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Navy News

VULCAN LEADS THE WAY FOR NAVY NUCLEAR REACTORS 07.01.03 11:42

Nuclear-driven warships are something of a conundrum.

On the one hand, awesome natural powers are being tamed, requiring sound technologies and constant vigilance.

But on the other hand, the basics of nuclear propulsion are as simple as boiling a kettle.

Water is heated into steam, which is forced through a turbine, and with the aid of a gearbox the propeller spins.

That hasn't changed in more than a century, and is still at the heart of the Royal Navy's nuclear submarine force, which is essentially a steam-driven flotilla.

Vulcan, the Naval Reactor Test Establishment on the north coast of Scotland near Thurso, is a crucial factor in the safe running of British submarines – and its role is expanding as its expertise is brought to bear in other, related disciplines.

The small site, set amidst the splendour of the mountains and sea cliffs of Caithness and fringed by an ever-changing sea, features a small Naval staff (currently five), who head up the organisation, and around 300 Rolls-Royce workers.

Both civilian and military plants occupy the site of an old Fleet Air Arm station, HMS Tern II, created in 1944 and transferred to the Air Ministry ten years later.

The remains of a concrete runway can be seen to the south east of present-day Vulcan, and the former control tower is now the visitors' centre for the civilian Dounreay plant.

But as that facility becomes history – it has not generated electricity commercially for more than ten years – Vulcan continues to look to the future, with a 13-year contract which arises from a partnering arrangement between the MOD and Rolls-Royce.

That VTOM (Vulcan Trials, Operation and Maintenance) contract keeps Vulcan at the very heart of the Royal Navy's submarine programme until at least 2014.

As such the Naval Superintendent Vulcan – Cdr Charles Hume has recently taken over the post from Cdr Simon Middlemas – has had the title project contract manager added to the collection of other tasks which fall to him as head of the establishment.

Cdr Hume's deputy, Lt Cdr Barrie Cran, said: "The five of us in the Royal Navy here have our fingers in virtually every pie on site – it's a very varied life. You do find you have a lot of authority and autonomy in your own world.

"Vulcan is self-contained, and you find yourself involved in activities that are carried out by the Commander-in-Chief Fleet's staff, the Submarine Support integrated project team, and the Naval Bases."

At Vulcan, within sight of the famous golf-ball reactor housing of Dounreay, Royal Navy reactors have been put through their paces in a rigorous regime of tests since the first, Core A, went critical in 1965, eight years after work began on building the complex.

That assembly of radioactive fuel modules and control rods heated water in a primary circuit, which passed its heat to water in a secondary circuit, creating the steam which drove the turbines. The materials and specifications have changed over the years, but the concept is the same.

That first core, along with subsequent versions (B, Z, G and H) were all built by Rolls-Royce, based in Derby, which has been operating the reactors and associated equipment at Vulcan from the first day.

Each reactor went to Vulcan to be tested ahead of use in submarines, so that any problems which may have arisen in a particular design would have arisen at Vulcan long before it became a problem in an operational boat.

The land-based reactor is always at least two years ahead of its sea-going counterparts – in the case of Core A, depletion occurred by 1967, by which time a great deal of experience and useful data had been gathered for operational purposes

and for feeding back into the development of new reactors.

The Vulcan reactor – designated Dounreay Submarine Prototype 1 or DSMP – also served as a full-scale training rig, allowing RN nuclear plant operators to gain hands-on experience.

But by the time Core A was burned out, a simulator had been opened, and training transferred on to it that same year.

Core A was removed in March 1968, and after the plant was overhauled, Core B was installed – which gave Vulcan the honour of achieving the first refuelling of a submarine reactor in the country. Maintenance and refuelling procedures still number among the prime tasks of the Vulcan site.

Core B went critical in June 1968, and far outperformed its predecessor before it closed down, its job done, in 1972.

By this time the Admiralty Research Test Establishment, as it was originally known, had been commissioned as HMS Vulcan (the HMS prefix was lost again in 1981), and Core Z was the centre of attention.

That reactor had been installed in 1974 after another major refit to the DSMP, and it lasted more than a decade. Core Z is fitted to the Navy's current fleet of hunter-killer Swiftsure and Trafalgar-class boats.

At that point DSMP was defuelled and decontaminated and, with more than a passing nod to its Scottish heritage, renamed LAIRD (Loss of coolant Accident Investigation Rig Dounreay), starting a new lease of life as a simulator.

The kettle analogy comes into its own here – the reactor which powered DSMP was replaced by a powerful electrical heater which could accurately replicate the pressure and temperature in a genuine reactor-driven system at the point of reactore shut-down.

LAIRD was thus able to demonstrate that the support systems around the radioactive core could cope with the most difficult of accident conditions – loss of coolant.

Indeed, with more than 250 separate trials having been run in five years, LAIRD has amply proved the ruggedness of Rolls-Royce's engineering in a series of simulated catastrophes.

In place of the old DSMP is its modern equivalent, the STF, or Shore Test Facility, in which the latest reactor, Core H, is performing well as it progresses through its trials period.

Although testing reactors is perhaps the more glamourous end of the business, Vulcan does not just put the nuts, bolts and pumps through their paces.

While it remains primarily a test-bed for submarine power plants, it is also instrumental in ensuring that operating procedures are up-to-date and within rigorous safety parameters.

"We do have tremendous relevance for the Submarine Flotilla," said Lt Cdr Cran. "If we didn't do our jobs, then the Fleet would suffer the consequences."

When reactor cores have burned out, they are dismantled and the components are examined to compare them with predicted performance, allowing the designers to modify the next generation of reactors accordingly.

Elements of Core G1 currently sit in an 18ft deep fuel storage pond within the Shore Test Facility in scrupulously clean water, making it a useful workspace for those carrying out post-irradiation examinations.

The STF is now operating with a modern safety case and leads the way in making sure that these requirements are used not only to ensure safety but also to make sure that those who operate the reactor know and understand what they have to do.

Through early identification of the restrictions that the safety cases may bring, it allows work to be done to allow the submarine flotilla to continue to operate in a world of ever-increasing regulation.

The STF also trials the operating procedures, especially when there has been a major change in design, which in turn guide the operators of boats at sea and contribute enormously to the training of RN personnel who will live and work in the current Vanguard and future Astute-class submarines for decades to come.