Response to Public Comments on Draft Regulatory Guide DG-1240
"Condition Monitoring Program for Electric Cables used in Nuclear Power Plants"
New Regulatory Guide RG 1.218

A notice that Draft Regulatory Guide DG-1240 was available for public comment was published in the Federal Register on June 15, 2010, on page 33853. The comment period ended on August 13, 2010. Comments were received from 11 organizations/individuals.

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The NRC has provided the staff's resolution of comments in the following table.

No.	Section of DG-1240	Originator	Specific Comment	NRC Resolution
1.	General	Bruce S. Burnstein	The application of dc to an ac XLPE cable may lead to premature loss of life under conventional service aging. Factors that influence this include degree of aging (oxidation), presence of impurities and operating temperature as well as operating voltage stress. The 5 year time frame after installation and energization, initially suggested by manufacturers for not applying DC, represents a 'good start', but does not (and cannot) take into account the degree of aging and degradation at any specific location, after any fixed time. Since cables age unevenly along their lengths, after any constant aging time the susceptibility to dc will vary by location. No specific changes were proposed by the commenter.	The commenter provided an accurate description of ac hi-pot testing. The concerns raised by the commenter with regards to the damage to the cables caused by hi-pot testing are consistent with DG-1240
2.	General	J. Butler NEI	DG-1240 is unnecessary and inconsistent with 10CFR50.65 (Maintenance Rule)	The staff disagrees.

			Paragraph (a)(1) of 10 CFR 50.65 (Maintenance Rule), states that "Each holder of an operating license for a nuclear power plant.. .shall monitor the performance or condition of structures, systems, or components.. .in a manner sufficient to provide reasonable assurance that these structures, systems, and components.. .are capable of fulfilling their intended functions." The industry implements this requirement through the use of Regulatory Guide 1.160, "Monitoring the Effectiveness of Maintenance at Nuclear Power Plants," which endorses NUMARC 93-01 "Industry Guideline for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants." The approach to Maintenance Rule implementation provided in RG 1.160 and NUMARC 93-01 is well understood by both industry and NRC and has been successfully implemented for nearly two decades. Contrary to the Maintenance Rule and approved implementation guidance, DG-1240 establishes a new position relative to condition monitoring for electric cables and concludes that "it is necessary to monitor the condition of electric cables throughout their installed life through the implementation of a cable condition monitoring program." 2 This degree of component-level monitoring of electric cables is not required under the Maintenance Rule. The industry should continue to address electric cables primarily through monitoring the performance of the trains and systems that they service pursuant to 10 CFR 50.65(a)(2) or through monitoring of plant-level performance where appropriate. This approach is supported by Regulatory Guide 1.160, which states: Some monitoring at the component level may be necessary; however, it is envisioned that most of the monitoring could be done at the plant, system, or train level. SSC'S with high safety significance and standby SSC'S with low safety significance should be monitored at the system or train level. Except as noted in the Regulatory Position of this guide, normally operating SSCs with low safety significance may be monitored through plant-level performance criteria, including unplanned scrams, safety system actuations, or unplanned capability loss factors. In DG-1240, the NRC staff proposes to modify this position by asserting that a comprehensive, component-level monitoring program is necessary in order to achieve compliance with the Maintenance Rule. Indeed, most of DG-1240 is devoted to describing the attributes of a cable monitoring program that the NRC staff would find acceptable under its modified interpretation of the Maintenance Rule. Such an explicit directive, coupled with detailed implementation direction, is inconsistent with the performance based intent of the Maintenance Rule	Operating experience reveals that the number of cables failure is increasing with plant age and these cable failures have resulted in plant transients and shutdowns, loss of safety function (s) and redundancy. The failures have occurred during normal operating conditions. DG 1240 is consistent with the maintenance rule 10 CFR 50.65 paragraph (a)(1) which requires that “Each holder of an operating license for a nuclear power plant under this part and each holder of a combined license under part 52 of this chapter after the Commission makes the finding under 52.103(g) of this chapter, shall monitor the performance or condition of structures, systems, or components, against licensee-established goals, in a manner sufficient to provide reasonable assurance that these structures, systems, and components, as defined in paragraph (b) of this section are capable of fulfilling their intended functions”. This regulatory guide provides a monitoring tool that licensees may employ to meet the monitoring requirement set forward by the maintenance rule, as it relates to components. The staff believes this new RG supplements RG 1.160 in the area of electrical cables. It does not conflict with it.

3.	General	J. Butler NEI	The New Position Articulated in DG-1240 Should Have Been Analyzed as a Backfit Our recommended course of action is for DG-1240 to be withdrawn from further consideration. However, should the NRC continue to pursue its issuance, it is imperative that the staff appropriately address the agency's obligations under 10 CFR 50.109 (i.e., Backfit Rule).	The NRC disagrees with the comment. As discussed in the *Implementation* section of DG-1240, the NRC staff does not intend to take any actions to impose the new positions contained in DG-1240 on existing licensees, absent voluntary action on their part to change their licensing bases (*e.g.*, seek license amendments). Accordingly, the new guidance represents 'forward-fitting," and no further action is required prior to issuing the guidance. This position is consistent with the July 14, 2010 letter from the NRC's General Counsel to NEI regarding backfit review and implementation requirements. To ensure clarity regarding the licensee's option to propose suitable alternatives to DG-1240 in a license amendment request, the NRC has further revised the Implementation language in the final regulatory guide.
4.	General	J. Butler NEI	The Stated Objective of DG-1240 is Better Met Through Available Alternative Means The "regulatory analysis" associated with DG-1240 states that "[t]he objective of this regulatory action is to identify acceptable condition monitoring techniques for electrical cables". This objective is accomplished with existing inspection and surveillance programs. Moreover, recently issued industry guidance documents provide specific guidance on appropriate cable assessment techniques and test methods. The industry guidance documents will be periodically updated to reflect advancements in cable managing techniques and thus provide an ongoing, up-to-date resource for industry use. In summary, we recommend that DG-1240 be withdrawn.	The staff agrees there are various means available to meet the intent. The guidance is written as a current range of choices available to licensees. The staff believes the document provides valuable information to NRC and its licensees, and thus will be published.
5	Page 5	G. Wilkosz, Zachry Eng.	Another disadvantage for the use of an illuminated borescope is that it may be considered a "pull-by" and not be allowed at many plants. For plants that allow "pull-bys", it is typically required that the cables in the conduit in which the "pull-by" occurred are functionally tested after the "pull-by". If the cable is baked into the conduit, which is typical for heater bay and steam tunnel cables, for example, the inspection could damage the cable.	Plant operators should use engineering judgment in evaluating whether visual inspection via an enhanced technique, such as the

