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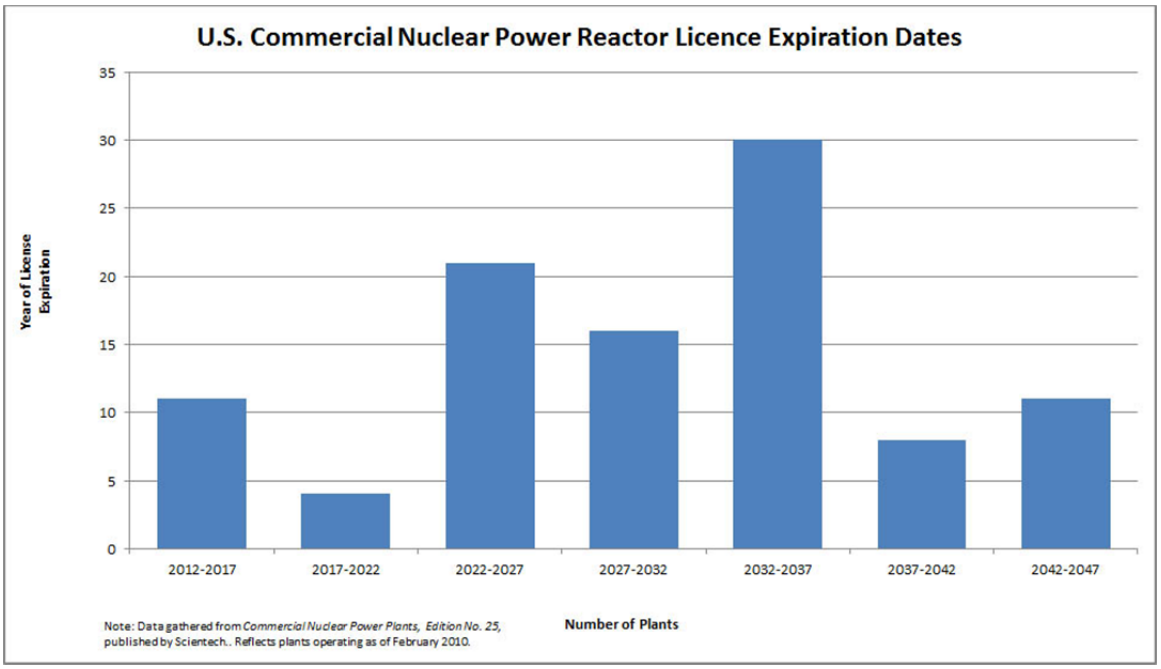
## Nuclear Facilities: Extending Service Life

Resurgence in the nuclear power industry has generated recent discussion about the service life of structural and construction material components in nuclear power facilities. As several new nuclear projects prepare to break ground, the industry is also faced with a number of aging nuclear facilities that have expiring operating licenses. In the next ten years, 30 out of the 104 nuclear power plant units licensed in the US for commercial operation will reach their license expiration date (Figure 1). A timely license renewal process and clear requirements have been established by the United States Nuclear Regulatory Commission (USNRC) to ensure safe plant operation for an additional 20 years. In order to ensure the continued safe operation of nuclear power plants, it is essential that the current condition and potential degradation of plant structures be evaluated.

Upgrading aging facilities can in some ways be more challenging than building new. However, with great challenge often comes greater reward. Sustainability and green building are increasingly important considerations in the power generation industry. From a power generation perspective, what could possibly be greener than retrofitting and modernizing an existing nuclear power generating facility?



Many available methodologies for implementing “environmentally friendly” construction practices don’t take full advantage of the option of retrofitting an existing facility. This can result in highly sustainable alternatives to new construction not being evaluated. The green building rating system, Leadership in Energy and Environmental Design Rating System for Existing Buildings: Operations & Maintenance (LEED-EB: O&M) addresses existing facilities that are operational, but focuses on operating facilities more efficiently and requires recertification every five years. As a result, it has limited applicability to structural retrofitting.

