicals, etc.)?	Explain or define the term "surface contamination".
48	Bibliography Page 13 of 13	Electric Power Research Institute Technical Reports	Add the following references: EPRI 1020804, Aging Management Program Development Guidance for AC and DC Low-Voltage Power Cable Systems for Nuclear Power Plants EPRI 1020805, Aging Management Program Guidance for Medium-Voltage Cable Systems for Nuclear Power Plants