				illuminated borescope inspection, could cause damage before the technique is applied in the field. A cautionary note has been added on page 6 to address the concern.
6.	Section B, Page 2, Paragraph 3 (S.B,P2 P3)	G. Toman/ EPRI	These are surveillance" tests, but the dg 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. Suggestion: Change "inservice tests" to "surveillance tests."	The staff agrees. The word "inservice" was changed to "surveillance."
7.	S.B,P2 Pg2)	G. Toman/ EPRI	Page 2, second paragraph, 2nd sentence: 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. Suggestion: Delete "fully loaded" from the sentence	The staff agrees. The word "fully" was deleted. Prolonged operation has an impact on aging effects and consequently insulation failure.
8.	(S.B,P2 P2)	G. Toman/ EPRI	Section B/page2/2nd paragraph/3rd sentence The sentence states that tests do not evaluate the dielectric strength of jackets. The dielectric strength of jackets is not an important factor. Suggestion: Reword sentence to: "or the dielectric strength of insulation or physical integrity of jackets and insulation."	The staff agrees. The sentence was reworded to read "or the dielectric strength of insulation or physical integrity of jackets and insulation." …
9.	(S.B,P2 P3)	G. Toman/ EPRI	B/page 2/3rd paragraph/last sentence. This sentence states that degradation could "significantly shorten its qualified life." The only cables that have regulated "qualified lives" are those subject to 10 CFR 50.49. The qualified lives are highly controlled and adverse environments are carefully considered and accounted for. 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. Suggestion: 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."	The word "qualified" was deleted, as suggested.
10	(S.B,P3 P1)	G. Toman/ EPRI	Section B/page 3 / 1st full paragraph/2nd sentence This sentence states that flooded conditions always remain undetected. This may be true at some plants but is not the case at others. Suggestion: Change to "may remain undetected for extended"	The staff agrees. The sentence was revised as suggested.

11	S.B,P3 P1	G. Toman/ EPRI	Section B/page 3/1st full paragraph/ 3rd Sentence The document states: “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. Suggestion: 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.	The sentence was modified as followed: “Cables that are not designed to operate in a submerged condition are likely to experience early failures, potentially resulting in significant safety consequences”
12	S.B,P3 P1	G. Toman/ EPRI	Section B/page 3/ 1st full paragraph, last sentence The document states "...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. Suggestion: Delete the sentence.	The word “would” was changed to “may.”
13	S.B,P3 P2	G. Toman/ EPRI	Section B/page 3/2nd full paragraph, 1st sentence 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. Suggestion: Delete the sentence or provide a statistically sound assessment of the data. See EPRI 1019160 for a statistical analysis of medium voltage cable failures	The staff disagrees. This statement is based on operating experience that records more than 200 failures under normal service condition. The added stress from design basis event could increase failures.
14	S.B,P3 P2	G. Toman/ EPRI	Section B/page 3/2 nd full paragraph/3rd sentence 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. Suggestion: 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."	The Staff disagree because the sentence states “Though 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”, which alludes to all cables, whether in service or not normally energized that failed prior to the detection of the failed condition.

15	S.B,P3 P2	G. Toman/ EPRI	Section B/page 3 /2nd full paragraph/last sentence "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. Suggestion: The concept 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	A sentence was added to the end of this section on page 3 that says" Condition monitoring of cables may be limited to a representative sample of cables and its frequency may be adjusted based on demonstrated plant-specific cable test results and operating experience." And the following write-up was added on page 10: Cable condition monitoring should be augmented for selected cables when the facility has (1) experienced failure of cables connected to critical equipment, (2) operational history indicates failure of cables, (3) there is a locally adverse operating environment; or (4) industry operating experience with similar conditions and equipment configuration to those at the licensed facility indicate a need for augmented monitoring. In other areas, condition monitoring of cables may be limited to a representative sample of cables. Further, frequency of condition monitoring may be adjusted based on demonstrated plant specific cable test results and operating experience
16	S.B,P3 P3	G. Toman/ EPRI	Section B/page 3/3rd full paragraph, last sentence 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.	The staff agrees. The last sentence and the list of attributes were deleted.

			Suggestion: Providing the list of ideal attributes serves no useful purpose. It could be deleted	
17	S.B,P3	G. Toman/ EPRI	Section B/page 4/1st paragraph after list This paragraph essentially disparages the use of condition monitoring and makes it seem impractical or extremely difficult. It provides no useful information and generally adds more confusion than useful insights. Suggestion: Delete the entire paragraph or implement the subsequent more specific comments.	Everything after the first sentence was deleted (see modified version). The following sentence was added: A combination of condition-monitoring techniques provide significant insights into the condition of cables.
18	S.B,P4	G. Toman/ EPRI	Section B/page 4 / 1st paragraph after list/ second sentence "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. Suggestion: 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.	The discussion was revised to reflect as follow: “Research and experience have shown that no single, nonintrusive, condition-monitoring method currently available, if used alone, is effective to predict the performance of electric cables under accident conditions. A combination of condition-monitoring techniques provides significant insights into the condition of cables”. (The remaining portion of the paragraph was deleted)
19	S.B,P4	G. Toman/ EPRI	Section B/page 4/1st paragraph after list/3r and 4 th sentences "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. Suggestion 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.	This portion of the discussion was deleted from the Regulatory Guide as discussed above in comments 17 & 18.

20	S.B,P4	G. Toman/ EPRI	Section B/page 4 / 1st paragraph after list/ 5th and 6th sentences "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. Suggestion Resolution Delete the paragraph. Once plants begin implementation of aging management programs, the insights gained will drive the need for further actions. This paragraph provides no useful direction or insights.	This portion of the discussion was deleted from the Regulatory Guide as discussed above in comments 17 & 18.
21	S.B,P4	G. Toman/ EPRI	Section B/page 4/2nd paragraph after list/ last sentence 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. Suggestion: This document should not reference NUREG/CR-7000	The staff believes that NUREG 7000 is an appropriate reference for the Regulatory Guide. Table 3.1 in the NUREG provides guidance as to which test type (Screening, diagnostic, pass/fail), applicable cable categories and materials (low voltage, and/or medium voltage and insulation types XLPE, EPR, CSPE, PVC ect), applicable stressors (elevated temperature, radiation exposure), advantages and disadvantages
22	S.B,P4	G. Toman/ EPRI	Section B/page 4/ General Comment on 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. Suggestion: 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.	Cautionary note and reference to IEEE standard were added. The licensees may choose the most appropriate technique for condition monitoring.
23	Sect.B	G. Toman/ EPRI	Section B/bottom of page/Item 1/1st sentence 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. But equally as important, IEEE Std 400 states that	The staff disagrees with the comment. The limitations on the use of dc HPT are adequately discussed No change is needed.

