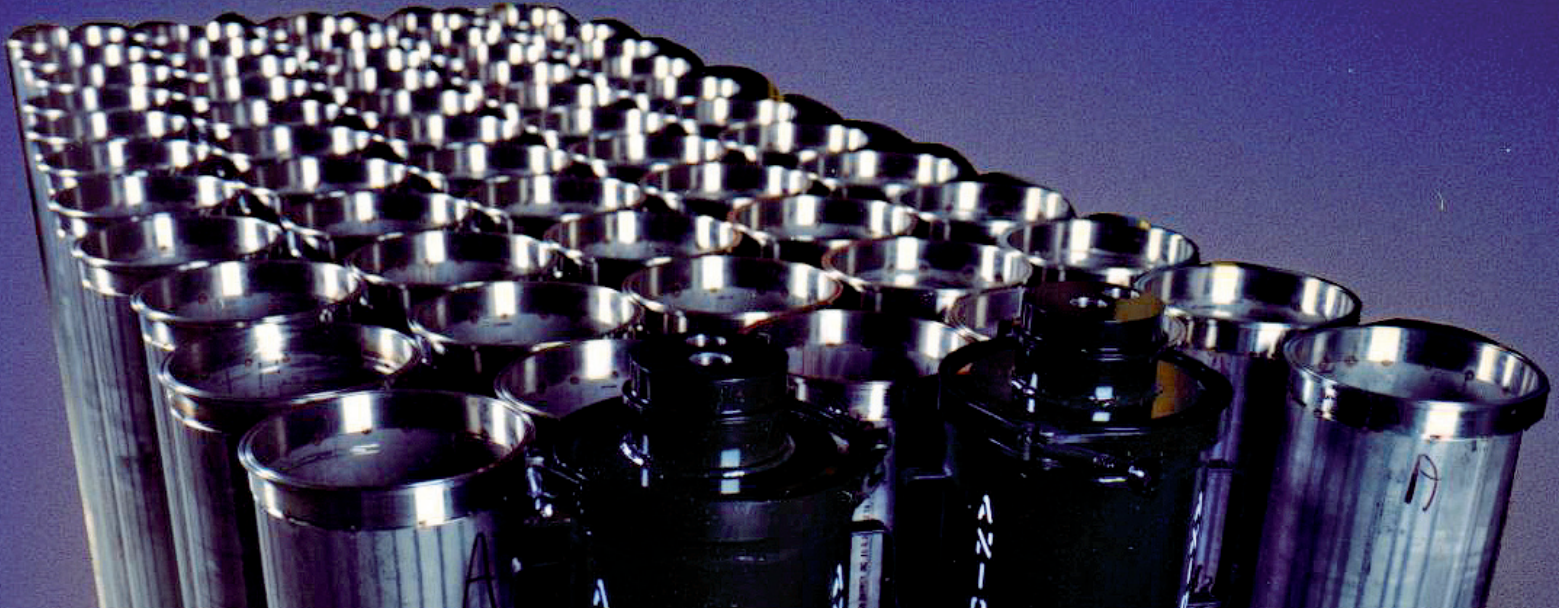


Nuclear Flasks and Containers

Mechanical Systems and Component Engineering



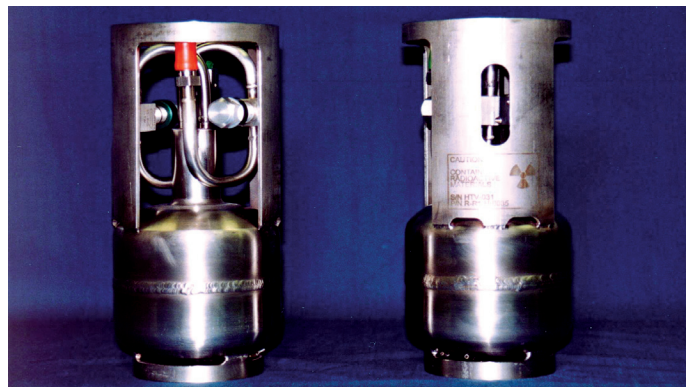
Providing the highest level of protection for nuclear employees requires an in-depth knowledge of design, fabrication, examination and testing, as well as application of the most stringent quality assurance programs.