Retrofitting and modernization of existing nuclear facilities to extend the structural service life offers savings by not requiring new construction of many components. Examples include:

- Site Work
- Grading
- Foundations
- Support Buildings
- Office Facilities
- Cooling Intake Systems
- Power Distribution

Another benefit to retrofitting existing structures is the potential for reduced public opposition when compared to new construction. It is less likely that upgrading or retrofitting an existing structure will face opposition, as the facility already has a presence and local residents will not feel the intrusion or disapproval of a new facility.

**Service Life and Structural Evaluation**

USNRC limits initial operating licenses to a 40-year period, but will permit licenses to be renewed for an additional 20 years. This 40-year term for reactor licenses was based on economic considerations, not the structural service life of the plant. Many other countries don’t limit the operating license period, but may require periodic safety reevaluations to continue operating. Due to this selected period, however, some structures and components may have been engineered on the basis of an expected 40-year service life, so a re-evaluation is necessary to provide a current condition assessment.

With respect to the structural components of nuclear power facilities – that is, concrete and steel materials – there hasn’t been a widespread problem with premature deterioration of these systems and, in general, they appear to be working well for plants that have been in service for 20, 30 or more years. This performance record has already provided valuable initial information when considering extending the remaining service life of these plants.

Reinforced concrete deterioration mechanisms are primarily associated with corrosion of concrete reinforcing steel, chemical attack, alkali silica reactivity, freeze thaw damage and other durability deficiencies. Fortunately, many of these deterioration mechanisms were recognized and mostly understood while plants were being designed and constructed in the 1960’s and 70’s. While there are some structural components in some plants that have exhibited minor deterioration, the extent and cause of these problems can be assessed by performing a proper evaluation and using tools such as nondestructive testing and evaluation (NDT&E).

In addition to structural system repair and rehabilitation of existing plants to extend service life, structural design codes have changed over the years, and most operating plants were not designed

to current codes. Code changes that have occurred can be addressed through performance evaluation review and retrofit, if necessary, so that plants can continue to operate. One of the major hindrances of assessing condition and service life assessment of many reinforced concrete civil structures is that there is often no record of their as-built condition or performance history. This isn't the case with nuclear facilities, as there is usually very good documentation and records on how these plants were constructed and maintained, so we know what we are working with when these retrofits take place.

Because many structural components of nuclear facilities are massive, the use of methods such as NDT&E, in conjunction with more routine procedures, can reduce the effort and cost in performing an evaluation, as well as giving a higher level of confidence in that evaluation. NDT&E can also provide a base line survey, which can then be checked at a later date in the life of the structure by a relatively rapid and economical repeat survey with the same techniques.

Traditionally, condition assessment of concrete and reinforcement placement in structures has been performed by visual inspection and intrusive sampling for strength tests. This does not provide quantitative data on in-place concrete durability and integrity. NDT&E can be used to assist in providing information on:

- Structural member dimensions
- Cracking, delamination and de-bonding
- Consolidation, voids and honeycombing
- Potential for active reinforcing steel corrosion
- Concrete reinforcing steel location ("cover depth") and size
- Freeze-thaw, fire, chemical and other damage

Upgrading, repairing and maintaining existing nuclear facilities so they can operate safely into the next generation is a viable and attractive option with respect to cost, schedule and sustainability. As these plants near the end of their 40-year licensing period, this does not suggest that they have all reached their usable service life and need to be abandoned. The solid performance history of the structural systems in these plants is proof that the service life of these facilities can be extended.

By adhering to USNRC requirements, conducting timely condition assessments and executing the required upgrades and maintenance, the service life of structural components in many existing nuclear facilities can be extended well beyond their original licensing period. It is not unreasonable to anticipate structural component service life extensions of 20 years or more, provided the appropriate evaluation, maintenance and repair programs are executed.