XCT INSTRUMENT Statement of Work

Dated June 30, 2022

Introduction

Outline of Procurement

The Particle Fuels Group at Oak Ridge National Laboratory performs a wide variety of high-quality characterization work on various fuel forms in support of both advanced fuel fabrication efforts and post-irradiation examination of fuels irradiated at the High Flux Isotope Reactor and elsewhere. X-ray computed tomography (XCT) is a key characterization method, enabling non-destructive three-dimensional imaging of samples to identify internal structures, measure key external and internal geometric parameters, and to guide further sample preparation for targeted microscopy. The Particle Fuels Group is seeking to replace the current aging XCT instrument while maintaining and expanding on its capabilities. To meet this objective, it is expected that an XCT instrument with multiple x-ray sources and detectors will be required to provide the range in resolution, field of view, and x-ray penetration required for the diverse fuel forms under investigation.

Technical Specifications

The seller shall provide the company Fuel Development Section with x-ray computed tomography (XCT) system(s) capable of imaging a wide range of samples both in terms of material type and size. The key instrument attributes to support this range of capability are a range of x-ray energies and magnifications. XCT imaging is predicated on x-ray attenuation by the sample, so low-Z materials such as graphite or silicon carbide require low beam energies (tens of kV), medium-Z materials or larger low-Z samples require moderate beam energies (approximately 100 kV), and high-Z materials such as uranium or refractory metals require high beam energies (hundreds of kV). To meet the diverse needs of the section, the purchased instrument(s) must be capable of imaging the following representative samples:

1) Individual fuel particles with a ~1mm diameter at a resolution of 1um or lower at low beam energies optimized for imaging low-Z coating materials such as graphite and silicon carbide. Nominally, beam energies of ~40kV are likely to produce high-quality images of such samples.

2) Integral particle fuel forms such as pebbles or compacts up to 60mm in diameter with a resolution of 50um or lower at moderate beam energies. Nominally, beam energies of ~60-100kV are likely to produce high-quality images of such samples.

3) Refractory metal assemblies or uranium oxide compacts with a resolution of 50um or lower at high beam energies. X-ray sources produce a distribution of x-ray energies with an upper limit of the accelerating voltage and a mean energy which is much lower. Uranium has very high x-ray attenuation with a strong increase in attenuation at 116 keV due to the K absorption edge. As such, a source with an accelerating voltage of at least 400kV is desired to ensure a substantial population of x-rays exceed this edge for imaging uranium bearing samples.

The preferred case is for a single XCT instrument with multiple internal sources and detectors to be capable of meeting all technical specifications. However, if a single XCT instrument cannot meet all three use cases, a combination of two instruments capable of meeting them may be considered. For example, a low-power unit capable of imaging in the range of ~40-100kV and a high-power unit capable of imaging at >400kV. In either case, the proposed instrument or combination of instruments, along with all peripherals must fit within a 20' by 20' footprint to be successfully installed in the available laboratory space.

Supplier Must Be Able to Meet Following Requirements Below

- Bidders must indicate ability, cost, and timeline for Nationally Recognized and Testing Laboratory (NRTL) certification of the instrument prior to delivery to ORNL
- Bidders must provide shipping, on-site installation, and follow-on maintenance cost and schedule
- Bidders must be fully registered as an ORNL Supplier by August 15, 2022