			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. Suggestion 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. This entire section should be removed from the document. The "recent" EPRI research that is alluded to in the draft Regulatory Guide is from 1995 and is well accepted across the industry.	
24	S.B,P5	G. Toman/ EPRI	Section B/page 5/Item 2 All of the comments in the previous item apply here. The same problem exists with the step voltage test as the dc high pot test. It applies to PILC not polymer cable. Suggestion Delete this section or make it specific to PILC.	The disadvantages and advantages given in this section are adequate to address the commentator's concern. The discussion was modified by adding the following sentence. It is typically used for PILC cables"
25	S.B,P5	G. Toman/ EPRI	Section B/page 5/Item 3 While a borescope 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. Suggestion: Boroscopic inspection should be listed as a troubleshooting or specialty information gather tool rather than a cable condition monitoring tool	Illuminated borescope was identified as a screening method. A cautionary note was also added on page 6 to address the concern
26	S.B,P5	G. Toman/ EPRI	Section B/page 5/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. Suggestion: The applicability of visual/tactile tests for low and medium voltage cable should be discussed.	The discussion was modified by adding the following sentences: Visual inspection may find surface corona damage of nonshielded medium-voltage cables. The staff did not believe it was necessary to include the portion of comment related to tactile assessment.
27	S.B,P6	G. Toman/ EPRI	Section B/page 6/Item 5/last sentence in section The document states "...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	The staff agrees with the comment. The discussion was modified as follow: The disadvantages are that the cables must be accessible for in

			degradation to the point of interest would take a long time, the indenter would likely be useful. Suggestion: 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.	situ measurements; measurements are made on the outer surface, so the condition of underlying insulation must be inferred; the underlying cable construction, cable geometry, temperature, and humidity affect the results; aging-related changes in the compressive modulus are very small for some polymers until the end of life; the compressive modulus does not give direct correlation to changes in electrical properties (such as insulation resistance and dielectric strength); and the test has limited usefulness for XLPE cables. However, it can be used on XLPE cable with neoprene or CSPE jackets to provide a leading indication of damage.
28	S.B,P6	G. Toman/ EPRI	Section B/page 6/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 6 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. Suggestion: 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 se or medium voltage cable.	The staff agrees with the comment. The RG was revised as suggested to limit tan delta technique to medium voltage cables.
29	S.B,P6	G. Toman/ EPRI	Section B/page 6/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	Research results have shown that aging degradation of cable insulation can be detected by insulation resistance/ polarization index measurements.

			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. Suggestion Describe the limitations and usefulness of insulation resistance testing appropriately. Leave polarization index testing out of the discussion of applicable cable tests.	The licensees can choose techniques which are most appropriate for the application.
30	S.B,P7	G. Toman/ EPRI	Section B/page 7/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 avoid 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 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. Suggestion 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.	The staff agrees with the comment. The section was revised as suggested by the commenter as follows; Disadvantages include that the end terminations of the cable must be disconnected to perform the test, the test is only applicable to cables that have shielded or sheath construction because it requires a defined ground return path of the loss (leakage) current back to the test set (supply source), the test should not be performed on low-voltage and medium voltage unshielded cables because of physical 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.
31	S.B,P7	G. Toman/ EPRI	Section B/page 7/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. Suggestion: Correctly characterize TDR as a troubleshooting tool rather than as an aging monitoring tool.	This is item 10 in the draft final guide. The discussion was modified to highlight the advantages and disadvantages of this testing choice.
32	S.B,P7	G. Toman/	Section B/page 7/Item 10	The discussion was modified.

		EPRI	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. Suggestion 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.	Disconnecting one end of the cable is not needed to perform this test.
33	S.B,P8	G. Toman/ EPRI	Section B/page 8/Item 11/ first paragraph/third sentence 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. However, it gives no direct information concerning the, effect of the elevated temperature on the degradation of polymers; it does not assess embrittlement or cracking. Suggestion: Delete the statement that infrared thermography can assess embrittlement and cracking.	The discussion was modified to delete the statement.
34	Sect .C Item 1.a	G. Toman/ EPRI	Section C/page 9/Item 1/a Some cables will be identified specifically in cable aging management programs such as medium voltage power cables. Others will be determined by identifying the adverse conditions first and, if there is degradation of cables, identifying the circuits. If there is no significant degradation, the cables will not be identified. Under the Maintenance Rule, individual components do not have to be identified if they are not causing adverse effects on function. Suggestion: Have the document recognize that various options exist for managing aging of cables and that identifying individuals cables is not necessary in many cases.	See NRC Resolution of Comment # 15.
35	Sect .C Item 1.b	G. Toman/ EPRI	Section C/page9/Item 1/b For some cable sets, such as wet medium voltage cable, information on cable condition will be directly linkable to individual cables. However, identification and evaluation of hotspots (thermal, radiation, chemical) are likely to be assessed and documented by plant location rather than specific cable until the degradation that is observed becomes significant enough to be concerned for effects on function of cables at which time the individual cables will be identified and followed. Accordingly, the information that will be recorded will not necessarily be cable based, but rather adverse condition location based until damage becomes significant. Suggestion: focus will be cables in adverse conditions, not all cables, and that the database or information retained is likely to be a combination of specific cable results and tracking of location and condition at identified local hotspots.	See NRC Resolution of Comment # 15.
36	Sect .C Item 1.c	G. Toman/ EPRI	Section C/page 9/Item 1/c The environments to be characterized should only be those that could cause adverse cable aging. Monitoring of the environment may or may not be useful. The more important item to monitor is the condition of the cable.	The guidance is targeted for cable performance.

			Suggestion Limit required characterization to adverse environments. Monitoring of environments should be on an as needed basis.	
37	Sect .C Item 2	G. Toman/ EPRI	Section C/page 9/Item 2/1st Sentence The document states "...a comprehensive cable condition monitoring program to be an acceptable method for satisfying the Commission's regulations with respect to condition or performance monitoring of electrical cables...." The only regulation quoted in the Regulatory Guide is 10 CFR 50.65, the Maintenance Rule. The Maintenance Rule provides various methods to assess effectiveness of maintenance. Setting up a cable program is one method; there are other acceptable alternatives such as monitoring performance and making improvements to performance via the corrective action process. Given that failures of cables are reasonably rare, citation of Maintenance Rule does not constitute a reason to require a large program. Suggestion: The regulations that the program is intended to support or fulfill should be detailed in Section A of the Regulatory Guide.	The staff agrees with the comment. Section A of the RG was revised to include a more complete discussion of the regulatory basis for this document.
38	Section B/p2/ 2nd para	G. Clefton/ NEI	"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.	The paragraph in question was slightly modified in response to other comments (see modified paragraph). Even though the some of the cable failures may be random and systems are redundant, the goal of condition monitoring is to mitigate cable failures.
39	B/p3/ 5th para	G. Clefton/ NEI	"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.	The paragraph in question was slightly modified in response to other comments. See modified paragraph. The purpose of the condition monitoring is to mitigate cable failures during design basis events.

