Pellet Injection Extruder Assembly
Summary for Supplier Information

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ITER Project Overview

ITER is a joint international project with the programmatic goal to demonstrate the scientific and technical feasibility of fusion power. The ITER machine is a Tokamak Reactor, a donut shaped reactor with a series of magnets and heating elements that generate and control a plasma reaction. The plasma is equivalent to a star, like the Earth's sun, and generates incredible amounts of heat. The plasma is controlled and fueled by the injection of hydrogenic pellets. More about the ITER project and Pellet Injection can be found at https://www.iter.org/.

The United States ITER Project Office (USIPO) is hosted by Oak Ridge National Laboratory (ORNL) in Oak Ridge, Tennessee, in the United States. The USIPO is responsible for the design and procurement of the Pellet Injection System for ITER. More about the USIPO can be found at https://www.usiter.org/

Summary of Equipment Being Procured

The USIPO is seeking interested suppliers for the design and prototyping of the Fueling Pellet Injection System (FPIS) extruder assembly. Each extruder assembly contains two pellet injectors, each with dedicated fuel recirculation loops. Each pellet injector requires a pre-cooler and liquefier. The extruder assembly includes a guard vacuum chamber to house the two pellet injectors (see Figure 1). Each pellet injector will include the capability to produce two sizes of pellets (small or large).

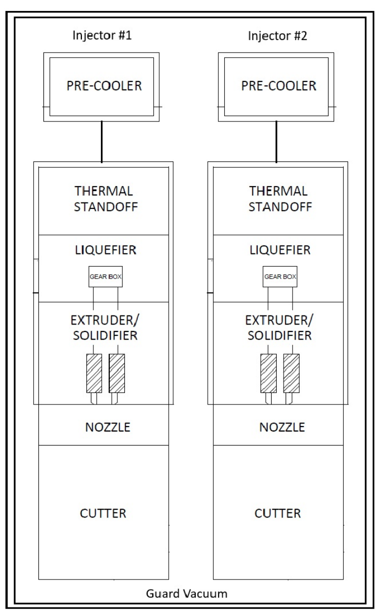

Figure 1: General layout of FPIS Extruder Assembly containing two pellet injectors inside of a guard vacuum chamber.

The pellet injectors will cut and propel solid hydrogenic (deuterium, protium, and tritium) pellets for core fueling and for control of Edge Localized Modes.

The FPIS shall have four injectors for Start of Research Operations and six injectors for DT-1 operation.

Project Management Expectations

The supplier will be responsible for the project management of the design, fabrication, and testing of the FPIS Extruder Assembly. Shipping is not included. Deliverables and activities include:

- Participation in status update meetings and development of status update reports;
- Developing and updating a Project Schedule;
- Coordination of document delivery, including submitting documents for review and approval;
- Implementing a Configuration Management Program, procurement of materials and components, fabrication, assembly, inspection, examination, testing, and cleaning.

Key technical and quality assurance requirements are stated in next sections. A full statement of work and technical specification, will be provided via formal solicitation. Suppliers interested in receiving this solicitation should indicate interest to Landen Treadway at treadwayla@ornl.gov. Questions can be directed via email or phone at +1 865-341-3071.

Technical Requirements

- The extruder assembly (currently assumes two injectors, but additional injectors could be added) must be compatible with a maximum of 2.8g/s flow rate of SHe 4.8K nominal and 15.4g/s GHe at 80K.
- The nominal pellet speed leaving the injector shall be 300m/s, with a maximum speed of 500m/s (pellet integrity is not required for injection velocities above 300m/s).
- The extruder assembly (including the guard chamber volume and fuel recirculation loops) must fit within the following dimensions: 1.26m long, 1.56m wide, and 1.63m in height.
- All equipment shall be able to withstand accidental scenarios that include earthquakes.
- The injectors shall be compatible with the following pellet fuel gas mixtures:
    - 100% protium (H_2)
    - 100% deuterium (D_2)
    - Deuterium / tritium mixtures ranging from 100% D_2 / 0% T_2 to 0% D_2 / 100% T_2
- The injectors must not introduce impurities that result in a total of more than 0.1% of a pellet's composition.
- The composition of the pellets must be constant throughout a single discharge.
- During SRO operation (up to 100 s flat-top) the bounding fueling rate shall not exceed 200 $Pa.m^3.s^{-1}$ when operating with H_2 and D_2.
- During DT-1/DT-2 operation, the bounding fueling rate shall not exceed 200 $Pa.m^3.s^{-1}$ for burn times up to 450s when operating with H_2, D_2, and T_2.
- During DT-1/DT-2 operation, the bounding fueling rate shall not exceed 160 $Pa.m^3.s^{-1}$ for burn times between 450 and 1000s when operating with H_2, D_2, and T_2.
- During DT-1/DT-2 operation, the bounding fueling rate shall not exceed 120 $Pa.m^3.s^{-1}$ for burn times between 1000 and 3000s when operating with H_2, D_2, and T_2.
- During DT-1/DT-2 operation the T_2 supply (90% T and 10% D) shall be limited to 111 $Pa.m^3.s^{-1}$ which is equivalent to 100 $Pa.m^3.s^{-1}$ of pure T_2.

- To meet the above bounding fueling rate the following should be assumed.
  - Typical volume of large pellets delivered shall be controlled to between 50mm^3±20% and 92 mm^3±20%. This assumes a diameter of 5mm. Final diameter of pellets must be compatibility with the flight tubes that have an ID of 10.2mm.
  - Typical volume of small pellets delivered shall be controlled to between 17mm^3±20% and 33 mm^3±20%. This assumes a diameter of 3mm. Final diameter of pellets must be compatibility with the flight tubes that have an ID of 10.2mm.
  - Nominal pellet injection frequency shall be adjustable from 4 Hz up to 60Hz. This can be achieved by the combination of several injectors.

The Extruder assembly must be compatible with the following environmental conditions. Any shielding, if required, must not exceed the space constraints listed above.

Table 1. Environmental Conditions

Environmental Parameter	Expected Range
Temperature	18 – 35 °C
Relative Humidity	20 – 60%
Magnetic Field	≤ 130 mT (vertical); 2 mT (continuous); 8mT (short duration)
Gamma Dose	$2.07*10^3$ Gy @4700h silicone dose
Neutron Flux	$2.71 * 10^7$ n/cm^2 /s
Neutron Fluence	$4.58*10^{14}$ n/cm^2

NOTE: Fluence is calculated for 4700h.

Code Requirements:

- ASME B31.3, Process Piping, Category M, 2014
- ASME BPVC Section II Part C – Materials
- ASME BPVC Section III – Nuclear Facility Components
- ASME BPVC Section V – Non-Destructive Examination
- ASME BPVC Section IX – Welding, Brazing, and Fusion Qualifications
- ANSI/AISC N690, Specification for Safety-Related Steel Structures for Nuclear Facilities, 2012
- AWS D1.6, Structural Welding Code - Stainless-Steel
- ESPN Order 30/12/2015
- European Directive PED 2014/68/UE
- ITER Vacuum Handbook
- ITER Tritium Handbook

Quality Assurance Requirements

The supplier is responsible for having a quality assurance program to ensure the conformity of the extruder assembly to the codes and standards used in the design, including the technical specification and statement of work. Quality assurance expectations include:

- Developing a Manufacturing and Inspection Plan;
    - Weld Inspections
    - Dimensional Inspections
- Providing evidence of conformity, such as fabrication reports, inspection data, and proof testing reports such as hydrotest or factory acceptance test reports;
- Reporting deviations or non-conformances from requirements and working with the USIPO to resolve these deviations and non-conformances.