UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

March 21, 2013

LICENSEE: NextEra Energy Seabrook, LLC

FACILITY: Seabrook Nuclear Power Station

SUBJECT: SUMMARY OF MEETING HELD ON FEBRUARY 21, 2013, BETWEEN THE U.S. NUCLEAR REGULATORY COMMISSION AND NEXTERA ENERGY SEABROOK, LLC., REGARDING THE SEABROOK NUCLEAR POWER STATION LICENSE RENEWAL APPLICATION (TAC NO. ME4028)

On February 21, 2013, the U.S. Nuclear Regulatory Commission (NRC) staff met with members of NextEra Energy Seabrook, LLC (NextEra or the applicant), in a public meeting to discuss the license renewal application (LRA) for the Seabrook Nuclear Nuclear Power Station (Seabrook). A list of attendees is provided in Enclosure 1 and the meeting agenda is provided in Enclosure 2. Copy of the slides presented by the NRC and the applicant are provided as Enclosures 3 and 4, respectively.

As part of its overall review of the LRA, the NRC staff indicated that it must be able to make a finding that there is reasonable assurance that the effects of the alkali-silica reaction (ASR) on in-scope structures will be adequately managed during the period of extended operation. Further, the actions to manage the effects of aging and the bases demonstrating those actions are adequate need to be on the docket during the license renewal review. While the license renewal staff may gain insights from other ongoing activities, the staff must ensure that its findings are based on information on the docket. After the license renewal staff completed the review of the applicant's responses dated November 2 and 20, 2012, to the last request for information, the staff concluded that the information provided was not sufficient to address its information needs.

The staff described the issues that it needs to review and understand in order to make its finding. Although the staff has a clear understanding of the actions being proposed, additional information is needed to better understand the basis for concluding that the actions will be adequate in managing the effects of aging due to ASR. The occurrence of ASR at Seabrook is a first-of-kind occurrence at a U.S. nuclear power plant. The NRC's guidance documents identify the reaction with aggregates as a degradation mechanism, which includes ASR, but do not cover actions for managing the effects associated with ASR to the same extent as more common degradation mechanisms.

The NRC staff's presentation followed the discussion in Enclosure 3 and included two parts. First, the staff discussed its views on the specific aging effects associated with ASR and the regulatory basis for the need to relate the potential effects to the function of the structure. Second, the staff discussed the degree of information needed to demonstrate that the actions proposed by the applicant are adequate. The staff's presentation focused on its evaluation of Elements 3 through 6 of an aging management program (AMP) review. The 10 elements of an AMP review are described in Appendix A to NUREG-1800, Revision 2, "Standard Review Plan for Review of License Renewal Applications for Nuclear Power Plants." In particular, the staff

questioned the level of inspection of inaccessible areas of the structures for ASR. The staff noted that the potential effects from ASR in inaccessible areas need to be managed and evaluated for the period of extended operation (PEO) as for accessible areas of structures.

The NRC staff stated that the basis for selecting 20 out of 131 areas affected by ASR for more frequent inspections is not clear. The staff expressed concern that the progression of ASR may not be fully understood by only inspecting 20 areas at six-month intervals. NextEra indicated that because of the slow progression of ASR, it does not see the need to expand the six-month inspection frequency to the remaining 111 areas. The staff also questioned whether the aggressive groundwater could affect corrosion of steel reinforcing bars (rebar). In this regard, NextEra indicated that ASR does not create this corrosive environment and that its inspection of rebar exposed during removal of concrete core bore samples has shown no signs of corrosion. NextEra also indicated that there is no empirical evidence of corrosion of rebar in plant structures

The NRC staff stated that the evaluation of the applicant's acceptance criteria for managing the effects of ASR is the major area of concern. The staff emphasized that the acceptance criteria selected should ensure that the intended functions are maintained consistent with all design-basis conditions in the current licensing basis during the PEO. The staff noted that the combined crack indexing criteria has not yet been correlated to the loss of concrete strength at Seabrook. NextEra stated that the selection of specific acceptance criteria was based on its review of industry experience. The large-scale testing, which it is currently pursuing, will provide results that will be used for its structural evaluation to determine operability and for assessing and evaluating plant structures impacted by ASR.