			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.	
40	B/p3/ 6th para	G. Clefton/ NEI	"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 requires 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.	Operating experience has shown that undetected degradation leading to failure has occurred on normally de-energized cables.
41	B/p4/ Items 1 & 2	G. Clefton/ NEI	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.	Manufacturers should be consulted if a cable has been in service for over 5 years. The list of CM techniques included in this regulatory guide is not intended to be all inclusive.
42	B/p5/ Item 3	G. Clefton/ NEI	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.	Plant operators should use engineering judgment in evaluating whether visual inspection via an enhanced technique, such as the illuminated borescope inspection, could cause damage before the technique is applied in the field. A cautionary note was added on page 6 to address the concern.
43	B/ p5/ Item 4	G. Clefton/ NEI	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 cables in the underground conduits or in an inaccessible conduits in adverse thermal or radiation environments	Cables should be visible and accessible to perform direct visual inspection.
44	B/p6/ Item 6	G. Clefton/ NEI	"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.	Discussion was modified to clarify that low voltage cables should not be tested as such.
45	B/p7/	G. Clefton/	The statement is made that this test “is able to detect aging mechanisms such as thermally induced cracking,	The staff agrees with the

	Item 9	NEI	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.	comment. However, the discussion of Time Domain Reflectometry adequately presents the advantages and disadvantages.
46	B/p8/ Item 11	G. Clefton/ NEI	"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 to 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.	Cables should be visible and accessible to perform IR inspections.
47	B/p8/ Item 11	G. Clefton/ NEI	According to the discussion 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 cables have 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.	The staff agrees with the comment. The section has been revised slightly to say that this technique can provide useful information that could be used to detect aging degradation, instead of stating directly that this technique can detect aging mechanisms.
48	B	G. Clefton/ NEI	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	See NRC Resolution of Comment # 15.
49	General	G. Clefton/ NEI	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 that the cable is not routed through an adverse environment Draft Regulatory Guide DG-1240: Condition Monitoring Program for Electric Cables Used in Nuclear Power Plants. *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.	See NRC Resolution of Comment # 15..
50	B/p2/ 2nd para	G. Clefton/ NEI	"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 test used to establish adequacy of components or systems, such as NDE of reactor vessel welds. Suggestion: Change "inservice tests" to "surveillance tests."	Incorporated. See NRC Resolution of Comment # 6.
51	B/p2/	G. Clefton/	"While these tests can demonstrate the function of the cables under test conditions, they do not verify the continued	The word "fully" was deleted.

	2nd para	NEI	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. Suggestion: Delete "fully loaded" from the sentence	See NRC Resolution of Comment # 7.
52	B/p2/ 2nd Para	G. Clefton/ NEI	"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 the tests do not evaluate the dielectric strength of jackets. The dielectric strength of a cable jacket is not an important factor. Suggestion: Reword sentence to "… or the dielectric strength of insulation or physical integrity of jackets and insulation.	Incorporated by previous comment (see NRC Resolution of comment # 8..
53	B/p2/ 2nd para	G. Clefton/ NEI	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. Suggestion: Condition Monitoring for cables in the following scenarios: • Failure of the equipment supported by the affected cable cannot be tolerated. • Failure history of the cable indicates that performance monitoring is not sufficient. • Equipment is subject to an adverse environment other that the conditions for which it was designed.. •	Guidance was added with minor modifications. See response to comment #9.
54.	B/p2/ 3rd para	G. Clefton/ NEI	"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 10CFR 50.49. Circuits in mild environments do not have "qualified lives" under NRC regulations. Suggestion: 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"	The staff agrees with part 1 of the suggestion. Discussion was revised as suggested by the comment. The staff disagrees with the part 2 since operating experience has shown that elevated temperatures shorten

			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.	cable . The staff agrees with Part 3 & 4. See NRC Resolution of Comment # 9.
55	B/p2/ 4th para	G. Clefton/ NEI	“…. 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. <u>Suggestion:</u> 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).	The staff agrees. Appropriate changes were made.
56	B/p3/ 1st para	G. Clefton/ NEI	"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. Suggestion: Change to "may remain undetected for extended...."	The staff agrees. Discussion was modified. See NRC Resolution of Comment # 10.
57	B/p3/ 1st para	G. Clefton/ NEI	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. Suggestion: 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.	Changes were made to address these points. See NRC resolution of Comments # 5 & 11.
58	B/3/ 1st para	G. Clefton/ NEI	"...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	A word change was made. . See NRC Resolution of Comment # 12.

			to say that it is likely that additional cable failures will result. There is no history of such events. Suggestion: Delete the referenced sentence.	
59	B/p3/ 2nd para	G. Clefton/ NEI	"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. Suggestion: 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.	See NRC Resolution of Comment # 13.
60	B/p3/ 2nd para	G. Clefton/ NEI	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. Suggestion: 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."	See NRC Resolution of Comment # 14.
61	B/p3/2nd para	G. Clefton/ NEI	“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”	See NRC Resolution of Comment # 15.

62	B/ p3/2nd para	G. Clefton/ NEI	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.	The staff disagress. The length of time to failure is not a consideration.
63	B/p3/ 2nd para	G. Clefton/ NEI	"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.'	See NRC Resolution of Comments 5 & 11.
64	B/p3/ 2nd para	G. Clefton/ NEI	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. Suggestion: Providing the list of ideal attributes serves no useful purpose; delete it.	See NRC Resolution of Comment # 16.

65	B/p3/ 3rd para	G. Clefton/ NEI	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.	See NRC Resolution of Comment # 15.
66	B/p4/ 1st para	G. Clefton/ NEI	"….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)	The staff agrees, based on conclusions by EPRI's reports TR-101245, "Effect of DC Testing on Extruded Cross-Linked Polyethylene Insulated Cables," Volumes 1 (1993) and 2 (1995), (Ref. 12), that a dc HPT of field-aged cables could potentially damage or cause extruded cables, especially field-aged XLPE-insulated cable, to fail prematurely. Therefore, a cautionary note indicating this fact has been added to the regulatory guide.
67		G. Clefton/ NEI	"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.	See NRC Resolution of Comments # 17-20.

			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	
68		G. Clefton/ NEI	"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.	See NRC Resolution of Comments # 17-20.
69		G. Clefton/ NEI	"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".	See NRC Resolution of Comments # 17-20.
70		G. Clefton/ NEI	"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.	See NRC Resolution of Comments # 17-20.

			Once plants begin implementation of aging management programs, the insights gained will drive the need for further actions.	
71		G. Clefton/ NEI	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.	See NRC Resolution of Comment # 21.
72		G. Clefton/ NEI	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	See NRC Resolution of Comment # 22.
73		G. Clefton/ NEI	"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 <u>not</u> recommended for polymer insulated cable, the dominant type of insulation in the nuclear industry, but is useful for PILC. Delete this entire section.	See NRC Resolution of Comment # 23.
74		G. Clefton/ NEI	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.	The discussion was modified to include the sentence that states "pre-energization dc HPTs of new medium-voltage cable

			Insert a new last sentence that says, “Initial DC HPTs of newly installed medium voltage cable does not significantly reduce cable life.”	does not significantly reduce cable life.
75		G. Clefton/ NEI	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.	The discussion was modified by removing the words “relatively easy to perform”, and adding a sentence that states that dc HPT is not trendable.
76		G. Clefton/ NEI	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.	The discussion was modified to acknowledge the fact that the step voltage test (SVT) is typically used for PILC cables.
77		G. Clefton/ NEI	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”.	The discussion was modified by deleting the words “relatively easy to perform”.
78		G. Clefton/ NEI	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.	Comments 23, 24, and 25 discuss dc HPT. The discussion regarding dc HPT was further modified by adding the following cautionary note: “certain cable manufacturers recommend that this test only be done on new cable installations and that it not be performed after the cable has been in service for over 5 years”
79		G. Clefton/ NEI	While a borescope 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.	Comment #25 on the comments matrix, which read as follow: “Illuminated borescope was identified as a screening method. A cautionary

			Boroscopic inspection should be listed as a troubleshooting or specialty information gathering tool rather than a cable condition monitoring tool.	note was also added on page 6 to address the concern". The regulatory guide in its current form list IB as screening method, an optically enhanced visual inspection, not a condition monitoring technique. Thus, no modification is needed.
80		G. Clefton/ NEI	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.	See NRC Resolution of Comment # 26.
81		G. Clefton/ NEI	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.	This technique is available when degradation is suspected in a local area. The statement is applicable to those instances.
82		G. Clefton/ NEI	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"	The discussion was modified as follow: the "used for low voltage cables" wording was deleted. In addition, the sentences "because it correlates to the phenomenon in elongation at break material test" and "However, it can be used on XLPE cable with neoprene or CS PE jackets to provide a leading indication of damage" were added to the discussion.

