

License Renewal Services and Fatigue Monitoring



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Background

- **SI is well qualified to provide technical support, consultation, preparation, review of License Renewal Applications (LRAs), and environmental fatigue evaluations**
- **Many of SI's experts have been involved in license renewal efforts since the Pilot Plant activities in the 1980s**
- **In particular, SI has been extensively involved in fatigue-related matters since the mid-1980s**
 - ◆ **EPRI's FatiguePro (1986 - present)**
 - ◆ **EPRI Fatigue Management Handbook (1994)**
 - ◆ **EPRI/NEI Environmental Fatigue Studies (1996 - 1999)**
 - ◆ **EPRI Materials Reliability Program (on-going)**

Support Areas for License Renewal

- **SI can provide support in any of the following ways:**
 - ◆ **Preparation and review of effective management programs to address potentially significant age-related degradation mechanisms**
 - Materials evaluations (fluence evaluation, RT_{NDT} and ART calculations, USE, P-T curves)
 - Projected fatigue usage and cycle counting estimates
 - Required to demonstrate neutron embrittlement and fatigue are adequately managed
 - Environmental fatigue issues require more refined approach
 - Implementation now will require significantly less effort later
 - ◆ **Preparation and review of Aging Management Reviews (AMRs)**
 - ◆ **Preparation and review of specific portions of the LRA**
 - ◆ **Preparation and review of analyses/evaluations initiated by AMRs**
 - ◆ **Preparation and review of responses to questions from the NRC after LRA submittal**

Support Areas for License Renewal

- ◆ **Consultation or third party review**

- Stress and Fatigue (including environmental effects)
- IGSCC and IASCC
- Corrosion
- BWR Vessel Internals
- PWR Vessel Internals
- Design Basis Documentation
- Material Embrittlement and Surveillance Program Review
- Inspection

Support Areas for Fatigue Monitoring

- **Stress-Based Fatigue Monitoring**
 - ◆ Stress-based fatigue (on-line stress analysis) for critical components
 - ◆ Takes account of *actual* plant transient severity and number of occurrences
 - ◆ Powerful graphics review of all relevant plant parameters, resulting stress, and fatigue usage
- **Automated Cycle Counting and Cycle-Based Fatigue Monitoring**
 - ◆ “Smart logic” counts and categorizes plant transients
 - ◆ All events and important parameters saved by software
 - ◆ Fulfills plant Technical Specification cycle counting requirements
 - ◆ Powerful, graphics review of all events
 - ◆ Cycle-based fatigue, utilizing cycle counts, for less severe components
- **Fatigue Crack Growth Monitoring**
 - ◆ Performs fatigue crack growth flaw tolerance assessments (actual or postulated flaws)
 - ◆ Takes account of actual plant transient severity and number of occurrences
 - ◆ Can be used to justify continued operation or determine re-inspection interval

Experience

- **SI has performed technical consultation and support for license renewal for the following utilities (plants):**
 - ◆ Baltimore Gas & Electric (Calvert Cliffs)
 - ◆ Duke (Oconee)
 - ◆ Entergy (ANO-1)
 - ◆ Southern Nuclear (Hatch, Farley and Vogtle)
 - ◆ Florida Power & Light (Turkey Point and St. Lucie)
 - ◆ Dominion Virginia Power (North Anna and Surry)
 - ◆ Dominion Nuclear Connecticut (Millstone)
 - ◆ Exelon (Peach Bottom, Dresden, Quad Cities, and Oyster Creek)
 - ◆ Carolina Power & Light (Robinson and Brunswick)
 - ◆ Omaha Public Power District (Fort Calhoun)
 - ◆ Nuclear Management Company (Point Beach, Monticello, and Palisades)
 - ◆ Tennessee Valley Authority (Browns Ferry)
 - ◆ First Energy Corporation (Beaver Valley)
 - ◆ Constellation Energy Group (Ginna and Nine Mile Point)
 - ◆ Wolf Creek Nuclear Operating Corporation (Wolf Creek)
- **Developed Fatigue Management Program (FatiguePro) for more than 60 nuclear units world-wide**
 - ◆ Includes most plants applying for license renewal
 - ◆ FatiguePro represents a key element of many plants' Fatigue Management Program for license renewal

Experience

Current and Pending **FatiguePro** Installations (PWRs)

| Plant | NSSS Vendor | ACC | CBF | SBF | FCG |
|-----------------------|-------------|-----|-----|-----|-----|
| ANO 2 | C-E | X | X | X | |
| Calvert Cliffs 1/2 | C-E | X | X | X | X |
| Ft. Calhoun | C-E | X | | | |
| Millstone 2 | C-E | X | X | X | |
| Waterford 3 | C-E | X | X | | |
| Angra 1 (Brazil) | W | X | X | | |
| Beznau 1/2 * | W | | | | |
| Callaway | W | X | X | X | |
| Catawba 1/2 | W | X | | | |
| Diablo Canyon 1/2 | W | X | | X | |
| Farley 1/2 | W | X | | X | |
| Ginna | W | X | X | X | |
| Kewaunee | W | X | | | |
| Maanshan 1/2 (Taiwan) | W | X | | X | |
| McGuire 1/2 | W | X | | | |
| Millstone 3 | W | X | X | X | |
| Prairie Island 1/2 | W | | | X | |

*Recommendation Report completed and/or plant-specific FatiguePro development in progress.

Experience

Current and Pending **FatiguePro** Installations (PWRs)

| Plant | NSSS Vendor | ACC | CBF | SBF | FCG |
|--------------------|-------------|-----|-----|-----|-----|
| North Anna 1/2 * | W | | | | |
| Point Beach 1/2 | W | X | X | X | |
| H. B. Robinson 2 * | W | | | | |
| Sequoyah 1/2 | W | X | X | X | X |
| Palisades | W | X | X | | |
| Surry 1/2 * | W | | | | |
| Vandellós (Spain) | W | X | X | X | |
| Vogtle 1/2 | W | X | X | X | |
| Watts Bar | W | X | X | X | |
| Wolf Creek | W | X | X | X | |
| ANO 1 | B&W | X | | | |
| Crystal River 3 | B&W | X | | | |
| Oconee 1/2/3 | B&W | X | | | |

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Experience

Current and Pending **FatiguePro** Installations (BWRs)

| Plant | ACC | CBF | SBF | FCG |
|-----------------------------|-----|-----|-----|-----|
| Browns Ferry 1/2/3 * | | | | |
| Brunswick 1/2 | | X | | |
| Chin-Shan 1/2 (Taiwan) | X | | X | |
| Clinton | X | X | X | |
| Cofrentes (Spain) | | | X | |
| Columbia Generating Station | X | X | X | |
| Dresden 2/3 | X | X | X | |
| FitzPatrick * | | | | |
| Grand Gulf | X | X | X | |
| Hatch 1/2 * | | | | |
| Kuosheng 1/2 (Taiwan) | X | | X | |
| Limerick 1/2 * | | | | |
| Leibstadt | X | X | X | |

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Experience

Current and Pending **FatiguePro** Installations (BWRs)

| Plant | ACC | CBF | SBF | FCG |
|--|-----|-----|-----|-----|
| Nine Mile Point 1/2 | X | X | X | |
| Oyster Creek | X | X | X | |
| Peach Bottom 2/3 | X | X | X | |
| Quad Cities 1/2 (BWR Demonstration Plant) | X | X | X | |
| River Bend | X | X | X | |
| Santa Maria de Garoña (Spain) | | | X | |
| Susquehanna 1/2 | X | X | X | |
| Tsuruga 1 (Japan) | | | X | |
| Vermont Yankee | X | X | X | |

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