NextEra's presentation followed the discussion in Enclosure 4. NextEra stated that full-scale testing is the most representative means for assessing the structural impact of ASR. Also, the measurement of combined crack index (CCI) is a more conservative approach than using the results from testing core bore samples. In this regard, the NRC staff noted that it does not have sufficient information against which to benchmark the CCI data.

Regarding the full-scale testing, NextEra described its replication of sections of concrete walls. The NRC staff indicated that it needs to understand how the sections correlate to the in-situ plant. Thus, if NextEra plans to use any of the information gained from this testing to inform the basis for its AMP, it would be advisable to discuss this information with the staff. If so, the staff noted that NextEra should engage the staff early in the process.

NextEra stated that its action levels are based on industry documentation. This includes reports prepared for the Oak Ridge National Laboratory, the Federal Highway Administration, and the Institute of Structural Engineers (United Kingdom). NextEra is also assessing the possibility of supplementing with other nondestructive examination (NDE) techniques such as impact sound propagation. These would then be evaluated against expansion and cracking monitoring criteria; however, the discussion of NDE techniques has not been included in the proposed AMP.

In summary, NextEra acknowledged that the issues deal with the ability to correlate the monitoring of crack widths and CCI to the strength of concrete structures. NextEra would use cracking as an indication of the strain in the structure. Regarding the use of the CCI criteria, the NRC staff would need to understand the correlation between CCI and those internal

mechanisms that could change the macro-cracking at the concrete surfaces. The NRC staff will need additional information that the criteria will ensure that the intended function of the structure is maintained. The staff would also need to know that these threshold values are adequate to assess the structure at this time. Thus, the key issue relates to the ability to prove the correlation between CCI and the concrete strength.

Regarding the NRC staff's concern with the ability of anchors to maintain the intended function, NextEra stated that cracking is a good means of assessing anchorage capability or performance. NextEra stated that pullout tests on ASR specimens would be used to show that the design basis requirements are being met. The NRC stated that a cracking index that does not correlate to a loss of strength will be a problem in its evaluation.

At the end of the meeting, the NRC staff stated that it needs NextEra to provide a complete technical basis to support any correlation between the CCI and the function of the structure. The staff reiterated that the regulatory requirements for license renewal state that the effects of aging must be managed such that the intended functions will be maintained. Lastly, NextEra may want to re-consider whether there is a role for its full-scale testing program in support of license renewal. NextEra stated that it would assess the information from the meeting and determine the best path forward.

Patrick D. Milano, Sr. Project Manager
Projects Branch 1
Division of License Renewal
Office of Nuclear Reactor Regulation

Docket No. 50-443

Enclosures:
1. Attendance List
2. Agenda
3. NRC Meeting Handouts
4. NextEra Meeting Handouts

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MEETING BETWEEN THE NUCLEAR REGULATORY COMMISSION STAFF AND
NEXTERA ENERGY SEABROOK, LLC.
SEABROOK STATION LICENSE RENEWAL APPLICATION

