NPEC Subcommittee SC-3, *Operations, Maintenance, Aging, and Testing*

Meeting S05-1
Tuesday Jan. 26, 2005
Las Vegas, NV

Members Present:	George Ballassi (Vice Chair)	Brij Bharteey
	Surin Dureja (Chair)	Dave Horvath
	Peter Kang	Jim Liming
	Jim Redmon	Ted Riccio (Secretary)
	Glen Schinzel	John Taylor (Past Chair – by phone)
	Jit Vora	
Members Absent:	Hamid Heidarisafa	Bob Lofaro
	Henry Leung	Burl Williams
	Mansoor Sanwarwalla	
Other Attendees:	Jim Gleason	

1.0 Introduction

- **Opening Remarks**

Surin called the meeting to order on Jan. 25 at 8:30 AM with news that John Taylor is stepping down as chairman of SC3 due to other commitments. Surin will step up to the chairman's position which leaves the secretary position open. George Ballassi accepted the position of Vice Chairman. Ted volunteered to take the secretary position. John Taylor could not attend due to weather related flight cancellations, but agreed to participate by conference call.

- **Introductions**

The members introduced themselves for the benefit of guest attendee.

- **Meeting's Agenda**

No changes of the agenda

2.0 Secretary's Report

- **Approval of SC04-2 Meeting Minutes**

The minutes of the June, 2004 meeting, in Chicago, were approved by affirmative vote.

- **Action Item Status**

All outstanding action items are closed. New action items are identified in the table and discussed in the text of these minutes.

Item No.	Description	Status

AI-05-1-1	Arrange S05-2 - Surin/Ted	Open
AI-05-1-2	Recruit new members –All	Open
AI-05-1-3	Try to get NRR Electrical representation - Peter K.	Open
AI-05-1-4	Check with Henry Leung for membership - Surin	Open
AI-05-1-5	Get clarification for the [point at which the PAR runs out - Surin	Open

Most action items had been reviewed during the WG-3.1 meeting. See WG 3.1 minutes

- **Alligator Fund**

The Alligator Fund is made up of voluntary contributions from SC-3 members to defray the cost of meeting rooms, refreshments, etc. The balance after S04-02 meeting was $312.14. Funds collected at the meeting were $200.00. A total of $359.82 was spent for refreshments (paid $299.32 to the hotel), and sharing the screen rental ($ 60.00 paid to NPEC- Satish). Balance after this 04-02 meeting is $312.14.

- **SC3 Membership**

Surin will check with Henry Leung on SC3 membership. Preston Dougherty and Sonny Kasturi are being taken off of the SC3 membership roster.

Name	**03-01 Houston, TX**	**03-02 Boston, MA**	**04-01 San Clemente, CA**	**04-02 Chicago**	**05-01 Las Vegas**
George A. Ballassi	X	X	X	X	X
Brij Bharteey	A	X	A	X	X
Surin Dureja	X	X	X	X	X
Hamid Heidarisafa	A	X	A	X	A
David A. Horvath	X	X	A	X	X
Peter J. Kang	N/A	N/A	N/A	Guest	X
Henry Leung	A	X	A	A	A
James K. Liming	N/A	X	X	X	X
Bob Lofaro	X	X	A	A	A
Jim Redmon	N/A	X	X	A	X
Ted Riccio	X	X	X	X	X
Mansoor Sanwarwalla	A	A	A	X	A
Glen E. Schinzel	X	X	X	X	X
John Taylor	X	X	X	A	X by phone
J. (Jit) T. Vora	A	A	A	A	X

X means Present A means Absent Attachment 1 is a copy of the current Subcommittee membership.

The current breakdown of SC 3 members by category is as follows:

Utility	**AE/Consultant**	**Gov't/National Labs**	**Other**	**Total**
5	5	4	1	15

The updated membership roster is included as Attachment 1 to the minutes. The current SC-3 and working group rosters are also on the IEEE/NPEC website at URL: http://grouper.ieee.org/groups/npec/private/sc3/sc-3.html: user name: [redacted], password: [redacted].

1.0 SC-3 Chair's Report

Although John couldn't attend the meeting, he did call in and stayed with us for most of the meeting.

- **NPEC Activities**

Dave reported that we could find the activities on the website. A brief description of the highlights is below:

NPEC Report to SC-3 (Based on Prior NPEC Meeting 04-2)

NPEC Chair Jack Carter reported that IEEE-SA is considering a new category of standard called a "stabilized standard." Such a standard is needed and used but it would no longer require revision or update. It is "frozen" indefinitely. The down side is that such a standard would lose its ANSI status.

NPEC is considering spearheading an effort to re-publish a compendium of superseded nuclear-oriented IEEE standards.

2005-2006 NPEC Goals were approved. These five goals are summarized as follows:

1. **Increase NPEC Participation in International (Joint) Standards**

Revise IEEE 323 and a Human Factors Standard in conjunction with IEC as a Pilot Program to understand the process of international standards development.

2. **Increase Standards Focus on Upgrade Of Existing Systems, Safety System Security, and I&C Related Digital Issues**

Address Upgrade of existing systems in NPEC standards.
Resolve the need for NPEC standards addressing Safety System Security and I&C Related Digital Issues (EMI/RFI, etc.).

3. **Improve NPEC Technical Leadership**

Continue existing efforts to improve technical skills of members.
Resurrect NPEC White Papers.
Subcommittees shall determine how to transfer knowledge to young engineers.

4. **Support NRC Staff In Endorsement and/or Incorporation of Standards into Regulatory Documents.**

Improve NPEC understanding of the NRC Regulatory Guide endorsement process.
Support the NRC staff in the endorsement/incorporation of standards.

5. **Incorporate Risk Informed Methodologies into IEEE Standards**

Identify and incorporate Risk Informed Methodologies into applicable IEEE Standards

[For more details on NPEC 2005-2006 Goals, see NPEC Meeting 04-2 minutes, Attachment C or http://grouper.ieee.org/groups/npec/private/npec04-2.pdf]

Next NPEC Meeting 05-2 will be held in San Francisco during last week of July 2005.

P344 Draft 23 was balloted on 4/1/04. 29 technical comments resulted. Several of the comments were on the experienced-based methodology. The working group plans to complete its response to the comments and to submit a 10 day recirculation ballot

Satish Aggarwal said progress has been made in pursuing IEEE Std 323-2003 as a dual logo (IEEE / IEC) pilot standard. The two organizations have agreed to this candidate possibility and the working group is in the process of identifying changes between IEEE Std 323 and its corresponding IEC counterpart.