			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.	
83		G. Clefton/ NEI	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".	The discussion has been modified to reflect the deletion of the word "low", and "relatively easy to perform".
84		G. Clefton/ NEI	"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."	Discussion was modified. See NRC Resolution of Comment # 28.
85		G. Clefton/ NEI	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.	The discussion was modified. See matrix comment #28
86		G. Clefton/ NEI	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	See NRC Resolution of Comment # 39.

			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.	
87		G. Clefton/ NEI	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".	The staff disagrees because it is our feeling that the regulatory guide in its current form accurately captures the disadvantages of the IR test without the need to insert polarization index.
88		G. Clefton/ NEI	"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.	Discussion was modified. See NRC Resolution of Comment # 30.
89		G. Clefton/ NEI	"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.	Discussion was modified. See NRC Resolution of Comment # 30.

			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.	
90		G. Clefton/ NEI	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	The discussion was modified to include the sentence "Partial discharge may not be effective for tape-shielded cable systems because of the attenuation of the signal from shield corrosion".
91		G. Clefton/ NEI	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.	Discussion was modified. See NRC Resolution of Comment # 31.
92		G. Clefton/ NEI	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.	Discussion was modified. See NRC Resolution of Comment # 31.
93		G. Clefton/ NEI	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.	The discussion was modified to include the sentence "Partial discharge may not be effective for tape-shielded cable systems because of the attenuation of the signal from shield corrosion".
94		G. Clefton/ NEI	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	Comment #32 "Disconnecting one end of the cable is not needed to perform this test".

			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.	
95		G. Clefton/ NEI	"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 sentence that infrared thermography can access embrittlement and cracking.	Discussion was modified. See NRC Resolution of Comment # 33.
96		G. Clefton/ NEI	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".	"Surface contamination" is commonly used term in the cable industry. It is understood to mean the accumulation of dust, dirt, moisture, chemicals or other residue on the outer surface of the cable.
97		G. Clefton/ NEI	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	The staff has not reviewed the EPRI reports to endorse their use. However, consideration of these documents for the bases of an acceptable cable monitoring program could be undertaken
98	General	W. Horin/ NUGEQ	The Maintenance Rule does not support the scope or means or methodology for cable condition monitoring envisioned by DG-1240. The NUGEQ agrees that the maintenance rule (MR) is the appropriate and only regulatory basis for requiring condition monitoring of cables during the current license term. Other regulations relevant to cables are focused on the adequacy of design (e.g.,GDC) or the assurance of quality (Appendix B). However, the MR provisions, its bases, related guidance (NUMARC 93-01, "Industry Guideline for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants" ("NUMARC 93-01") and Regulatory Guide 1.160, "Monitoring the Effectiveness of Maintenance at Nuclear Power Plants" (RG1.160")), and industry implementation do not support the apparent scope of cable condition monitoring envisioned by DG-1240 when it states; "it is necessary to monitor the condition of electric cables throughout their installed life through the implementation of a cable condition monitoring program." Recommendation: Withdraw DG-1240 or substantially revise "Section B. Discussion" to comport with the MR and approved implementation guidance.	This regulatory guide describes a programmatic approach to condition monitoring of electric cables and their operating environments and acceptable condition monitoring techniques. Appropriate changes were made in Section B and Section D.
99	General	W. Horin/ NUGEQ	The vast majority of MR scope cables are highly reliable and do not require component level performance or condition monitoring. The vast majority of MR scope cables are highly reliable and can appropriately be classified as "inherently reliable" under current MR guidance. The NRC recognized the inherent reliability of cables in the SOC accompanying the	The operating experience reveals that the number of cable failures is increasing with age.

			original MR. The SOC state: "The purpose of paragraph (a) (2) of the rule is to provide an alternate approach (a preventive maintenance program) for those SSCs where it is not necessary to establish the monitoring regime required by (a)(1). For example, this provision might also be used where an SSC, without preventive maintenance, has inherently high reliability and availability (e.g., electrical cabling) or where the preventive maintenance necessary to achieve high reliability does not itself contribute significantly to unavailability (e.g. moisture drainage from an air system accumulator)."For such cables with high reliability and availability it is appropriate that they be monitored under 50.65(a)(2). Further, 50.65(a)(2) is the appropriate classification for SSCs where it is not necessary to establish the monitoring regime required by (a)(1). It is well established that (a)(2) can be used for SSCs, like the vast majority of cables that have high reliability and availability without preventive maintenance. Recommendation: Withdraw DG-1240 or substantially revise "Section B. Discussion" to comport with the MR and approved implementation guidance.	It is, therefore, necessary to monitor the condition of cables throughout the remainder of their installed life.
100		W. Horin/ NUGEQ	The NRC's stated basis for extensive condition monitoring of cables under 50.65 is substantially flawed. In "B. Discussion" the NRC argues that periodic operability testing of cables is inadequate because it does not: (1) specifically focus on cables, (2) detect all aging/degradation mechanisms, (3) demonstrate performance under prolonged normal or accident conditions, or (4) provide "specific information" on degradation processes or physical integrity. Given these operability testing deficiencies the NRC concludes that cables might pass an operability test and subsequently fail when operation is required.' The NRC also argues that CM of cables throughout their installed life is needed because (1) "several" power cable failures have occurred, (2) the failure rate is increasing with plant age, (3) these cable failures have had safety significance, and (4) some failures occurred before they were identified. The stated NRC concerns with periodic operability tests do not apply to cables that are normally operating (i.e., not in standby mode). Consequently, these concerns are not a basis for condition monitoring of normally operating cables. The NRC claim that periodic operability tests are inadequate because they do not specifically focus on cables is without merit. This view conflicts with other MR guidance which recommends that most performance monitoring be conducted at the plant, train, and system levels and not at the component level. Further, RG1.160 encourages the use of such periodic operability tests for performance monitoring. RG1.160 states: "The NRC staff encourages licensees to use, to the maximum extent practicable, activities currently being conducted, such as technical specification surveillance testing, to satisfy monitoring requirements." The other operability test deficiencies cited by the NRC (failure to - detect all aging/degradation mechanisms; demonstrate prolonged performance; or provide "specific information" on degradation or integrity) are stated as concerns because cables might pass an operability test and subsequently fail when operation is required. This view fails to recognize the objectives (e.g., reasonable assurance) associated with such operability tests and that such limitations or "failures" exist to varying degrees with the operability tests of virtually all other types of equipment, including active components. However, such operability tests remain a critically important element of plant safety and the MR performance criteria and monitoring.	Extensive condition monitoring of cables is not expected. See NRC Resolution of Comment # 15-17.

