The NASA Glenn Research Center (GRC) is seeking to improve the operating regime of the Particulate Aerosol Laboratory (PAL). As part of that effort, a new combustor assembly is required. The combustor will be used to simulate aircraft exhaust at cruise conditions. As a result, the effluent must resemble said emissions with respect to particulate size distribution and number density. The combustor assembly shall be comprised of two essential parts. The first is a dual-fuel injector capable of burning gaseous and liquid fuels either individually or simultaneously. The second part is a combustor housing to contain the combustion and direct the effluents into the other parts of the PAL facility. The dual-fuel injector shall have separate paths for the liquid and gaseous fuels. The combustor assembly mate to the existing facility piping via a 2.75" ConFlat type Flange. The inner diameter is not to exceed 6.000". Detailed specifications, a notional drawing, and a list of Deliverables are given below.

Detailed Specifications, Combustor Housing

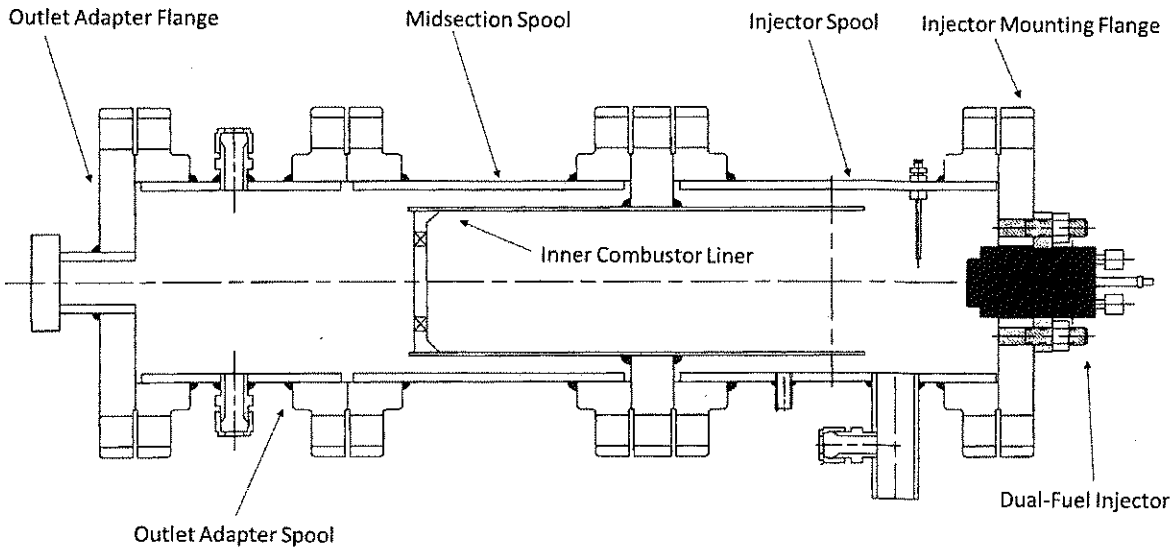
1) The contractor shall design fabricate, inspect and test the Combustor Housing in accordance with the latest edition of the ASME Boiler and Pressure Vessel Code (ASME BPV, Section VIII Div. 1 or Section VIII Div. 2). As the chamber shall not exceed 6" ID a Code Stamp shall not be required, although all of the code requirements shall apply. The fabricator shall submit an equivalent U1A form to the customer and all code documents typically supplied to an Authorized Inspector;
2) The contractor shall supply an engineering report with detailed calculations, FEA analysis, fabrication drawings and all electronic versions along with a description of the source code used;
3) The contractor shall prepare & submit Welding Procedure Specifications (WPS) Procedure Qualification Records (PQR), and Welder Performance Qualifications (WPQ) in accordance with the latest edition of ASME BPV. The qualification documentation shall be submitted at least 5 work days prior to the start of fabrication;
4) 100% radiography inspect all butt welds and longitudinal welds per the latest edition of ASME BPV Code. Other welds shall be liquid penetrant inspected in accordance with the latest edition of ASME BPVC, using a water washable fluorescent dye penetrant. Provide all material test reports, inspection reports and hydro test reports. No ASME code rejectable defects are allowed;
5) The Design Pressure shall be 20 PSIG;
6) The Design Temperature shall be 1000°F;
7) There shall be Six (6) components, each consisting of a cylindrical pipe and mating flanges (notional drawings below);
8) The pipe material shall be ASTM A312 TP316H Stainless Steel;
9) The internal diameter of the cylindrical pipes shall not exceed 6.000";
10) The mating flanges shall be ASME SA240 316H Stainless Steel;
11) The flanges shall be designed and fabricated according to Best Practice for the use of Garlock Graph-Lock Type 3123 1/8" Gasket Material or equivalent;
12) All Flanges and Spool pieces shall be made to the minimum weight and size in accordance with the ASME code cited above;
13) A Waterline is defined for the vessel as a the fiduciary section taken midway through the vessel diameter and running the length of the long axis;