- **Future Meeting Location and Dates**

The next meeting is scheduled to be held in San Francisco, CA. During the week of August 1 at the Marriot San Francisco. Room rates are $126 per night plus tax. Total will be $143.74 per night.

To book on-line, click on the link below. Use usgusga for the Group Code.
http://marriott.com/property/propertypage.mi?marshaCode=SFODT

To book by phone, call the hotel at 415-896-1600 or Marriot reservations at 800-228-9290. It is recommended that you book as soon as possible as this is the peak visitor season. Cancellation can be done up to 6:PM day of arrival without penalty.

2.0 Working Group 3.1 (Testing) Report

Since most of the members were already present at the WG 3.1 meeting, most of the report was not necessary. George did report that he along with Jim and Glen will give an orientation to NPEC on Wednesday to introduce them into the risk based annexes the WG3.1 is working on. This is an effort to help pave the way for approval in a timely fashion. A question was raised as to where in the preparation/approval process of a revision the PAR time runs out George will look into this. As for the preview, the revision has to be complete and to NPEC 30 days prior to the NPEC meeting. After the presentation, NPEC requested 60 days due to the nature of the revision. A schedule was prepared to help accomplish this. The schedule can be found in Attachment 3.

WG 3.1 is responsible for maintenance of IEEE Std 336, *"Guide for Installation and Testing for Class 1E Power, Instrumentation, and Control Equipment at Nuclear facilities"* and IEEE Std. 338, *"Standard Criteria for the Surveillance Testing of Nuclear Power Generating Station Safety Systems".*

3.0 Working Group 3.2 Report

P692 - IEEE Standard Criteria for Security Systems for Nuclear Power Generating Stations. Dave reported that 21 of 26 balloters responded and that 20 of the 21 approved. The negative comment was although the standard did not change much, it should have because of all the changes required by the NRC. Dave will try to get the negative ballot reversed.

WG 3.2 is responsible for maintenance of IEEE Std 692, *"IEEE Standard Criteria for Security Systems for Nuclear Power Generating Stations".*

4.0 Working Group 3.4 (Aging) Report

WG 3.4 is looking into reaffirmation of 1205 - IEEE Guide for Assessing, Monitoring, and Mitigating Aging Effects on Class 1E Equipment used in Nuclear Power Generating Stations. Peter reported that the NRC has updated the Generic Aging Lessons Learned (GALL) Report incorporating new information from plants. One question that came up but wasn't resolved at the time was if 1205 should be revised to use information from the updated GALL Report.

WG 3.4 is responsible for maintenance of IEEE Std 1205 "*Guide for Assessing, Monitoring, and Mitigating Aging Effects on Class 1E Equipment Used in Nuclear Power Generating Stations".*

5.0 Presentations

Jit gave a presentation on the Application of the Broadband Impedance Diagnostic/Prognostic Technique To Nuclear Power Plant Electric Cables. See attachment 2. Some of the symbols may not be presented properly if using a different version of Microsoft Office that Jit used. If you have questions, please let Ted Riccio know.

6.0 New Business

The subject of developing an EMI standard was considered. NPEC is looking for suggestions on the subject. SC2, SC3 and SC6 all have some sort of jurisdiction. 323 IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations comes under WG2 and may be a good place. A tabletop meeting will be held to discuss this further.

Glen made a suggestion that we may want to send 338 to the Nuclear Risk Management Committee for information or comment.

7.0 Liaison Reports

- **ASME Liaison Report**

ASME Liaison Report

Glen E. Schinzel
STPNOC
January 2005

The ASME Operations and Maintenance (O&M) committees last met on December 1-3, 2004 in Tampa, FL. The following are some pertinent insights that were gained from the most recent set of meetings:

Risk-Informed In-service Testing standard development

ASME is developing a Risk-Informed In-service Testing standard currently entitled ISTE. This draft standard is intended to provide nuclear licensees with consistent guidance in testing affected pumps and valves, with the scope and frequency of testing commensurate with the component's safety significance. Once approved, it is anticipated that ASME will seek NRC endorsement of the ISTE standard.

The draft ISTE standard was re-balloted in first quarter 2004 with additional comments received. Following an adjustment to the methodology, it is expected to re-ballot again later in 2005.

ASME Codes and Standards development

A proposed standard on Low Safety Significant Component Treatment is in the process of development, and is expected to be initially balloted at the end of 2005. While no specific interface points with IEEE were identified during the previous set of ASME O&M meeting discussions, IEEE should maintain an awareness of the Low Safety Significant Component Treatment Standard, as this may be an area that IEEE will need to develop future guidance for electrically-related components.

ASME Interactions on 10CFR 50.69

10CFR 50.69 is an approved rule which allows the special treatment requirements (Class 1E, EQ, etc) currently invoked on safety-related equipment categorized as low safety significant to be reduced.

ASME has developed a categorization approach for passive components (Code Case N-660) which is utilized in the broad industry categorization guidance. The NRC has raised some questions concerning the passive categorization methodology, and a meeting is scheduled between ASME, NRC, and industry personnel on February 10, 2005 to address NRC comments. This is an area where IEEE should maintain an awareness of the outcome if it is desired to specifically categorize passive electrical components (i.e., cabling, transformers, etc) at some point in the future.

Nuclear Risk Management Coordinating Committee (NRMCC)

ASME, in conjunction with the American Nuclear Society (ANS), the Nuclear Energy Institute (NEI), and the NRC, formed a joint industry oversight group in February 2004 to better integrate risk-related standards development and usage within the nuclear industry. The majority of NRMCC efforts include development and integration of PRA standards. Most business is handled on teleconferences, with the last telecon held on January 12, 2005. No specific IEEE interface is required on the NRMCC, however, various members of Subcommittee 3 have participated in NRMCC meetings or telecons over the past 11 months. Glen Schinzel will continue to participate in NRMCC telecons, and will keep Subcommittee 3 appraised of activities in this area. However, no direct IEEE participation/membership in the NRMCC is warranted at this time.