			The NRC also argues that CM is necessary because there have been "several" cable failures and the failure rate is increasing with plant age. The vast majority of MR scope cables are highly reliable and can appropriately be monitored under (a)(2) or classified as "inherently reliable" under current MR guidance. Any unbiased review of operating experience and failure data would conclude that cables exhibit availability and reliability characteristics substantially exceeding those of their active supported equipment. Simply stated cables are not one of the weak links when evaluating system, train, or supported equipment performance. The NRC does not cite the basis for its conclusion that cable failure rates are increasing. However, EPRI in its analysis of the medium voltage failures reported in response to Generic Letter 2007-01 (see EPRI handout from May 2009 meeting) concluded that there was no correlation between the number of failures and cable age at the time of failure. Recommendation: Withdraw DG-1240 or substantially revise "Section B. Discussion" to comport with the MR and approved implementation guidance.	
101		W. Horin/ NUGEQ	Broad-based cable condition monitoring will not materially affect plant Safety The NRC's apparent goal of eliminating virtually all cable failures while laudable is unrealistic, unobtainable, and even if achievable would have no significant effect on plant risk given the high inherent reliability of cables in most plant applications. Regarding the benefit of such extensive monitoring we cite the NRC's own conclusions as part of the resolution of GSI-1 68. A GSI-1 68 evaluation of the core damage frequency (CDF) reduction determined that the monetized benefits from requiring measures (such as condition monitoring) to reduce the contribution to the CDF of cable failures appear to be relatively modest. In that report the NRC concluded that, "The risk assessment suggests that, at our current level of understanding, a cost beneficial improvement is not supported." (emphasis added) The NRC affirmed this view during a June 2002 ACRS meeting on the GSI-168 resolution when the staff stated: "If you reduce the cable failure probabilities to zero, the benefits are modest. There are benefits. The benefits are not zero. But they're modest." Recommendation: Withdraw DG-1240 or substantially revise "Section B. Discussion."	The broad-based condition monitoring is not expected.
102		W. Horin/ NUGEQ	The guidance fails to recognize that the MR is a risk-based regulation and performance criteria for SSCs are related to their safety significance. As described in NUMARC 93-01, for SSCs within the scope of the Maintenance Rule it is necessary to establish safety significance. The associated performance criteria for 50.65(a)(2) SSCs or goals for 50.65(a)(1) SSCs should reflect that safety significance. The safety significance of a cable is application dependent and is directly related to the safety significance of the supported equipment (e.g., pump). DG-1240 fails to recognize that the MR is a risk based regulation and performance expectations are related to safety significance. Recommendation: Withdraw DG-1240 or substantially revise "Section B. Discussion."	The staff agrees the significance of a cable is application dependent and directly related to the safety significance of the supported equipment. See NRC Resolution of Comment # 15-17.
103		W. Horin/ NUGEQ	The proposed DG-1240 guidance fails to recognize that under the MR the NRC has recommended that most performance criteria and goals for high safety-significant and stand-by applications be established at the system, or train level and not at the component level. DG-1240 directly conflicts with other MR guidance when it apparently recommends that all cable need to be condition monitored at the component level using the describe techniques. Specifically, Regulatory Guide 1.160 states: "The extent of monitoring may vary from system to system depending on the system's importance to safety. Some monitoring at the component level may be necessary; however, it is envisioned that most of the monitoring could be done at the plant,	For operating plants, the condition monitoring of selected cables under certain conditions is expected. See NRC Resolution of Comment # 15-17.

			system, or train level. SSCs with high safety significance and standby SSCs with low safety significance should be monitored at the system or train /eve/. Except as noted in the Regulatory Position of this guide, normally operating SSCs with low safety significance may be monitored through plant-level performance criteria, including unplanned scrams, safety system actuations, or unplanned capability loss factors. For SSCs monitored in accordance with 10 CFR 50.65(a)(1), additional parameter trending may be necessary to ensure that the problem that caused the SSC to be placed in the Paragraph (a)(1) category is being corrected." "Recommendation: Withdraw DG-1 240 or substantially revise "Section B. Discussion."	
104		W. Horin/ NUGEQ	The NRC conclusion that cable condition monitoring is necessary throughout cable installed life is inconsistent with the MR and related guidance. The vast majority of plant cables under the MR are highly reliable, are appropriately classified under (a)(2), and their performance is monitored at the train, system, or plant level depending on their safety significance and operational configuration (e.g., standby). According to RG 1.160 additional component level monitoring and trending may be necessary if a performance problem causes a SSC to be placed into (a)(1). Other than cables with performance problems the MR and its guidance neither require nor recommend such component level monitoring. Consequently, it is inappropriate based on existing MR guidance and implementation for the NRC to claim that "it is necessary to monitor the condition of electric cables throughout their installed life through the implementation of a cable condition monitoring program." Recommendation: Withdraw DG-1 240 or substantially revise "Section B. Discussion."Specifically, were the NRC to revise the DG, to provide for consistency with the MR, we recommend deleting the following text: "Therefore, it is necessary to monitor the condition of electric cables throughout their installed life through the implementation of a cable condition monitoring program." That text would then be replaced with the following text: "Under existing NRC and industry MR guidance the establishment of performance criteria, goals, and monitoring must consider both safety significance and operational configuration (e.g., normally operating or in standby). MR guidance documents recognize that most monitoring will be accomplished at the plant, system, or train levels and not at the component level. It may be appropriate to monitor additional cable parameters for cables that have been placed into (a)(1) because of performance problems. Licensees may also choose to monitor the performance of cables under (a)(2) as part of a preventative maintenance program."	Licensees may choose to monitor the performance of cables as a part of preventive maintenance program.
105		W. Horin/ NUGEQ	The NRC definitions of "wet" and "submergence" are inconsistent with the codes and standards applicable to cables. In "B. Discussion" the NRC attempts to establish its own definitions for wetting and submersion as - "wetting (i.e., an operating environment in which a cable is exposed to moisture or high humidity for extended periods of time, with intermittent brief periods of complete submergence in water)" and "submersion (i.e., an operating environment in which a cable is completely submerged in water continuously or for extended periods of time)." These definitions serve apparent NRC staff efforts to create distinctions between these and related terms. However, these definitions are wholly inconsistent with the codes and standards applicable to plant cables and licensee specifications and design bases for such cables. Both the Underwriters Laboratories, Inc. (UL) and the National Electric Code (NEC) define the terms dry, damp, and wet locations but not submersion. These definitions indicate that the term wet location is meant to include submerged conditions particularly when viewed in the context of the related definitions of dry location and damp location. More importantly, the cable standards and cable designs applicable to power plant cables (e.g., ICEA, NEMA, AEIC,	Submersion is an operating environment in which a cable is completely submerged in water continuously or for extended periods of time.