This knowledge is best gained from experience. From small, leak-tight containers for transporting medical isotopes, to huge lead-shielded flasks weighing more than 40 tonnes, Rolls-Royce has the knowledge and expertise to supply flasks and containers for a wide range of nuclear applications.

Over the past 40 years, Rolls-Royce has provided hundreds of flasks and containers, each with features unique to individual customer needs. We have supplied a variety of leak-tight containers used to store and transport radioactive gases and liquids. These containers are designed to enable in-depth non-destructive examination (NDE) and highly sensitive testing (e.g. full radiography, mass spectrometer helium leak testing). The gases are generally beta particle emitters that do not require significant radiation shielding. For more energetic sources (gamma particle emitters) significant shielding is usually required and can come from a combination of steel, lead, concrete, or in rare cases, depleted uranium. We've recently designed, fabricated, and tested a large flask for on-site transport of spent fuel, with several inches of lead shielding and weighing over 82000 lb.

We have a breadth of capabilities in design or review of designs for "manufacturability". We can design to reduce manufacturing risks, obtain repeatable product, and to reduce materials and fabrication costs for our customers.

Rolls-Royce specializes in the application of a range of QA programs, commensurate with the specific requirements of the product. Our certifications include ASME N, NPT, NS, and U, and QA programs satisfying NQA-1 and a number of other nuclear industry standards. We are accustomed to providing the level of support documentation demanded by the nuclear industry.



Nuclear Flasks and Containers

Demonstrable expertise

Rolls-Royce recently completed conceptual design studies for retrieval and re-packaging of waste currently stored in underground silos. The scope of the first study included options for the safe retrieval of intermediate-level solid waste and analysis of potential deterioration of the storage containers. The second study was primarily to recommend solutions for shielded overpacks based upon the inventory of the various waste containers once they were safely retrieved. The scope of the second study included significant shielding design and calculations, and making recommendations based on our experience with shielding design and fabrication.

The scope of the study included:

- **Categorizing waste containers into groupings based on raw waste dose rates.**
- **Performing shielding calculations using a number of available shielding materials (steel, lead, concrete).**
- **For each grouping, recommending a shielding configuration and material to meet dose limits for handling, that can be manufactured using conventional techniques, and that meets the Waste Acceptance Criteria (WAC) for long term storage.**
- **Providing budgetary cost estimates for the recommended configurations for each container size and dose rate grouping.**

It is possible to perform basic shielding calculations for simple configurations using longhand methods, however more complex problems can be solved using sophisticated computerized analysis. Rolls-Royce uses specialized software to perform detailed shielding analysis and to determine exposure rates. The type of source (point, surface, volume) and the applicable radioactive sources are modeled. The shielding thickness and configuration is also modeled, and the user can select from a database of conventional shielding materials, or input their own custom material properties. The shielding material selected consider a number of factors, including suitability for the source of radiation, complexity of the final configuration, and ease of manufacturing. The user can determine, at various distances from the source, the exposure rates to personnel. These rates are compared to the customer's acceptable dose rates, and adjustments to the shielding thickness are made to achieve the target dose limit. Also important to the shielding designer, the software can determine decay heat generated by the source, which can then be used in subsequent analyses.

The software can be used to estimate source strength from radiation measurements, an important tool when specific waste characterization data is not available. The software will also predict future makeup of sources based on source decay models, and will forecast the resulting daughter products generated.