- **EPRI Liaison Report**

NEI/EPRI Liaison Report

Glen E. Schinzel
STPNOC
January 2005

A number of industry activities are currently underway to address risk-informed applications as follows:

10CFR 50.69 on Reduction of Special Treatment Requirements

10CFR 50.69, a new voluntary rule which allows the special treatment requirements (Class 1E, EQ, seismic, etc) currently invoked on safety-related equipment to be reduced for those components categorized as low safety significant, was approved on November 22, 2004. Industry is still assessing the rule language and it's accompanying Statements of Consideration, and has expressed some concerns with potential regulatory uncertainty in going forward. In addition, the Nuclear Energy Institute (NEI) is developing a categorization guide for 50.69, while the Westinghouse Owner's Group (WOG) is funding industry pilot efforts to allow a smooth transition into this new regulatory environment.

The NEI Categorization Guideline (NEI-00-04) is being finalized, and should be forwarded to the NRC by February 2, 2005 for review and expected endorsement. This categorization guideline will be the implementing details for draft Reg Guide 1.201 which supports the 50.69 rule. RG-1.201 is expected to be published prior to June 30, 2005.

In addition, the Electric Power Research Institute (EPRI) is developing specific treatment guidance in the areas of seismic qualification and environmental qualification to permit consistent industry implementation. The seismic qualification document was published in preliminary form in December 2004, while the EQ document is expected to be published by June 2005. EPRI is also developing a broad Treatment Guideline for Low Safety Significant components. This guideline is expected to address a significant portion of the 50.69 areas of implementation, and should be published in third quarter 2005. An EPRI meeting to address additional comments on the

broad Treatment Guideline is scheduled for January 27, 2005.

Two licensees (Wolf Creek and Surry) are serving as pilot plants of the 50.69 categorization effort. These licensees have performed trial system categorizations, and intend to formally request adoption of the 50.69 allowances by submitting a License Amendment Request (LAR) in third quarter 2005 for NRC approval. It is uncertain how long this first-time-evolution approval process will take.

While much work continues in this area, IEEE should continue to monitor industry progress and to assess the strategic position that IEEE wishes to take, if any, to move further into this risk-informed rule.

Other areas of focus

NEI continues to coordinate industry efforts to risk-inform the NRC regulations (Option 3). The major focus of Option 3 is to redefine the design basis accident, i.e., the large break LOCA. This effort is expected to garnish the maximum benefit for future plant construction, however, existing licensees can benefit from streamlining testing and qualification activities. This effort is a long-term action that will require continuing licensee and regulator interface.

NEI continues to coordinate industry efforts to risk-inform the Technical Specifications. While the short-term efforts will not revise the scope of what is currently in Tech Specs, it will alter the way a licensee responds to an issue when a Tech Spec action statement is entered. The focus of the effort is for licensees to properly manage the risk to their station operations with the subject component out of service. It is expected that the outcome of this effort will permit safer plant operations that are not driven by deterministic action statements when a component fails. Two of the eight initiatives, missed surveillances and mode change flexibility, have already been approved. In addition, South Texas Project is piloting the Tech Spec Initiative 4(b) which permits flexible allowed outage times (up to 30 days). A number of NRC interactions are occurring in this area, and it is expected that NRC approval of this allowance will be granted in third quarter 2005.

NEI continues to coordinate industry actions on PRA comprehensiveness. Per the NRC's four-phase PRA quality effort, it is desired to gradually 'raise the bar' on PRA quality. The industry's Nuclear Risk Management Coordinating Committee (NRMCC) continues to take a leading role in this effort. No direct IEEE involvement on the NRMCC is warranted at this time.

- **NRC Liaison Report**

NRC Liaison Report
By Peter J. Kang and Jit Vora
Office of Nuclear Regulatory Research, NRC
January 24-27, 2005

The following items would be of interest to the members of the IEEE SC-3 and its working groups:

Updating of License Renewal Guidance Documents (LRGDs)

The LRGDs consist of GALL report, SRP-LR, RG 1.188, and NEI 95-10. These guidance documents were developed for the license renewal (LR) review process to be more effective, efficient, and have been in use for LR since 2001. Based on the experience gained from LR review process, the applicants and the staff have been finding a need for upgrading the documents to address newly emerged technical issues, and revisions to various aging management programs (AMPs). For this effort, the industry has been very responsive by standardizing their LR application format to gain further efficiency and to reduce the LR review period. The updating process requires the public and industry participation and preparing the basis documents for the changes. The staff has drafted preliminary updates to GALL report and SRP-LR, and posted on September 30, 2004. This also includes draft basis document that provides explanation and justification for the updates. Public meeting was held on November, 2004 and received positive feedback. By January 31, 2005, approved draft updated to GALL report and SRP-LR will be available for public comments. On January 13, 2005, a meeting was held to finalize NEI 95-10 (Rev. 4). Public Comments period will be provided from February 1, 2005 to March 30, 2005.

Generic Letter on Medium Voltage (4.16 kV) Underground Cable Aging Issues
NRC staff plans to issue a generic letter on potential degradation concerns identified for the medium voltage underground cables during reviews of license renewal application and operating experience related to emergency component cooling water system cable at a nuclear power plant. The staff has reviewed the operational data (LERs) and finds that medium voltage cables can fail due to water treeing or a decrease in dielectric strength due to aging, if it is exposed to condensation and wetting in inaccessible locations such as conduits, cable trenches, and duct banks. It was decided that this issue should be reviewed under 10 CFR Part 50., On February 5, 2004 the staff issued a letter (ML040370628) titled, "Potential Common Mode Failure of Medium Voltage Underground Cables" to NEI to engage the industry regarding the potential common-mode failure of medium voltage cables. The staff met with NEI on June 2, 2004 to seek clarification on the issues and for discussion of the staff's concerns. NEI agreed that cable water trees could be a problem for those medium voltage underground cables susceptible to degradation, but it occurs only randomly, disagreed with the staff opinion of a common mode failure implication requiring an immediate resolution.

Generic Letter on “Grid Reliability, Impacts on Plant Risk, and Operability of Offsite Power”

In connection with August 14, 2003 blackout event in Northeastern United States of America and a part of Canada, NRC issued a Regulatory Issue Summary (RIS) (ML040990550) on April 15, 2004 to advise nuclear power plants of the requirements of Section 50.65 of Title of the 10 CFR (10 CFR 50.65), "Requirements for monitoring the effectiveness of maintenance at nuclear power plants," 10 CFR 50.63, "Loss of all alternating current power," 10 CFR Part 50 Appendix A, GDC 17, "Electric power systems," and plant technical specifications on operation of offsite power. Subsequent to the issuance of the RIS, the staff issued TI (ML040360320) titled, "Offsite power system

operational readiness" for inspections on April 29, 2004. The purpose of the TI was to confirm the operational readiness of offsite power system in accordance with NRC requirements prescribed in 10 CFR Part 50, GDC-17, Plant TS for offsite power systems, 10 CFR 50.63, and 10 CFR 50.65(a)(4). After reviewing TI information collected, the staff determined that a generic letter is required to access grid reliability, impacts on plant risk, and operability of offsite power.