US NUCLEAR REGULATORY COMMISSION
ONE WHITE FLINT NORTH, ROOM O-3B4
ROCKVILLE, MD 20852

MEETING ATTENDANCE LIST
FEBRUARY 21, 2013

ATTENDEES	ORGANIZATION
Melanie Galloway	Nuclear Regulatory Commission (NRC)
Dennis Morey	NRC
Michael Marshall	NRC
Patrick Milano	NRC
Abdul Sheik	NRC
Alice Erickson	NRC
James Trapp	NRC
Richard Conte	NRC
William Cook	NRC
William Raymond	NRC
Jacob Philip	NRC
Thomas Nicholson	NRC
Mark Fuhrmann	NRC
Anthony McMurtray	NRC
Richard Cliché	NextEra Energy Seabrook (NextEra)
James Connolly	NextEra
Richard Noble	NextEra
Theodore Vassallo	NextEra
Michael O'keefe	NextEra
Steve Hamrick	NextEra
Noel Bakhtian	Office of US Senator Jeanne Shaheen
Kenneth Synder	National Institutes of Standards and Technology
Victor Saouma	University of Colorado
Andrei Blahoianu	Canadian Nuclear Safety Commission
Nebojsa Orbovic	Canadian Nuclear Safety Commission

ENCLOSURE1

MEETING BETWEEN THE NUCLEAR REGULATORY COMMISSION STAFF AND
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AGENDA
FEBRUARY 21, 2013

I.	Introduction and opening remarks	15 minutes
II.	Discussion of Aging Management and Structures Monitoring Program	150 minutes
	a. Identification/Characterization of aging effects associated with alkali-silica reaction (ASR) b. Effectiveness of proposed actions to manage the effects of aging associated with ASR c. Applicability of technical basis to the various structures within scope of license renewal	
III.	Public Comments	10 minutes
IV.	Adjourn	

ENCLOSURE 2

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Public Meeting Regarding Seabrook Station License Renewal Application

Alice Erickson and Abdul Sheikh

February 21, 2013

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Overview

- Understanding of aging effects
- Review of plant-specific aging management programs
- Staff's issues with specific elements of plant-specific ASR Monitoring Program

License Renewal Requirement

- In accordance with §54.21(a)(3), for each structure and component within the scope of license renewal, an applicant must demonstrate that the effects of aging will be adequately managed so that the intended function(s) will be maintained consistent with the current licensing basis for the period of extended operation.

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Identification of Aging Effects

- **Standard Review Plan - License Renewal (SRP-LR) (NUREG-1800)**
  - applicable aging effects should be based on aging mechanisms that have occurred and those that potentially could cause structure and component degradation
  - effects of aging on intended function(s) should be considered

- **Generic Aging Lessons Learned (GALL) Report (NUREG-1801)**
  - plant conditions and operating experience must be bound by that for which the GALL report was evaluated
  - may be necessary to augment aging management programs to address additional aging effects

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Potential Effects from Reaction with Aggregates

- Industry Standards and Reports
  - Expansion
  - Cracking
  - Loss of strength (changes in mechanical properties)
- GALL Report
  - Cracking due to expansion from reaction with aggregates
  - Reduction in concrete anchorage capacity due to local concrete degradation/service-induced cracking or other concrete aging mechanisms

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Elements of Plant-Specific ASR Monitoring Program

- Scope of Program
- Preventive Actions
- Parameters Monitored or Inspected
- Detection of Aging Effects
- Monitoring and Trending
- Acceptance Criteria
- Corrective Actions
- Confirmation Process
- Administrative Controls
- Operating Experience

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ASR Aging Management Program Element 3 - Parameters Monitored/Inspected

- **Applicant's Approach as Stated in the LRA:**
  - Monitor Crack Width (CW) and Combined Cracking Index (CCI) to manage cracking due to expansion
- **Information Needed**
  - SRP-LR states the AMP should provide a link between the parameters that will be monitored and how the monitoring of these parameters will ensure adequate aging management.
- **Issue**
  - How method of monitoring CW and CCI in <u>local</u> areas provides sufficient data regarding the <u>global</u> expansion of the structures
  - Correlation between crack width and CCI, and:
    - Loss of strength in concrete
    - Loss in load carrying capacity of concrete anchors, bolts, rebars

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ASR Aging Management Program Element 4 - Detection of Aging Effects