14) The Waterline shall be used to define the locations of penetrations and bolt hole patterns;
15) The first component is the Injector Mounting Flange;
    a. Mates with the Injector Spool (described below);
16) The second component is the Injector Spool,
    a. Not to exceed 10" in overall length,
    b. Mating flanges on either end,
        i. Flange holes to be offset 45° from waterline
    c. A penetration for mounting a 14 mm x 1.25 Spark Plug on waterline,
    d. A .750" OD, .065" wall thickness, by 3.00" long 316 Stainless Steel tubing Instrumentation Port with a 1/8" SwageLok SS-200-1-2W Weld to Swage adapter fitting welded 1" from burner at 90° from waterline.
17) The Third Component is the Inner Combustor Liner
    a. ID 4.25"
    b. OD 4.50"
    c. Overall Length not to exceed 12.5"
    d. Flange welded at center of overall length
    e. Flange to mate with the Injector Spool and the Midsection Spool (described below)
    f. Open on one end
    g. Closed on the other end with multiple penetrations providing *ca.* 50% Blockage
18) The Fourth Component is the Midsection Spool
    a. Overall length not to exceed 8.00"
    b. Flanges on either end
    c. Flanges mate to Inner Combustor Liner and the Outlet Adapter Spool (described below)
    d. The Injector Spool, Inner Combustor Liner, and Midsection Spool Flanges meet in a three flange assembly (see drawing below)
    e. All flanges shall have bolt hole pattern offset 45° from waterline
19) The Fifth Component is the Outlet Adapter Spool
    a. Overall length not to exceed 6.00"
    b. Two Stainless Steel SwageLok SS-810-1-8W fittings on either side at Waterline
    c. Schedule 40 316 Stainless Steel 1-1/2" pipe at 90° offset to Waterline for relieve protection
        i. Pipe not to exceed 4" height from spool OD
        ii. Pipe not to be less than 3" height from spool OD
        iii. A 1-1/2" SwageLok SS-2400-1-24W Weld to Swage adapter fitting welded 90° from waterline.
    d. Both the SwageLok Fittings and Pipe to be at overall length centerline of part
    e. Flanges at either end
        i. Bolt hole pattern to be offset 45° from waterline
    f. Flange mates to the Outlet Adapter Flange (described below)
20) The Sixth Component is the Outlet Adapter Flange
    a. Flanges at either end
        i. One flange mates to the Outlet Adapter Spool
        ii. The other flange to be a fixed 2.75" OD ConFlat.