On Going Research Project, "Effects of Switchgear Aging on Energetic Faults"

An event at a Taiwan nuclear power plant resulted in a energetic fault and a fire that damaged medium voltage (4.16 kV) switchgears. The damage affected both safety division buses in the plant and the event resulted in a station blackout, because emergency diesels were not available on time. Since the design of switchgear was based on the US specification, such energetic faults can occur in US nuclear plants. The NRC initiated a research project to evaluate the effects of switchgear aging on energetic faults (Task 1) and performed the sensitivity analysis (Task 2). The research identified that aging of Class 1E power system components could contribute and increase frequency and severity of such energetic faults if aging is not properly managed, A system level evaluation of medium voltage electrical distribution systems Task 3 (completed on December 31, 2004) was conducted to examine the effects of various system transients. This task involved a review of plant electrical distribution system designs for transients. Two representative nuclear plant distribution systems were modeled using power system analysis software (ETAP) to aid the evaluation of medium voltage system operating and fault transients. Under Task 4, impact of equipment aging on system protection will be reviewed. Task 4 is scheduled to be completed this year and a NUREG/CR report is also planned by the end of this year.

Ongoing Research Project, "Collaborative Research on Wire System Aging"

At the ANS Embedded Topical Meeting, November 14-18, 2004, the NRC/BNL/Boeing staff presented a technical paper on the effectiveness of the BBIS methods for detecting and locating localized anomalies in cable systems. Examples were provided on cables with humidity and thermal hot spots. Research is continuing to detect and locate anomalies attributable to abrasion, cracking and varying environments. Emphasis is being placed on "collaborative research" with interested institutions and organizations. Future research opportunities are being sought for evaluating the effectiveness of the BBIS method in nuclear plant environment. For additional details please review the ANS paper and the presentation made at the subject IEEE SC3 meeting.

Federal Register Notice (FRN): Public Comments on Draft Report on," Evaluation of Loss of Offsite Power Events at Nuclear Power Plants: 1986-2003"

On December 8, 2004, NRC issued a request for public comments (FRN) on the draft report titled, "Evaluation of Loss of Offsite Power Events at Nuclear Power Plants: 1986-2003." This report is an update of two previous analyses of loss of offsite power (LOOP) events at U. S. commercial nuclear power plants. LOOP frequency and duration estimates for critical plant operation and shutdown operations were generated for five categories of LOOPs (plant centered, switchyard centered, grid related, severe weather related, and extreme weather related). Overall findings

are: LOOP frequencies have decreased significantly, while LOOP durations have increased in recent years. This information is useful for probabilistic risk assessment models and for evaluating associated station blackout scenarios.

- **SC2 Liaison Report**

IEEE SC-2 Liaison Report

By Robert J. Lofaro
Brookhaven National Laboratory
January 2005

1. Highlights of Standards Activities

- Standard 323 - Qualification of Class 1E Equipment
  - < The next revision to the standard is being discussed. The working group is considering expanding the scope to include all safety equipment, including non-Class 1E and mechanical equipment.
- Standard 383 - Qualification of Class 1E Electric Cables and Field Splices
  - < The revised standard 383-2003 has been published and is now publicly available.
- Standard 344 – Seismic Qualification of Class 1E Equipment
  - < This standard was revised to address lessons learned since the previous revision. The revision is now in the process of being submitted to the IEEE Standards Board for review and approval.
- Standards 334 (Motors), 382 (Motor Operated Valves), 572 (Connectors), and 649 (Motor Control Centers) and 650 (Battery Chargers and Inverters)
  - < The working groups have started meeting to work on revising or reaffirming the standards
  - < New members are needed for 382 and 572 working groups. Those interested should contact Satish Aggarwal (sk@ieee.org).

2. New Business

- A special working group was formed to look into what activities SC-2 should take to address qualification of fiber optic cables, including modifications to 383 or the development of a separate new standard. The group, chaired by Jan Pirrong, recommended that a new standard be developed to address qualification of fiber optic cables. A PAR is now being prepared for submission to IEEE.
- A special working group was formed to look into what activities SC-2 should take to address qualification of microprocessor-based equipment, including modifications to 323 or the development of a separate new standard. The group, Chaired by Jeff Chivers, made a presentation on the differences between international standards on this subject, including IEEE, IEC, KTA and RCC standards at the October 2004 SC-2 meeting. Work is continuing to develop a joint IEEE/IEC standard on qualification.
- A special working group was formed to look into what activities SC-2 should take to address ISO-9000 standards. The group, Chaired by Tom Hencey, will provide a

report at the next SC-2 meeting.

3. Next Meeting

- The next meeting of SC-2 is planned for April 2005 in San Diego.

SC2 Liaison Report January 2005 Page 1 of 1

The meeting adjourned at 12:35 PM on Tuesday.

Prepared by Ted Riccio SC-3 Secretary.

ATTACHMENT 1

IEEE - Nuclear Power Engineering Committee
Subcommittee SC-3 Membership List
Operations, Maintenance, Aging, And Testing

Name/Company	Address	Assignment
BALLASSI, A. (GEORGE) GENERAL DYNAMICS/ ELECTRIC BOAT CORP.	[redacted]	SC-3 (VC) WG 3.1(C) WG-3.4(M)
BHARTEEY, B.M. (BRIJ) SPECTRUM TECHNOLGIES a division of ATNC.	[redacted]	SC-3(M) WG-3.1(M) WG-3.4(M)
DUREJA, S.K. (SURIN) CONSTELLATION NUCLEAR	Calvert Cliffs Nuclear Power Plant [redacted]	SC-3 (C) WG-3.1 (M) NPEC (M)
HEIDARISAFA, HAMID R. AMERICAN ELECTRIC POWER	[redacted]	SC3 (M) SC3.1 (M)
HORVATH, D.A. (DAVE) ADVENT ENGINEERING SERVICES, INC.	[redacted]	SC-3(PC) WG-3.1(M) WG-3.2(C) WG-3.4(PC) NPEC (S)
PETER J. KANG US NUCLEAR REGULATORY COMMISSION	Office Of Nuclear Regulatory Research [redacted]	SC-3(?) WG-3.1(M)

