In-situ weld material characterisation of Neutron Scatter Plug (NSP) components using a Stand-Off LIBS instrument 2013 – 2016

Dungeness B nuclear power station, Kent, UK

Within the Reactor Fuel Plug Unit Assembly there is a component termed a Neutron Scatter Plug (NSP). The NSP's are approximately 231 mm diameter and 2489 mm long, with two welds, 1700 mm (axially) apart. The welds are designated "weld 13" and "weld 14" which connect between a 347 stainless steel (ss) casting to a tubular 321 ss component.

Due to a variety of reasons some of welds 13 and 14 were welded without use of filler – these are known as "autogenous" welds and some were welded using a 316 ss filler wire. Both NSP welds were ground flush with the tubular component surface post welding. During subsequent long term testing it was found that the filled welds were preferred for long term operation. As both types of weld are visually identical it is not possible to sort between the two types of construction design. If sorting cannot be accomplished then an entire batch (approximately 350) of NSP's will need to be disposed of. This has several undesirable issues, the main ones being; the financial cost of replacing the affected NSP's; the filling of a disposal facility which was intended for a relatively small number of NSP's throughout DNB lifetime and the construction of additional storage (and handling) facilities for the greater number of NSP's than originally planned for station lifetime.

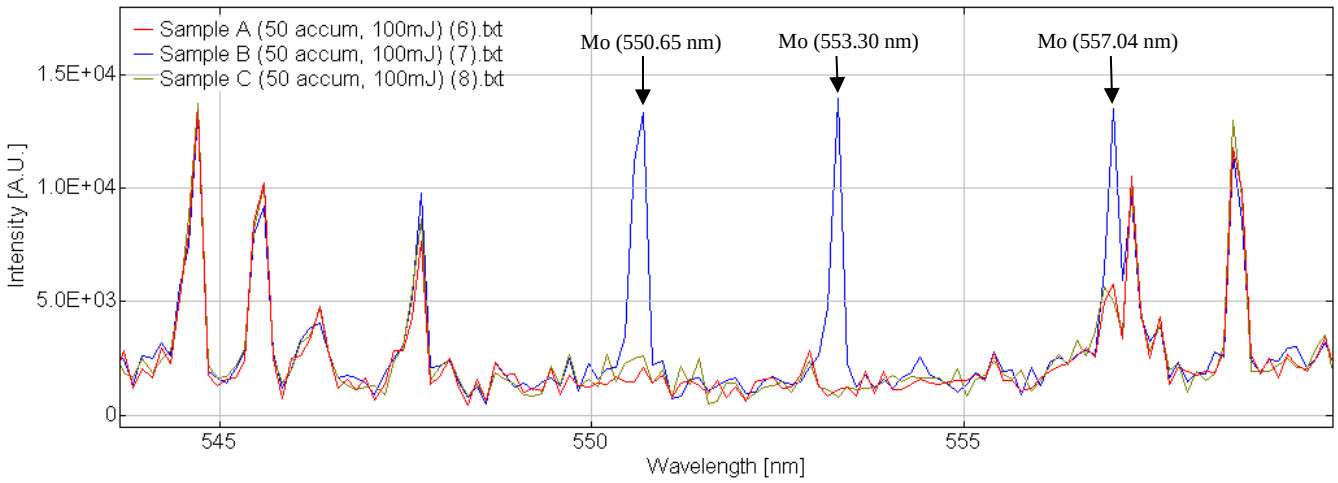
The NSP's, which are now highly radiologically active, are handled remotely within the NSP Handling Facility (NSP HF) at the power station which is approximately 107 feet high. The facility comprises several levels, one of which has a glovebox. A suite of remote cameras are installed which enable the NSP to be observed remotely from the NSP HF control room. The NSP's are raised and lowered by a hoist at the top of the NSP HF. The NSP's can be positioned axially using remote cameras within the glovebox.