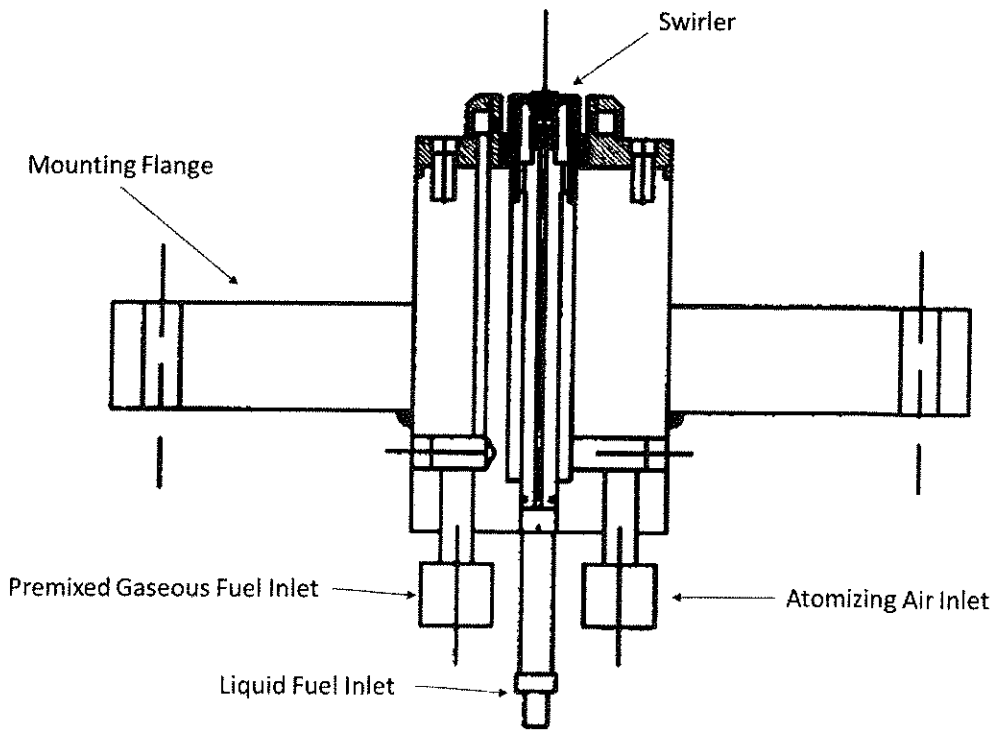
Detailed Specifications, Dual-Fuel Injector (DFI)

1) The DFI shall mount to a flange that is itself mounted to the Injector Spool;
2) There shall be blind holes in that flange for mounting the DFI;
3) The DFI shall have three input ports
    a. One for liquid fuel
    b. One for atomizing air
    c. One for a premixed gaseous fuel and air
4) The liquid fuel flow rates shall be in the range of 0.005 to 0.10 Liters per Minute;
5) The atomizing air flow rate shall be in the range 10 to 30 Standard Liters per Minute;
6) The premixed gaseous flow rates shall be in the range 1 to 5 Standard Liters per Minute;
7) The DFI shall light with a sparkplug at all conditions listed in 4 through 6 above;
8) The DFI shall have stable operation at all condition listed in 4 through 6 above;
9) The DFI shall have a swirl stabilized flow;
10) The DFI shall operate stably and with a low soot incandescence on either the liquid fuel, the gaseous fuel or a combination of either;
11) The contractor shall provide alignment tools for installing and aligning the swirler assembly within the DFI;
12) The DFI shall be mounted such that no less than 0.500" and no more than 1.00" penetrate the Injector Spool;
13) The DFI shall be no more than 3.00" in diameter;

Notional Drawing of Assembled Combustor Housing



Notional Drawing of Assembled Dual Fuel Injector



Deliverables

There are Seven (7) Deliverables for this effort. The first Three (3) are for the Combustor Housing, the second Three (3) are for the Dual Fuel Injector. The final deliverable is the Acceptance Test

1) Fabrication drawings and engineering report with detailed calculations for the Combustor Housing. Welding Procedure Specifications (WPS) Procedure Qualification Records (PQR), and Welder Performance Qualifications (WPQ) in accordance with the latest edition of ASME BPV. This documentation shall be submitted at least 5 work days prior to the start of fabrication;
2) Radiography and dye penetrant test reports on all welds and hydro test reports as per Item 4 in Specifications;
3) The assembled, as tested, Combustor Housing;
4) A prototype brass body Dual Fuel Injector assembly and test report listing operating conditions and photographic (or spectroscopic) evidence of low soot incandescence while operating on liquid fuel, gaseous fuel and combinations of both;
5) Fabrication drawings for the production version Dual Fuel Injector;
6) An assembled and tested 316 Stainless Steel production version Dual Fuel Injector with photographic (or spectroscopic) evidence of low soot incandescence while operating on liquid fuel, gaseous fuel and combinations of both;

7) An Acceptance Test of the integrated Combustor Assembly and Dual Fuel Injector at the NASA Glenn Research Center. The test will be considered successful if the integrated assembly demonstrates ignition on both fuels, stable burning, and operability over the ranges listed in Items 4 through 6 in the Detailed Specifications above. The test is to be performed at the NASA Glenn Research Center PAL Facility.