LEUNG, C.W. (HENRY) CANADIAN NUCLEAR UTILITY SERVICE [redacted]	[redacted]	SC-3(M) WG-3.4(M)
LIMING, JAMES K. ABS CONSULTING INC. [redacted]m	[redacted]	WG-3.1(M) SC3 (M)
LOFARO, ROBERT (BOB) BROOKHAVEN NATIONAL LAB [redacted]	[redacted]	SC3 (M) WG -3.1 (M)
REDMON, JIM SOUTHERN CALIFORNIA EDISON [redacted]	San Onofre Nuclear Generating Station [redacted]	SC-3(M) WG-3.1(M)
RICCIO, TED South Texas Project Electric Generating Station [redacted]	[redacted]	SC3 (S) WG 3.1 (S)
SANWARWALLA, M.H. (MANSOOR) SARGENT & LUNDY [redacted]	[redacted]	SC-3 (M) WG-3.4 (M)
SCHINZEL, G.E. (GLEN) South Texas Project Electric Generating Station [redacted]	[redacted]	SC3 (M) WG-3.1 (M)
TAYLOR, J.H. (JOHN) BROOKHAVEN NATIONAL LAB [redacted]	[redacted]	SC-3(PC) WG-3.1(M)
VORA, J.P. (JIT) US NUCLEAR REGULATORY COMMISSION [redacted]	Office Of Nuclear Regulatory Research [redacted]	SC-3(M)
WILLIAMS, B. (BURL) ENERGY OPERATIONS [redacted]	Arkansas Nuclear One [redacted]	SC-3 (M) WG-3.4 (M) Mailing list only
GLEASON, JAMES (JIM) BSC, LLC (Yucca Mountain) [redacted]	[redacted]	Guest at Las Vegas meeting

IEEE - Nuclear Power Engineering Committee
Working Group WG-3.1 Membership List

Testing
Standard IEEE Stds 336 and 338

Name/Company	Address	Assignment
BALLASSI, A. (GEORGE) GENERAL DYNAMICS/ ELECTRIC BOAT CORP. 8		SC-3(VC) WG-3.1(C) WG-(3.4)
BHARTEEY, B.M. (BRIJ) SPECTRUM TECHNOLGIES a division of ATNC.		SC-3(M) WG-3.1(M) WG-3.4(M)
DUREJA, S.K. (SURIN) CONSTELLATION NUCLEAR	Calvert Cliffs Nuclear Power Plant	SC-3(C) WG-3.1(M) NPEC (M)
HEIDARISAFA, HAMID R. AMERICAN ELECTRIC POWER		SC-3(M) WG-3.1(M)
HORVATH, D.A. (DAVE) ADVENT ENGINEERING SERVICES, INC.		SC-3(PC) WG-3.1(M) WG-3.2(C) WG-3.4(PC) NPEC(S)
PETER J. KANG US NUCLEAR REGULATORY COMMISSION	Office Of Nuclear Regulatory Research	SC-3(?) WG-3.1(M)
LEUNG, C. W. (HENRY) CANADIAN NUCLEAR UTILITY SERVICE		SC-3(M) WG-3.4(M)
LIMING, JAMES K. ABSG CONSULTING INC. (		SC-3(M) WG-3.4(M)
LOFARO, ROBERT (BOB) BROOKHAVEN NATIONAL LAB		SC-3(M) WG-3.1(M)
REDMON, JIM SOUTHERN CALIFORNIA EDISON	San Onofre Nuclear Generating Station	SC-3(?) WG-3.1(M)

RICCIO, TED STP Nuclear Operating Co. [redacted]	[redacted]	SC-3(S) WG-3.1(S)	
	SCHINZEL, GLEN STP Nuclear Operating Co [redacted]	[redacted]	SC-3(M) WG-3.1(M)
TAYLOR, J.H. (JOHN) BROOKHAVEN NATIONAL LAB [redacted]	[redacted]	SC-3(PC) WG-3.1(PC) WG-(3.4)	
VORA, J.P. (JIT) US NUCLEAR REGULATORY COMMISSION [redacted]	Office Of Nuclear Regulatory Research [redacted]	SC-3(M) WG-(3.4)	
WILLIAMS, B.E. (Burl) ENTERGY [redacted]	Arkansas Nuclear One [redacted]	SC-3(M) WG-3.1(M) WG-(3.4)Mailing List Only	
GLEASON, JAMES (JIM) BSC, LLC (Yucca Mountain) [redacted]	[redacted]	Guest at Las Vegas meeting	

IEEE - Nuclear Power Engineering Committee
Working Group WG-3.2 Membership List
Security Systems
Standard IEEE Std 692

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SIMS, J (JERRY) SOUTHERN NUCLEAR OPERATING CO. [redacted]	[redacted]	WG-3.2 (M)
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WILLIAMS, B.E. (BURL) ENTERGY [redacted]	Arkansas Nuclear One [redacted]	WG-3.1 (M) WG-3.2 (M)

IEEE - Nuclear Power Engineering Committee
Working Group WG-3.4 Membership List
Assessing, Monitoring, And Mitigating Aging Effects On Npgs Equipment
Standards: IEEE Std 1205

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FLEISCHER, L.Q. (LAMIS) EXELON CORP. [redacted]	Peach Bottom Nuclear Station [redacted]	SC-3(M) WG-3.4(M)
HORVATH, D.A. (DAVE) ADVENT ENGINEERING SERVICES, INC. [redacted]	[redacted]	SC-3(C) WG-3.1(M) WG-3.2(C) WG-3.4(PC) NPEC (S)
LEUNG, C.W. (HENRY) ATOMIC ENERGY OF CANADA LIMITED [redacted]	[redacted]	SC-3(M) WG-3.4(M)
LOFARO, R.J. (ROBERT) BROOKHAVEN NATIONAL LAB [redacted]	[redacted]	SC3 (M) WG3.1 (M) WG-3.4(M)
SANWARWALLA, M.H. (MANSOOR) SARGENT & LUNDY [redacted]	[redacted]	SC-3 (M) WG-3.4 (M)

ATTACHMENT 2

Application of the Broadband Impedance Diagnostic/Prognostic Technique To Nuclear Power Plant Electric Cables