- **Applicant's Approach as Stated in the LRA:**
  - ASR is detected by visual inspection
  - All in scope structures are monitored for ASR
  - Examination of inaccessible areas, such as buried foundations, will be completed during inspections of opportunity or during focused inspection
- **Information Needed**
  - GALL Report recommends evaluation of the acceptability of inaccessible areas when conditions exist in accessible areas that could indicate the presence of, or result in, degradation to such inaccessible areas
- **Issue**
  - Seabrook concrete structures have the same concrete aggregates
  - ASR is likely to be present in accessible and inaccessible structures
  - Frequency of focused inspection or evaluation of ASR in accessible areas, including base slabs and foundations

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ASR Aging Management Program Element 5 – Monitoring and Trending

- **Applicant's Approach as Stated in the LRA:**
  - Baseline inspection performed on 131 areas with ASR associated cracks
  - Areas with Tier 3 (largest CCI) will be monitored at six months interval
  - Areas with Tier 2 CCI will be monitored on a frequency of 2 ½ years
  - Areas with Tier 1 (smallest CCI) will be monitored on a frequency of 5 years
  - Structural Monitoring Program will be used for inspection of embedments, anchor bolts, and rebar
- **Information Needed**
  - SRP-LR (NUREG 1800) states the monitoring and trending activities should provide a prediction of the extent of degradation and thus effect timely corrective or mitigative actions
- **Issue**
  - Basis for selecting only Tier 3 areas for more frequent inspection without any trend data is not clear
  - Continuous flow of ground water with chlorides may cause corrosion in rebars embedded in concrete over time
  - It is not clear on how the applicant plans to trend the loss due to corrosion in rebar exposed to ground water with chlorides

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ASR Aging Management Program Element 6 – Acceptance Criteria

- **Applicant's Approach as Stated in the LRA:**
  - Use a screening criteria based on crack width and CCI
  - Applicant has initiated testing on full scale replica of station structural configurations
    - Information from these tests may be used to amend the acceptance criteria under the operating experience element of the ASR AMP.
- **Information Needed**
  - GALL report recommends that acceptance criteria selected for each structure/aging effect should ensure that the need for corrective actions is identified before loss of intended functions
- **Issue**
  - Basis for not correlating CCI Screening Criteria to the loss in strength of concrete is not clear
  - CCI Screening Criteria basis for applicability to Seabrook concrete structures is not clear
  - Basis for selecting visual inspection acceptance criteria for anchor bolts not clear

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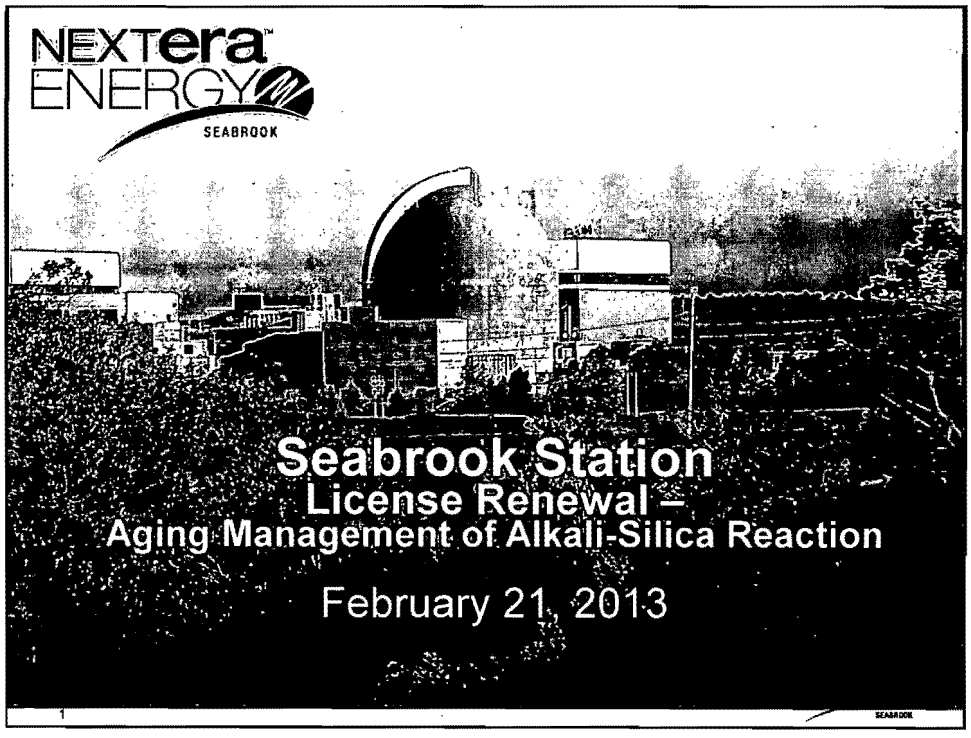