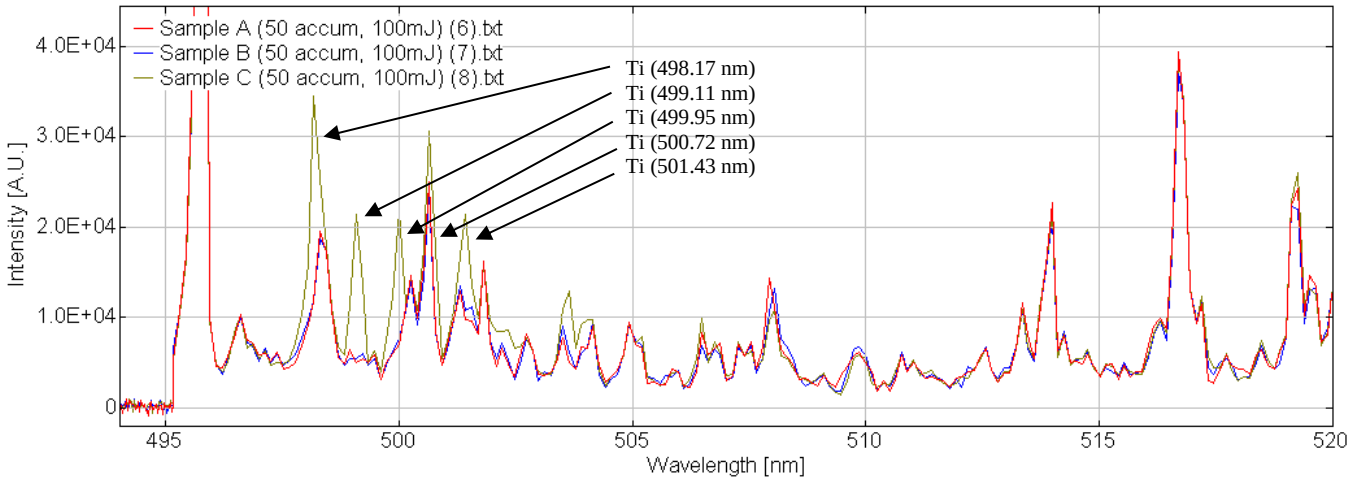
The LIBS system was required to perform a semi-quantitative measurement of the molybdenum content of the steel, together with an indication of the presence or otherwise of titanium and niobium, so that the steel grade could be identified as 316, 347 or 321.

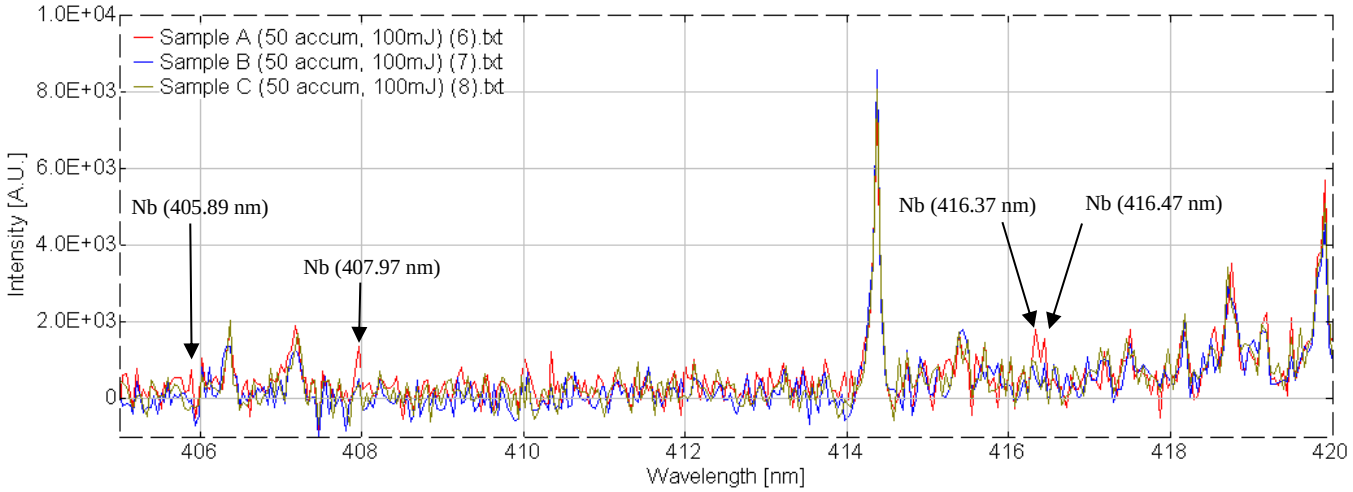
Location:	NSP Handling Facility, Dungeness B AGR power station
Inspection task:	Elemental analysis of Neutron Scatter Plug (NSP) weld material
Environment:	Shielded glovebox with dose rates up to several 10s of mSv / hr
Location of material:	Circumferential weld in NSP
Access:	Optical access via 75 mm thick lead-glass shield window (NSP located approx. 250 - 300 mm from inside face of shield window)

A feasibility study was conducted to confirm that LIBS could meet the analytical requirements of the application, the results of which were positive. LIBS spectra of test samples of steel provided by the plant operators were recorded under similar conditions to that of the NSP HF and are reproduced below. Sample A is 347 steel (contains Nb), Sample B is 316 steel (contains Mo) and Sample C is 321 steel (contains Ti).

