tion—and further continue during the dismantling stage, according to the specific plant and regulatory requirements. Characterization data must be collected to determine the type and extent of contaminants before decontamination or dismantling begins, as this information is imperative to planning those activities, including from an "as low as reasonably achievable" (ALARA) perspective. The scope of the characterization activities includes not only the nuclear installation but also areas of the site that could have been radiologically or environmentally contaminated during the plant's operational lifetime.

Radiological characterization of activated and contaminated components throughout the plant is essential for planning the appropriate and optimum dismantling approaches and identifying the necessary waste streams that are needed to formulate waste management strategies. The reactor vessel internals, second only to the spent fuel, have the highest activity levels and need to be adequately characterized in order to develop and fully optimize the segmentation and packaging plans.

Accurate waste characterization allows the main objective of the reactor vessel internals segmentation and packaging plan to be realized. That objective is to determine the strategy for separating the highly activated components, called Greater-than-Class-C waste (GTCC), from the less activated material, called Class A, B, or C, so that all components can be disposed of in the most cost-effective manner.

Different countries have different regulations concerning how the various classes of waste must be handled. In the United States, GTCC waste cannot be shipped off-site, so it must be packaged such that it can be dry-stored in an independent spent fuel storage installation. Waste classified as Class A, B, or C can be shipped to an off-site disposal site, depending on space availability. Several of the U.S. plants dismantled to date have repackaged the Class A, B, and C component segments back into the (Class A) reactor vessel, in accordance with the Nuclear Regulatory Commission's concentration averaging guidance, and have shipped the entire assembly to the disposal site. Decisions like these are driven by many factors, such as disposal costs, transportation logistics, and licensing fees, among others. Since disposal methods have a significant impact on the reactor vessel internals segmentation and packaging plan, they must be considered early in the planning phase, and this consideration begins with accurate waste characterization data.

Referring again to the José Cabrera nuclear power plant decommissioning project as an example, neutron flux calculations were made and benchmarked against the vessel surveillance capsule measurements to characterize the reactor internals, reactor vessel, vessel insulation, and the concrete biological shield. Before beginning the segmentation portion of the project, these calibrations were checked and the theoretical model calibrated by measuring radiation on the upper and lower reactor vessel internals with high-level gamma probes. During the segmentation, underwater characterization of each cut piece was performed using a gamma probe (with weights and dose rates measured at three points) to check individual waste acceptance. Once the waste baskets were loaded, each loaded basket was then also characterized with a gamma probe spider, which consists of gamma probes positioned at eight points (each face and corner) of the cubic-shaped container, to verify average dose acceptance before grouting. The waste containers were then transported to the appropriate depository, depending on the activity concentration.

Planning technical strategies

Many factors play a role in determining the best technical strategies for dismantling a given plant. Among them is assessing and planning the most effective use of the available plant space for dismantling activities so that each can be scheduled and