			and UL), including associated qualification tests, make no distinctions between cable designs for wet and/or submerged applications. For example, the current ICEA standard applicable to shielded medium voltage power plant cables is ICEA S-97-682. This standard and earlier ICEA versions establish moisture-related design criteria and qualification tests that are used to demonstrate cable suitability for all plant applications - both dry and wet. Regarding moisture tolerance the standard requires the following qualification test - Accelerated Water Treeing Test (AWTT) Procedure. ICEA issues similar standards that are used for industry/commercial/government, but not power plant, applications. For example, ICEA S-93-639 is the equivalent ICEA standard for shielded medium voltage power cables for "indoors, outdoors, aerial, underground, or submarine" applications. Like the power plant standard the moisture-related design criteria and qualification tests are the same for these applications. Interestingly, the Accelerated Water Absorption Test (EM-60) specified in this standard for cables, including submarine cables, is generally considered to be less demanding than the AWTT test specified in the power plant standard. Recommendation: Withdraw DG-1240 or delete in "Section B. Discussion" two parenthetical statements associated with the terms "wetting" and "submersion."	
106		W. Horin/ NUGEQ	The NRC neglects to acknowledge and integrate into the draft guidance the fact that an "ideal" condition monitoring technique does not exist. In "B. Discussion" the NRC identifies the nine desired attributes of an "ideal" condition monitoring technique. These nine are a subset of the eleven attributes initially identified in NUREG/CR-6704 Vol. 2 and recently restated in NUREG/CR-7000 along with the observation that no single CM technique possesses all these attributes. The two attributes included in the NUREGs but omitted from DG-1240 are "Inexpensive and simple to perform under field conditions" and "Available to the industry immediately." Apparently, the NRC does not consider availability, cost, or simplicity to be desirable attributes. Recommendation: Withdraw DG-1240 or revise the text to include the two additional attributes identified in the NUREGs - "Inexpensive and simple to perform under field conditions" and "Available to the industry immediately." Furthermore, the NRC should add the clarification (again, assuming that the DG is not withdrawn as recommended) that "No existing techniques, including those described in the draft guide, possess all these desirable attributes."	The Section related to attributes was deleted.
107		W. Horin/ NUGEQ	The NRC distorts its own research regarding predicting cable survivability under accident conditions. In "B. Discussion" the DG states - "Research and experience have shown that no single, nonintrusive, currently available condition monitoring method can be used alone to predict the survivability of electric cables under accident conditions." The clear implication is that the application of more than one technique can and will predict cable survivability under accident conditions. This is not supported by the NRC's own research. As stated in the NRC's GSI-168 technical assessment - "No single condition monitoring technique is non-intrusive and effective to detect degradation in incipient states prior to failures of installed cable systems," and "although a single reliable condition-monitoring technique does not exist walkdowns to look for any visible signs of anomalies attributable to cable aging, coupled with the monitoring of operating environments, have proven to be effective and useful (emphasis added)." Regarding predicting LOCA survivability that assessment concluded that such predictions were "possible" but data on physical and electrical properties of cable segments along with suitable predictive models would be needed. And further that "while condition monitoring methods may be viable at their current level of development, application specific demonstrations are needed to ensure that the techniques can predict LOCA survivability (emphasis added)." To our knowledge generally accepted predictive models correlating cable physical or electrical properties from suitable monitoring techniques to LOCA survivability have not been demonstrated. Recommendation: Withdraw DG-1 240 or substantially revise "Section B".	The staff agrees that a combination of condition monitoring techniques can be used and walk-downs to look for any visible signs of anomalies attributable to cable aging, coupled with the monitoring of operating environments, have been proven to be effective.

			The NUGEQ submits that the NRC should replace - "Research and experience have shown that no single, nonintrusive, currently available condition monitoring method can be used alone to predict the survivability of electric cables under accident conditions." And instead insert - "NRC research has determined that no single condition-monitoring technique is nonintrusive and effective to detect degradation in incipient states prior to failures of installed cable systems. Although a single reliable condition-monitoring technique does not exist, a combination of condition monitoring techniques can be used and walk downs to look for any visible signs of anomalies attributable to cable aging, coupled with the monitoring of operating environments, have proven to be effective and useful."	
108		W. Horin/ NUGEQ	The NRC understates the implications for techniques that require cable determination. The NRC should make clear that any techniques requiring cable de-termination also involve re-termination, operability verifications, and potential reliability and availability effects. Significant efforts are involved when cables are de-terminated and subsequently must be re-terminated and operability and performance of the affected equipment verified in accordance with plant requirements. The significance of these efforts will vary based on a number of factors including the type of termination, plant location, accessibility, and cable design/voltage level. However, these efforts and associated post-maintenance operability verifications, including equipment/system alignments and operation, can adversely affect equipment reliability and availability. The NRC's Generic Letter 2007-01 Summary Report when analyzing failure root causes attributed approximately the same number of failures (roughly 25) to "Human Error" as were attributed to "General or Age-Related Degradation." Utilities must balance these considerations when determine the need for and type of condition monitoring. While condition monitoring may be appropriate for cables with problems, the implementation' of certain techniques for highly reliable cables is not safety beneficial when considering reliability, availability, and human factors considerations. Recommendation: Withdraw DG-1 240 or add the following text: "Utilities should consider the potential adverse impact of condition monitoring and associated maintenance and post-maintenance testing efforts when determining the need for and type of condition monitoring techniques being used. These activities, particularly when devices must be de-terminated and re-terminated, can adversely affect equipment reliability and availability. The impact of these efforts will vary based on a number of factors including but not limited to the type of termination, plant location, accessibility, and cable design/voltage level. While condition monitoring may be appropriate for cables with problems, the implementation of certain techniques for highly reliable cables may not be safety beneficial when considering reliability, availability, and human factors considerations."	The staff agrees that licensees should consider the potential adverse impact of condition monitoring and associated maintenance when determining the type of condition monitoring techniques being used.
109		W. Horin/ NUGEQ	Information presented on CM Techniques is confusing, in many places erroneous, and may cause inappropriate conclusions. "Section B, Discussion," because of numerous technical errors and inadequate guidance may cause utility personnel to misapply condition monitoring techniques and come to erroneous conclusions about the condition of their cables. Technical errors include a) recommending the use of DC high-pot and step-voltage tests for plant cables and b) mischaracterizing several techniques that may be useful for troubleshooting and failure evaluations or characterizing the environments as methods that can assess cable functionality or age degradation. Many of these errors similarly appear in the cited NUREG/CR-7000. In addition to these errors the technical guidance fails to distinguish among several factors that limit the use of certain techniques to specific types or classes of cables (e.g., medium voltage, low voltage, shielded) or to the effects of certain service conditions (e.g., wet/submerged, temperature/radiation, mechanical damage). Absent this additional information, and potentially relying on these misleading statements, utility personnel might misapply condition monitoring techniques and come to erroneous conclusions about the	Section B was revised on various CM techniques and references to IEEE standards were added.