Personnel in Attendance

Jim Connolly	Engineering Director
Mike O'Keefe	Licensing Manager
Rick Noble	Special Projects Manager
Ted Vassallo	ASR Monitoring Program Owner
Rick Cliche	License Renewal Project Manager

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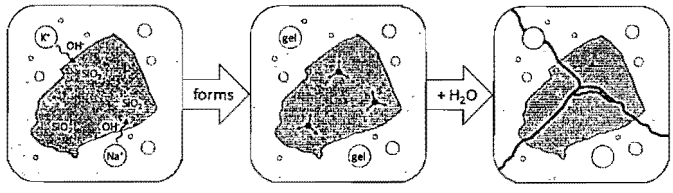
ASR is the Aging Mechanism

- **The direct aging effect is the production of an expansive gel that results in micro and macro cracks in the concrete.**
- **ASR does not involve a direct chemical loss of strength.**
- **The potential impact of ASR on the structural strength is a result of the expansive gel and associated cracking.**
- **Even when cracking occurs, confinement (resulting from the steel reinforcement) reduces the structural consequences.**



alkali cement + reactive aggregate | expansive gel | cracking of the aggregate and paste

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Structural Effects of ASR

- The potential structural effects of ASR including impacts to mechanical properties like compressive strength, shear strength and modulus, as well as effects on reinforcement anchorage and anchor bolts, are a result of expansion and micro cracking.
- The extent of mechanical property impact from ASR is influenced by the degree of confinement (structural context). Confinement acts to restrain expansion of concrete similar to pre-stressing, thus mitigating the potential impact of expansion on performance of structural elements.
- Removed cores are tested in an unrestrained condition. No direct correlation exists between mechanical properties of unconfined concrete cores and in situ properties of reinforced concrete with an expansive degradation mechanism.
- Evaluations of structural impact must take into account the specific reinforcement details of the affected structural element.
- Testing full scale structural elements provides the most accurate concrete performance parameters.

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Two Potential Paths to Evaluate ASR Impacts

Evaluation using Mechanical Properties

- **Approach**
  - Determine concrete properties as function of cracking
    - Testing of cores
    - Published data
  - Use degraded properties in evaluations
- **Considerations**
  - Does not account for confinement
    - Results do not correlate to real structural performance of ASR impacted structures
  - Cores provide a "soda straw" view might miss larger impact
  - Cores are not an NDE technique

Evaluation using Structural Testing

- **Approach**
  - Determine impact of ASR based on testing of specific ASR-affected structural elements
    - Published data
    - Testing of structural elements representative of plant
  - Use data to adjust structural capacity
- **Considerations**
  - Limitations of published data
    - May not be representative of plant (scale, configuration)
    - Results not correlated to severity of ASR
  - Schedule for large-scale testing

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Large Scale Testing

- Large scale destructive testing of reinforced concrete beams with various levels of accelerated ASR is being conducted at the Ferguson Structural Engineering Lab at the University of Texas at Austin to determine the actual structural impact of ASR.
  - Test beams are representative of design details of Seabrook plant structures
  - Establish definitive correlation between level of ASR and structural performance. Separate test programs to evaluate:
    - Structural performance of walls and slabs, considering
      - Shear strength
      - Flexural stiffness
      - Reinforcement anchorage
    - Anchor bolt capacity

