Date: 11 May 2015

To: Dana Beavis

CC: Ed Lessard and Chris Cullen

From: Suzanne Smith and Matt Gott

Subject: Addendum to the Safety Submission submitted on the Irradiations of Osmium to produce Re-186.

The scheduled irradiation for osmium was stopped last week because the Osmium target did not specifications (0.035 vs 0.02 " thick). This is a request for approval to irradiate a thick Osmium target.

Background:

On preparation of the Osmium target in the glove box last Friday we found that the osmium disc supplied by the contracted commercial supplier was thicker than what has been specified by Uni Missouri. Unfortunately, it was not possible to measure the disc prior (provided in an vacuum sealed case from commercial supplier at $1500 per disc) as it needed to be conducted in a glove box (under helium gas) and we were awaiting safety approval to move forward.

The measurement of the osmium disc was found to be 0.035" thick instead of the specified 0.020". We stopped the scheduled irradiation as we need to redo the thermal calculations and seek your safety approval to move forward.

New calculations - 0.035" thick osmium target

The energy deposition profile for the revised target array (item 1) and the steady state thermal analysis (item 2) of the 0.035" osmium target were calculated.

Item 1 – New Target Array for Irradiation of Thicker Osmium Disc (Sr-82_Os_02)

In the new target array given below, shows more energy is deposited into the osmium disc (0.035") and reduces the energy deposition into the thick aluminium backing. The total energy deposition into the thicker osmium disc is 21.0 MeV (10.3 MeV greater than old array), while the energy deposition into the aluminium backing is 10.1 MeV (9.0 MeV less than old array).

Layer	Layer Material	Thickness		Entry Proton Energy (MeV)	Exit Proton Energy (MeV)
		Inch	mm		
Window 1	Beryllium	0.012	0.305	116.8	116.5
Window 2	AlBeMet	0.012	0.305	116.5	116.2
Beam Line Window	Stainless Steel	0.031	0.787	116.2	113.3
Water Gap	Water	0.106	2.692	113.3	111.5
Box Window	Stainless Steel	0.020	0.508	111.5	109.6
Water Gap	Water	0.200	5.080	109.6	106.1
SS Degrader	Stainless Steel	0.058	1.473	106.1	100.2
Water Gap	Water	0.200	5.080	100.2	96.5
Target Front	Inconel 600	0.012	0.305	96.5	95.2
RbCl Target 1	RbCl	0.646	16.400	95.2	73.7
Target Back	Inconel 600	0.012	0.305	73.7	72.1
Water	Water	0.200	5.080	72.1	67.2
Target Front	Inconel 600	0.012	0.305	67.2	65.5
RbCl Target 2	RbCl	0.500	12.700	65.5	43.7
Target Back	Inconel 600	0.012	0.305	43.7	41.2
Water Gap	Water	0.200	5.080	41.2	33.0
Target Front	Aluminium	0.020	0.508	33.0	31.1
Os Metal Target	Osmium	0.035	0.899	31.1	10.1
Target Back	Aluminium	0.145	3.683	10.1	NIL
Water Gap	Water	0.298	7.569	NIL	NIL
Water Gap	Water	0.100	2.540	NIL	NIL
SS Degrader	Stainless Steel	0.521	8.992	NIL	NIL
Box Window	Stainless Steel	0.020	0.508	NIL	NIL

Item 2 – Steady State Thermal Analysis of theNew Target Array (Sr-82_Os_02)

The thermal analysis (data given below) was conducted in similar manner to that reported in the safety submission i.e. irradiation to be conducted with 116.8 MeV protons (entry to target assembly box) at **an average current of 30 µA for up to 30 minutes.** It is assumed only 60% beam is on target. Total energy deposited in the osmium disc is 21.0 MeV as given in the new target array (Item 1). Analysis shows the maximum achievable temperature for the osmium disc and the aluminium can were found to be 401° C and 205° C, respectively. This is well within the melting range for each material.

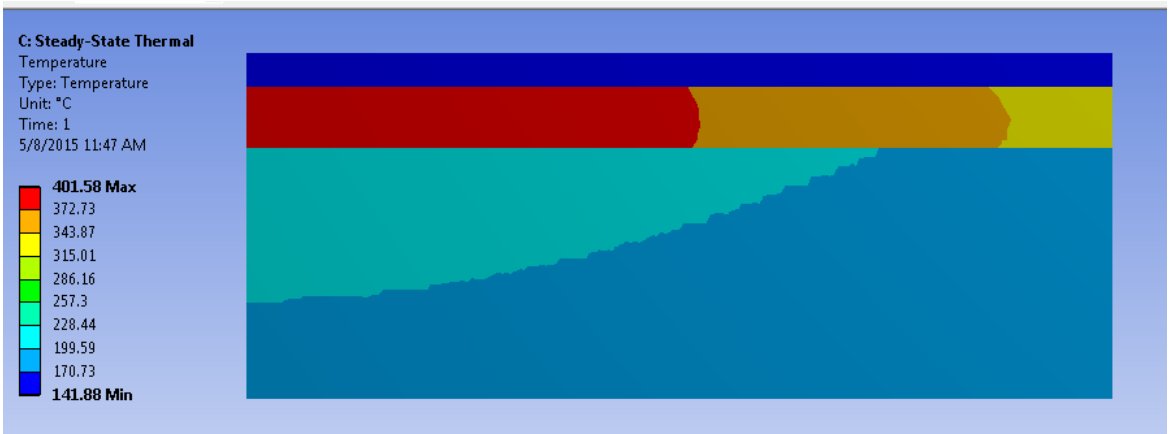

Figure 1. Thermal profile for 0.035” osmium target enclosed in screw-bolted aluminium target can. Note: Calculation conditions: 2D Axi-symmetric model, 0.035” thick Osmium in a bolted aluminium can, Steady-state analysis, 2000 $W/m^2.°C$ thermal contact resistance between each layer, 4000 $W/m^2.°C$ steady-state water cooling convection on exterior, Gaussian internal heat generation for all bodies.