			condition of their cables. Recommendation: Withdraw DG-1240 or substantially revise "Section B. Discussion" on the various CM techniques or reference EPRI guidance on medium and low voltage cable aging management programs, applicable IEEE standards, and other guidance on uses and limitations of the various techniques.	
110	General	J. Vandenbroek	The published response to Generic Letter 2007-01 indicates that there were fewer than 300 reported cable failures over the past 30 years. Although anecdotally, there may be a few more, this is the only reliable number we have. Since we have over 100 operating plants in the US, this works out to one cable failure per plant per decade. This failure rate is much lower than the failure rate of many other components and has not proven to be a safety concern. Please perform an analysis to determine the safety benefit of the monitoring program described in DG-1240 in consideration of the following factors: 1. low actual cable failure rate. 2. destructive effect of some of the testing described in DG-1240. 3. reduction in cable insulation life as a result of some testing described in DG-1240. 4. Potential for equipment damage due to cable de-termination and re-termination of hundreds of safety related cables. 5. Diversion of resources from plant modifications that would result in actual reduction in CDF and LERF. Without a risk analysis that weighs the positive impact against the negative impact of the proposed monitoring program, we won't know if the monitoring program will actually reduce plant safety.	See NRC Resolution of Comment # 3&4.
111	Page 2 (last full paragraph)	J.Vandenbroek	DG-1240 uses the word “qualified” twice. Please reword. The term “qualified” has meaning in the context of the EQ rule. Except for the EQ rule qualification, cables have never been “qualified,” so the use of the term in this context is incorrect.	The word “qualified” was deleted from the third paragraph of Page 2, last line.
112	General	J.Vandenbroek	Please review the GL2007-01 data to support the term "often resulting in significant safety consequences." Cable failures have been "seldom." If no significant safety consequences HAVE resulted, please change the text to reflect this fact. 2. "Eventually, “will experience early failures." These two terms contradict each other. 3. The question is not "will a submerged cable fail sooner that a dry cable," but "will a submerged cable remain operable throughout its [40 year] design life." 4. Please supply support for the contention that control cables (low voltage) will fail early when submerged. I believe that this is supposition rather that fact.	Changes were made to the first full paragraph on page 3 of the RG: The sentence was modified to change the word “often” to “Potentially). The word “Eventually” was deleted and the word “will” was replaced by “ are likely to” The comment (3) is tutorial in nature. It is implicit that the regulatory guide refers to the design life of the cable. Few failures of low voltage control cables in a submerged condition have been reported.

				The records collected through GL 2007-01 indicated cable failures under normal service condition and standby cables during surveillance. The staff is concerned about potentially more failures when responding to a design basis event for long duration.
113	Sect. B Item 6	R. Konnik/ Marmon	Item 6, the DF test should be changed to only be applicable to shielded MV cables as noted in the second paragraph. This test is generally used for water issues in MV cables. I do not think it can be related to surface contamination. I also have not seen it associated with cracking, and it should be noted that if insulation is cracked, it is not likely to hold voltage, and is way beyond end of life Insulation resistance is maybe used on many cables, but would not provide results that can be trended unless the cable was shielded, and even then the result will probably not correlate to a reliable qualified condition. Polarization index is generally used on motors, nit cables. I have not seen information indicating that polarization index would generally be applicable to cables to show radiation or aging damage. Insulation resistance is sensitive to aging and end effects. I do not think partial discharge is applicable to jacket testing. Partial discharge is not sensitive to water trees, since if there is water in the void, there is no partial discharge. It may be somewhat sensitive to electrical trees. Even if the cable is shielded, if the shield is not a low enough resistance path, it may not be able to be used. I do not think it has been sown to be suitable on nonshielded cables, so last sentence should be changed. This also does not correlate to EQ and the qualified condition, but maybe suitable for some shielded MV cables in wet locations. General PD testing does not provide locations and size of defects. I do not think TDR has been proven to do what is claimed here. It has not been shown to be able to be trended and correlated to the qualified condition. I suggest deleting this. It is hoped LIRA will be able to do what is claimed here, but testing is just being done. It shows potential, but additional information is needed to confirm the claims being made here. I do not think infrared imaging thermography has been proven to be able to do what is claimed here, and I suggest this be deleted. I do not see how it is applicable to jackets and how it can be trended for insulation, etc	Most of the comments are tutorial in nature. The technical issues identified have been addressed by other comments.
114	General	STARS (C. Corbin)	STARS recommends that DG-1240 be withdrawn. STARS concurs with the NEI position that DG- 1240 establishes a new position relative to condition monitoring for electric cables inconsistent with previously endorsed guidance for the implementation of the Maintenance Rule and requires a backfit analysis. The most significant concern, however, is the absence of an analysis demonstrating a positive effect on nuclear safety through the cable monitoring program described in DG-1240. The monitoring techniques described in DG-1240 can actually reduce cable insulation life or cause the catastrophic failure of a fully operable safety-related cable (Direct Current High-Potential Test). Additionally, the potential for equipment damage through repeated cable de-termination and re-termination of hundreds of safety-related cables needs to be evaluated and	See NRC resolution of NEI comment #3. Regarding the comment that excessive performance of cable CM techniques could potentially reduce cable life, a cautionary note was added on page 5 of

			addressed prior to issuing this Regulatory Guide.	the RG to address the concern.
115	General	John McCann/ Entergy	Entergy agrees with and endorses NEI's comments, including the recommendation that the draft Regulatory Guide be withdrawn for the reasons presented in the NEI letter. Entergy also believes that the objectives of the proposed NRC action are better met through existing programs and recently issued industry guidance documents that provide specific guidance on appropriate cable assessment techniques and test methods. If the guidance is to be issued, Entergy believes that it should be subject to the requirements of 10 CFR 50.109 (i.e., the Backfit Rule).	See NRC Resolution of NEI comment #3.
116	General	John McCann/ Entergy	STARS recommends that DG-1240 be withdrawn. STARS concurs with the NEI position that DG- 1240 establishes a new position relative to condition monitoring for electric cables inconsistent with previously endorsed guidance for the implementation of the Maintenance Rule and requires a backfit analysis. The most significant concern, however, is the absence of an analysis demonstrating a positive effect on nuclear safety through the cable monitoring program described in DG-1240. The monitoring techniques described in DG-1240 can actually reduce cable insulation life or cause the catastrophic failure of a fully operable safety-related cable (Direct Current High-Potential Test). Additionally, the potential for equipment damage through repeated cable de-termination and re-termination of hundreds of safety-related cables needs to be evaluated and addressed prior to issuing this Regulatory Guide.	See NRC Resolution of comment #3.
117	Page 7- Tech. # 10	Chris Campbell	The Frequency Domain Reflectometry (FDR) method is missing. This is another technique based on transmission line theory such as Time Domain Reflectometry (TDR) that should be included in this NRC document. The NRC draft guide includes the technique LIRA, which is cable testing technique that uses the FDR principle. FDR is the actual technique whereas LIRA is a trademarked product of a European company and is patented.	The discussion under Line Resonance Analysis (LIRA) was modified to identify FDR, LIRA is identified as an example.