Presented By
Jit Vora
Office of Nuclear Regulatory Research

Page 1

Presentation and Discussion Topics

- Installed Cable System with Localized Defects
- Issues
- Broadband Impedance Spectroscopy (BIS)
- Research Approach
- Research Results
  - Global Aging
  - Localized Aging
- BIS Advantages
- Conclusions
- Research in FY 2005
- Recommendations for FY 2006 – FY 2007

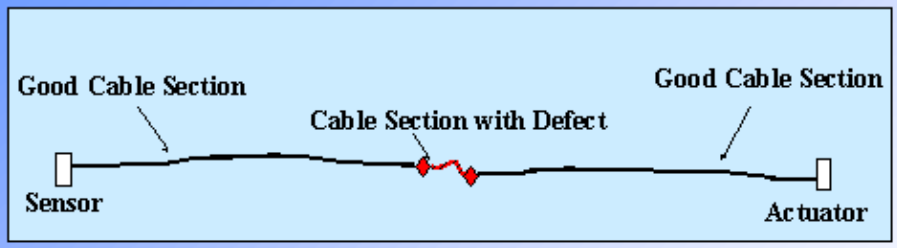
Page 2

Overview of Broadband Impedance Spectroscopy

- Developed by The Boeing Co. and Rockwell Scientific under the sponsorship of the FAA for aircraft applications
- Evaluated by the U.S. NRC Office of Nuclear Regulatory Research and Brookhaven National Laboratory for nuclear power plant applications

Page 3

Installed Cable System with Localized Defect



- Cable defects can be caused by thermal and radiation aging, by mechanical damage inflicted during installation or maintenance, or by moisture ingression.
- Defects can lead to failure of a component to operate, or mis-information to the plant operator resulting in a potential safety concern.
- An effective, viable condition monitoring technique for installed cable systems is needed to detect and locate defects before they result in failures.

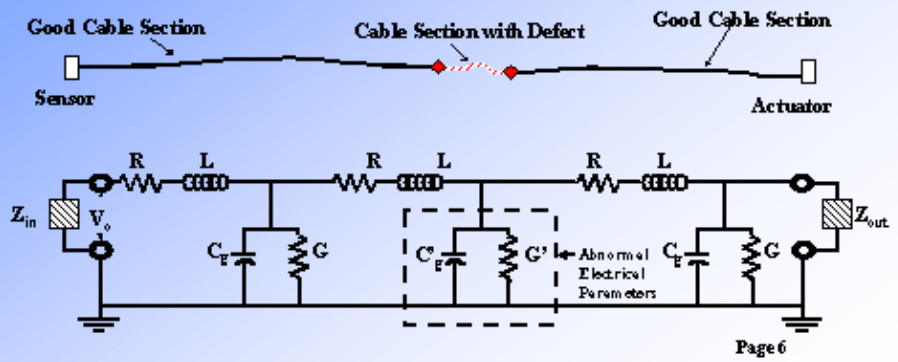
Page 4

Issues

- Aging of cable systems has been identified as an important public health and safety issue that transcends all government agencies – White House OSTP Report, November 2000
- It is an issue for aircrafts and space crafts, submarines and surface ships, residential homes and commercial nuclear power plants
- Currently, there is no viable diagnostic and condition monitoring method available for installed cable systems in operating nuclear power plants, especially for low-voltage I&C cables.

Broadband Impedance Spectroscopy

- BIS has the potential to detect and locate anomalies in an installed cable system by evaluating relevant electrical circuit parameters (R, L, C, and G)



Broadband Impedance Spectroscopy

- Impedance data from the cable system are analyzed to extract information on the cable properties using models developed by Boeing
  - Capacitance, Resistance, Inductance
  - Impedance magnitude and phase angle
  - Dielectric function
- The wire properties extracted from the impedance data are then evaluated to determine the health of the wire
  - Detection of degradation from both the low-frequency and high frequency data
  - Location of degradation from high-frequency data

Page 7

Theory of Broadband Impedance
(System Electrodynamics)

$$\frac{\partial}{\partial x} V(x,t) = -R\, I(x,t) - \frac{\partial}{\partial t} L\, I(x,t)$$

$$\frac{\partial}{\partial x} I(x,t) = -G\, V(x,t) - \frac{\partial}{\partial t} C\, V(x,t)$$

Note: (x, t) represents a function of (space, time)

Page 8

Extraction of Wire Electrical Properties from BIS Data

- BIS data provide the characteristic impedance, $Z_0(\omega)$, and the propagation function, $\gamma(\omega)$, from which the electrical properties can be extracted. Their definitions are:

$$Z_0(\omega) = \sqrt{\frac{R(\omega) + i\,\omega\,L(\omega)}{i\,\omega\,\Lambda\,\varepsilon(\omega)}}$$

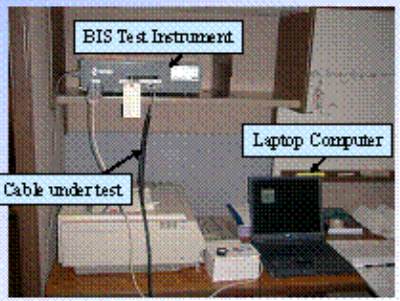
$$\gamma(\omega) = \sqrt{(R(\omega) + i\,\omega\,L(\omega))\; i\,\omega\,\Lambda\,\varepsilon(\omega)}$$

- Here R(❄), L(❄) and ε_0(❄) are the cable's resistance per meter, inductance per meter, and dielectric function, respectively.