A design and build solution for peace of mind

Once a suitable shielding material and thickness is established, the designer must produce an acceptable design that satisfies the shielding requirements, yet is able to be manufactured in accordance with conventional techniques to minimize cost and risk. As a result of Rolls-Royce manufacturing the final product, our designers have a strong knowledge of how to design the product to minimize the risk of issues in manufacturing. The designer must consider potential shine paths and radiation scatter, and provide suitable

safeguards. They must apply their knowledge of manufacturing tolerances to ensure the shielding requirements will be achieved. Lead is commonly used, but to produce complex geometries the lead must be melted and poured into a steel shell. The designer must have in-depth knowledge of the process to design a suitable geometry to accommodate pouring molten lead without creating voids and significant shrinkage cracks, and the manufacturing drawings we generate need to ensure that the design requirements are realized. The Rolls-Royce design/build model is sought after by customers looking for a single contractor to design and fabricate turn-key equipment; thereby avoiding potential issues with responsibility should problems arise.

Once fabricated, it's often necessary to verify shielding integrity using a method such as gamma scanning. It's very difficult to repair issues with lead shielding once cooled and hardened, so design and manufacturing must ensure a quality product so there are no issues during this final check. Rolls-Royce has developed and applied a procedure for gamma scanning of thick shielding sections (in excess of 4 inches of lead) to determine shielding integrity with excellent success and good correlation with theoretical values.

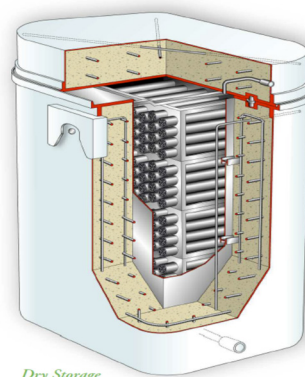
Custom fabrication relies heavily on welded construction to produce complex geometries and leak-tight joints. Rolls-Royce is a recognized expert in the design, fabrication, and examination of welded joints. We've developed a large number of weld procedures, in several processes and a wide range of materials. We have the capability to perform a variety of inspection and testing, including:

- Hydrostatic and pneumatic testing. Air leak, pressure decay
- Mass spectrometer helium leak testing (detector probe, hood methods)
- Liquid penetrant, magnetic particle, ultrasonic and radiographic examination
- Flow testing
- Full functional testing with mockups.

Supporting capabilities

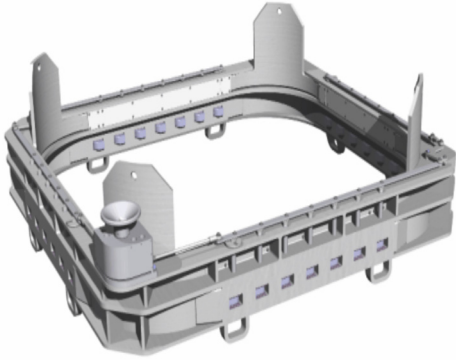
Dry Storage Container

After removal from the spent fuel storage bay, spent nuclear fuel can be stored in above-ground Dry Storage Containers (DSCs). For this project, we were contracted to build a prototype Dry Storage Container. We performed a thorough manufacturing review of the DSC design in terms of manufacturing steps, techniques, processes, materials, NDE and inspection, with particular attention to design to suit concrete pouring.



DSC Lid Clamp

The dry storage container lid clamp is a mechanism that secures the lid to the DSC. The clamp measures 33" high by 95" wide by 107" long and weighs 4,500 pounds. It has an actuation mechanism that swivels a series of dogs inward from each side of the clamp to engage the top flange of a DSC and hold its lid in place.



Radwaste Flask and Trolley

This specially designed Transportation Trolley handles and maneuvers 14,000 pound Shielded Flasks in a reactor building. Rolls-Royce scope of work included design and manufacturing of the trolley and manufacturing the shielded flask.



FRS Transport Flask

The FRS Transport flask is designed to retrieve high level waste from in-ground tile holes, and contain the waste and debris during transport to a new facility for processing. The flask is made of multiple sections, all with a minimum of 4" of lead shielding, and was designed, manufactured, and fully inspected for shielding integrity by Rolls-Royce.



Immobilized Tritium Containers

The standard immobilized tritium containers house a titanium sponge "getter" for tritium storage in the form of titanium tritide. The ITCs are stainless steel vessels with embedded leak tight valves designed to withstand extreme pressures and elevated temperatures.





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