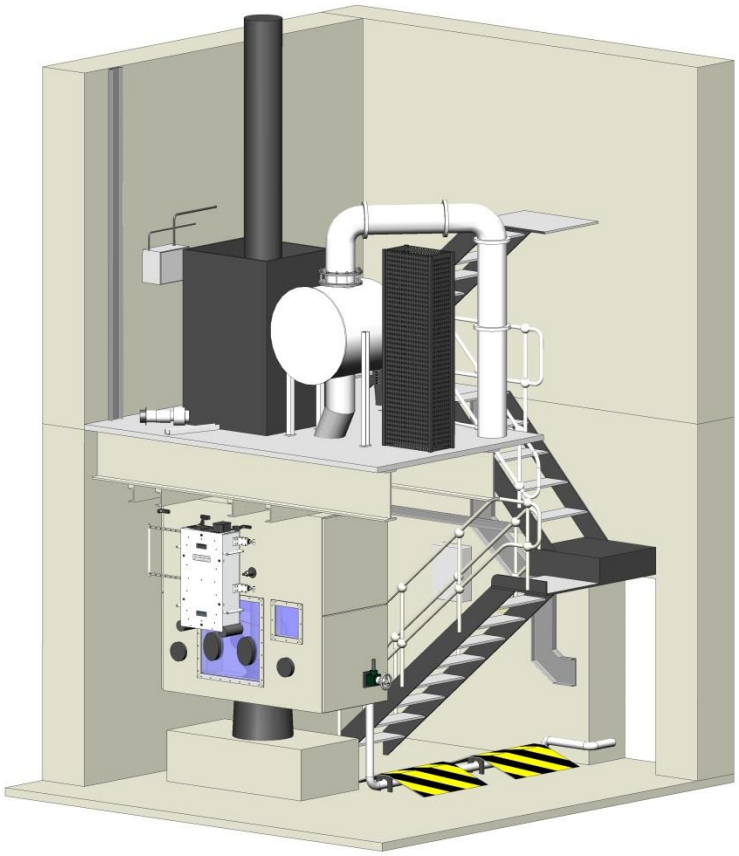
Applied Photonics Limited Unit 8 Carleton Business Park, Skipton, North Yorkshire BD23 2DE United Kingdom
Telephone: +44 (0)1756 708900 **Email:** mail@appliedphotonics.co.uk **Website:** www.appliedphotonics.co.uk



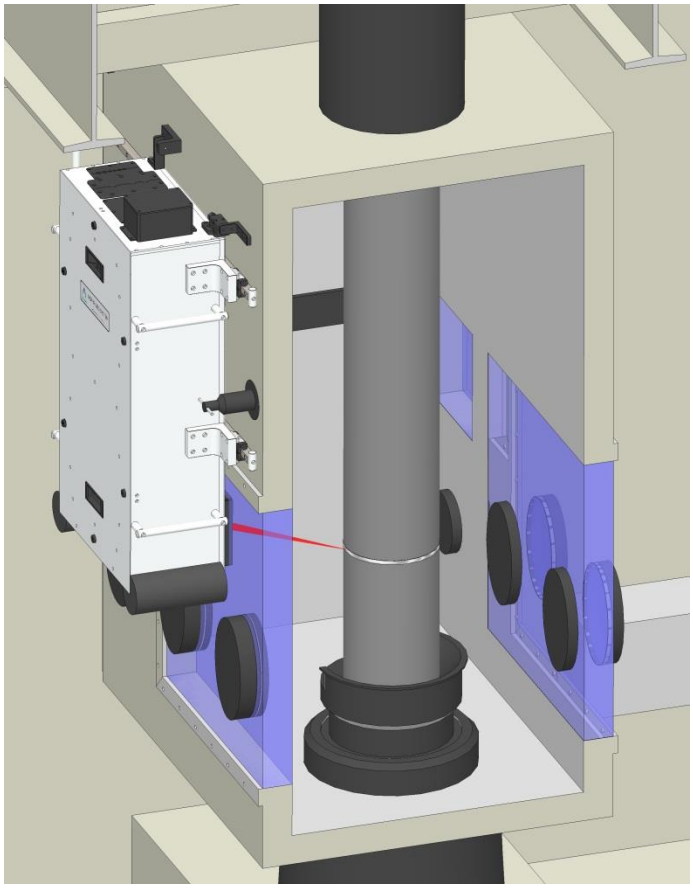




Applied Photonics Limited Unit 8 Carleton Business Park, Skipton, North Yorkshire BD23 2DE United Kingdom
Telephone: +44 (0)1756 708900 **Email:** mail@appliedphotonics.co.uk **Website:** www.appliedphotonics.co.uk



CAD illustration of the NSP Handling facility showing the shielded glovebox with LIBS system installed



CAD illustration showing cut-away view of the shielded glovebox with LIBS system located adjacent to a shield window

End of Document

Applied Photonics Limited Unit 8 Carleton Business Park, Skipton, North Yorkshire BD23 2DE United Kingdom
Telephone: +44 (0)1756 708900 **Email:** mail@appliedphotonics.co.uk **Website:** www.appliedphotonics.co.uk