Note: Λ is a structure factor determined by the wire configuration and is independent of ω

Broadband Impedance Spectroscopy

- The impedance measurements are controlled by a computer software program to automatically obtain data over a broad range of frequencies
- The impedance data are stored on the computer, and later downloaded for analysis



Impedance test measurement setup

Page 10

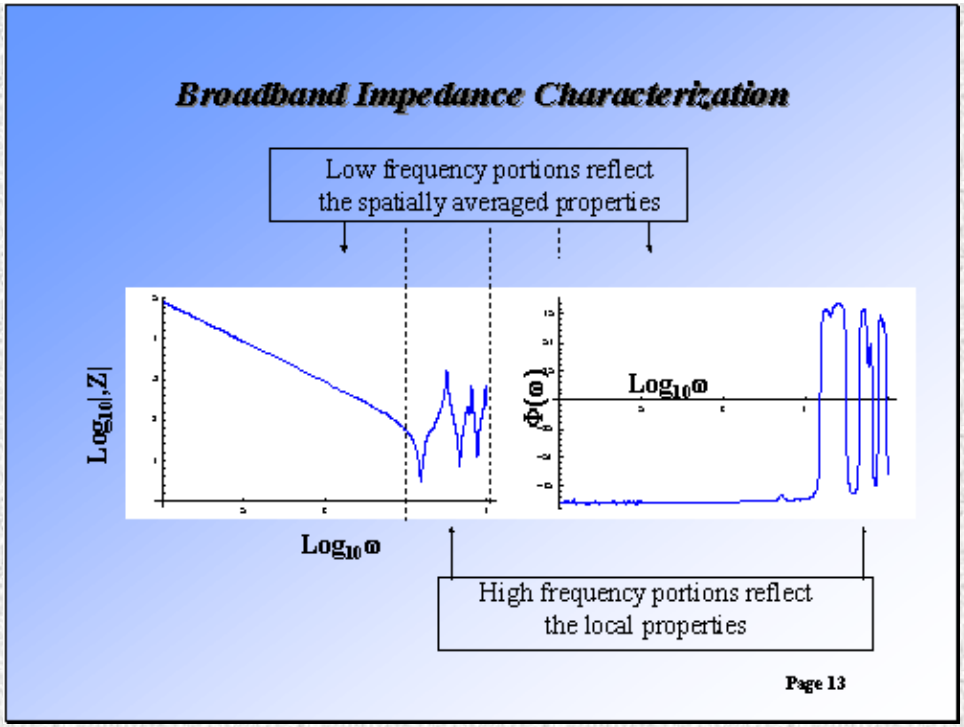
Research Approach

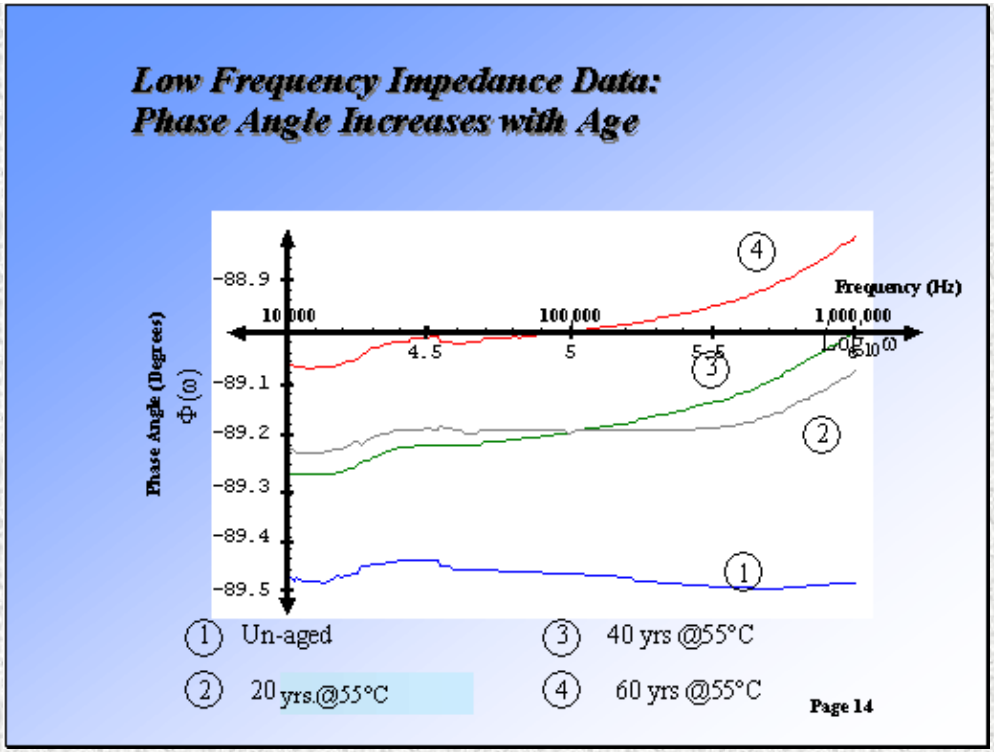
- **Samples of I&C cables commonly used in nuclear plants were prepared by BNL and provided to Boeing for BIS testing**
  - 2/C #14 AWG, 600 Volt rating
  - 30 mil XLPE insulation/45 mil Neoprene outer jacket
- **Accelerated global thermal aging of the samples was performed by BNL to simulate various service lives**
  - Un-aged, 20 yrs., 40 yrs., 60 yrs.
  - 3 samples of each age were provided

Page 11

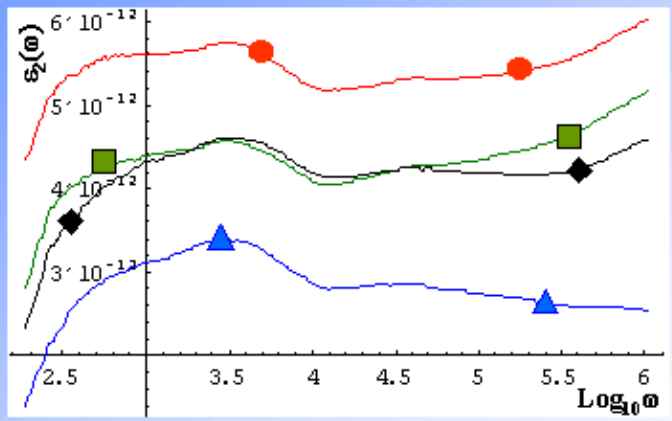
Research Approach (continued)

- Impedance measurements were made on the globally aged cables to demonstrate that the BIS method can detect global degradation
- One of the samples was exposed to localized degradation by placing a 1-foot section of the cable in a humidity chamber
- Impedance measurements were made to demonstrate that localized degradation can be detected and located


Broadband Impedance Characterization
Low frequency portions reflect
the spatially averaged properties
Log10|Z|
Log10ω
Φ(ω)
Log10ω
High frequency portions reflect
the local properties
Page 13


Low Frequency Impedance Data:
Phase Angle Increases with Age
Phase Angle (Degrees)
Φ(ω)
-88.9
-89.1
-89.2
-89.3
-89.4
-89.5
10,000
100,000
1,000,000
Frequency (Hz)
4.5
5
5.5
Log10 ω
1 Un-aged
2 20 yrs.@55°C
3 40 yrs @55°C
4 60 yrs @55°C
Page 14