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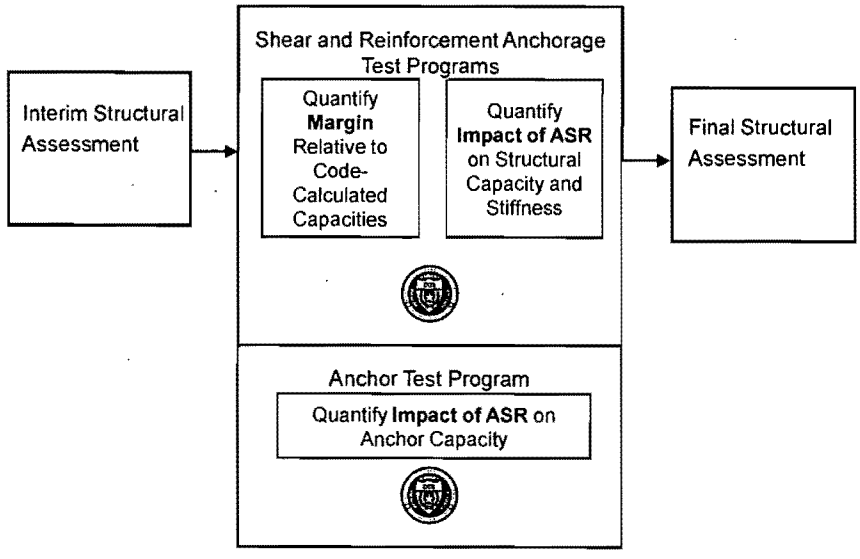

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Monitoring

- Cracking due to expansion is the direct aging effect of ASR and the is most effectively measured parameter to monitor and trend the progression of ASR.
- The best parameter to correlate to the test specimens would be engineering strain, but cracking is the best surrogate for existing structures.
- Other NDE methods have been and are being investigated. However at this time alternate methods do not have a proven track record on their own and as such they are typically validated against the direct indications of cracking and expansion.

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Monitoring Action Levels

- ASR monitoring action levels are based on a broad industry review of reinforced concrete structures outside the nuclear industry where the ASR problem has been observed.
- The action levels are intended to provide triggers for increased monitoring frequency and levels at which condition-specific structural evaluation should occur. They are intentionally not based on Seabrook only data as the plant has a variety of environmental conditions and levels of ASR. There is no singular Seabrook station condition and so the monitoring plan is best served by 50+ years of experience in ASR in the broader industry.
- The specific structural implications are significantly influenced by the actual structural details. The test specimens for the large-scale testing programs reflect Seabrook structural details

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Evaluation of Structural Anchors

- Anchor Test program at University of Texas at Austin initiated to establish structural capability of anchors in ASR-affected concrete specimens
  - Girder Series—Complete
    - Used ASR-affected concrete specimens readily available
    - Studied phenomena related to anchor performance in ASR affected concrete
  - Block Series—In progress
    - Uses concrete specimens representative of Seabrook
    - Systematically quantify the impact of ASR on anchor capacity
- Girder Series Conclusions
  - Tests conducted in "bone yard" bridge girders with heavy ASR impact show that ASR cracks behave as any cracked concrete would.
  - There are no new degradation or aging mechanism for anchor bolts, but rather cracking from ASR will need to be monitored and the structural impacts if any evaluated. This will be done with the proposed monitoring plan.

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Questions?

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mechanisms that could change the macro-cracking at the concrete surfaces. The NRC staff will need additional information that the criteria will ensure that the intended function of the structure is maintained. The staff would also need to know that these threshold values are adequate to assess the structure at this time. Thus, the key issue relates to the ability to prove the correlation between CCI and the concrete strength.

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NAME	IKing	PMilano	MMarshall	MSmith	DMorey
DATE	3/13/13	3/19/13	3/15/13	3/15/13	3/21/13

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