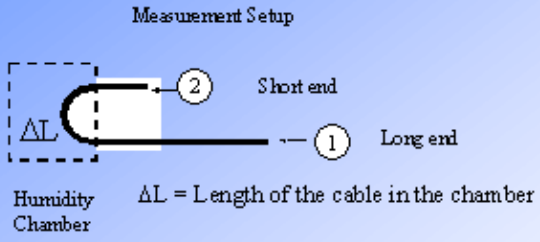
Thermal Aging Influence on the Dielectric Function: $\varepsilon_2(\omega)$



- Baseline (new)
- 20y of thermal aging (65hr @ 250°F)
- 40y thermal aging (130hr @ 250°F)
- 60y thermal aging (195hr @ 250°F)

Page 15

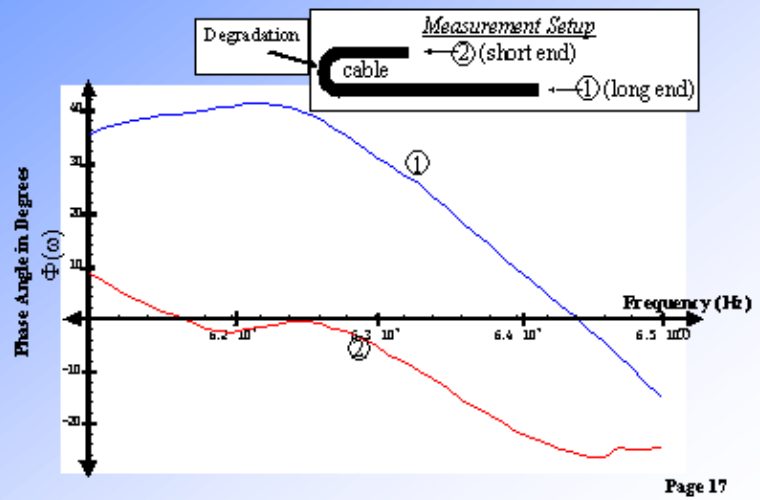
Locating Localized Degradation (Humidity)



- A cable model was developed in which only a portion of the cable (ΔL) is exposed to humidity.
- The cable is not symmetric about its middle. Thus, the high frequency portion of the broadband impedance should be different as measured from the two ends.

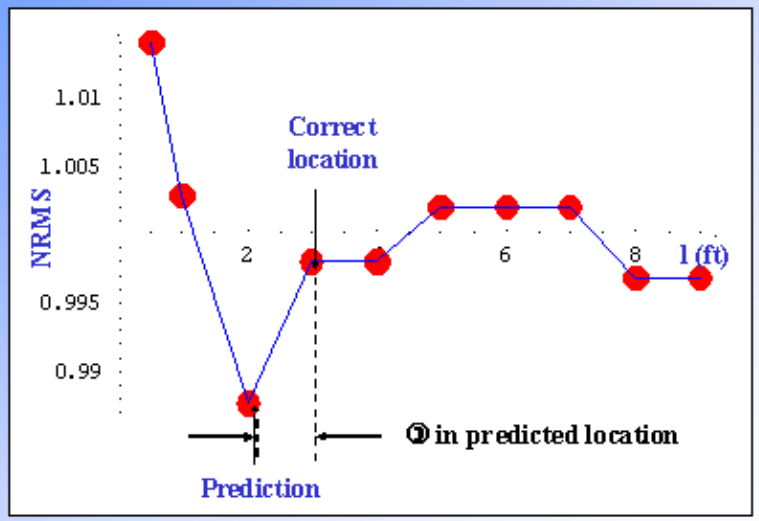
Page 16

Zero Crossings of Impedance Phase Angle – Localized Degradation Simulated by 15 Days of Humidity



Page 17

Predicted vs. Actual Location of Defect



NRMS is the normalized root mean square of differences between the calculated and measured zero crossings.

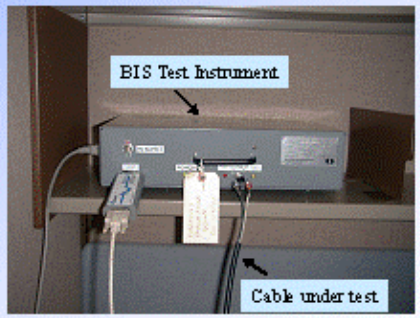
Page 18

BIS Advantages

- Electrical technique capable of scanning the entire length of an installed cable system
- Non-destructive technique
- Can detect and locate anomalies using low voltages
- Non-intrusive technique (loads/circuit can remain connected)
- Detects global and/or localized degradation
- Locates localized defects
- Uses commercially available technology

BIS Advantages (continued)

- The cable impedance is measured using a portable, hand-held, briefcase sized instrument
- The leads of the wire under test are attached to the instrument and a low voltage (<24 volts) signal is input to the wire at varying frequencies



Impedance test instrument developed by Eclypse

Page 20

Conclusions

- The BIS method is a potentially useful method of monitoring the health of electric cables in situ in nuclear power plants
  - Can detect global and localized degradation
  - Can locate localized degradation or "Hot-spots"
- Further research is needed to evaluate its effectiveness in a plant environment

Page 21

Research in FY 2005

- Research in FY 2005 will further evaluate the feasibility of applying this technique to nuclear plant cables. Specific issues to be addressed are the following:
  - Effectiveness for detecting thermal hot-spots
  - Effectiveness for detecting mechanical damage
  - Impact of varying environments along cables
  - Impact of loads attached to cables
- Develop a NUREG/CR report

Page 22

ATTACHMENT 3

Schedule for 338

02/15 - WG3.1 to get all comments on Annexes A and B to Jim

02/15 - WG3.1 to get all comments on Std 338 & Annex C to Ted

03/10 - Updated 338 & Annexes A-C forwarded to WG3.1 for R&C

03/31 - WG3.1 conference call to address comments from members

04/18 - Updated 338 & Annexes A-C forwarded to WG3.1 and SC3 for comments (changes tracked)

05/02 - WG3.1 and SC3 conference call or e-mail to address final comments

05/16 - Final version of 338 with Annexes forwarded to WG3.1 and SC3 for concurrence (changes tracked)

05/26 - Conference call or e-mail with WG3.1 and SC3 to approve forwarding final version to NPEC for preview

05/31 - Final 338 with Annexes forwarded to NPEC for preview

08/03 - NPEC preview discussion at 05-02 meeting