

# TESTING AND FUNCTIONS OF THE J-2X GAS GENERATOR



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**Abstract:** The Ares I, NASA's new solid rocket based crew launch vehicle, is a two stage in line rocket that has made its way to the forefront of NASA's endeavors. The Ares I's Upper Stage (US) will be propelled by a J-2X engine which is fueled by liquid hydrogen and liquid oxygen. The J-2X is a variation based on two of its predecessor's, the J-2 and J-2S engines. ET50 is providing the design support for hardware required to run tests on the J-2X Gas Generator (GG) that increases the delivery pressure of the supplied combustion fuels that the engine burns. The test area will be running a series of tests using different lengths and curved segments of pipe and different sized nozzles to determine the configuration that best satisfies the thrust, heat, and stability requirements for the engine. I have had to research the configurations that are being tested and gain an understanding of the purpose of the tests. I then had to research the parts that would be used in the test configurations. I was taken to see parts similar to the ones used in the test configurations and was allowed to review drawings and dimensions used for those parts. My job over this summer has been to use the knowledge I have gained to design, model, and create drawings for the un-fabricated parts that are necessary for the J-2X Workhorse Gas Generator Phase IIc Test.

## Workhorse Gas Generator

- Drives turbopumps of the J-2X main engine
- Is used on the:
  - Ares I upper stage (US)
  - Ares V US
  - Earth Departure Stage (EDS)
- Mixes liquid oxygen (LOX) and liquid hydrogen (LH2)
- Once the engine starts, the J-2X's helium spin start system draws the propellants into the GG
- The hot gas spins the turbine blades
- The turbomachinery delivers the high pressure gas to the J-2X main injector

**Overview: The Workhorse Gas Generator increases the delivery pressure of the supplied combustion fuels that the engine burns, and drives the turbomachinery that starts the J-2X engine .**



**J-2X Workhorse Gas Generator Firing**

## Workhorse Gas Generator (GG) Testing Phase IIc

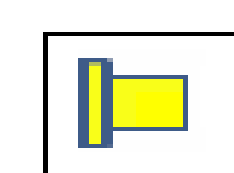
### GOALS

- Tests temperature and pressure of exhaust gas
- Makes sure temperature and pressure satisfy conditions needed to drive the turbo pump in the J-2X engine.
- Reflect the length of the module that will actually be used in the engine.
- Reflect the configuration of the module being used in the engine.
- Optimize the length of ductwork
  - Find configuration that satisfies the conditions needed to drive the turbo pump while also utilizing the least amount of pipe
- Less pipe=Less weight.
  - This lightens the overall load that the rocket has to get off the ground.

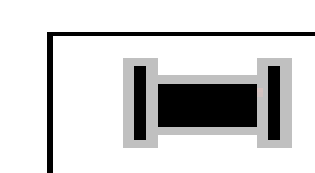


Engineers at the Marshall Center conduct a battery of tests on the J-2X's workhorse gas generator, the driver for the turbopumps which start the engine for the Ares I rocket upper stage.

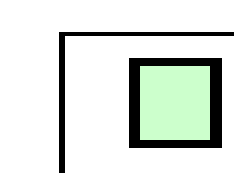
During my time here at the Marshall Space Flight Center (MSFC), I have learned how to use the ProEngineering (ProE) design software. I have used it to model small components of the test configurations being used for the J-2X Workhorse Gas Generator Testing Phase IIc.



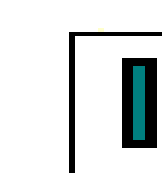
**Nozzle**



**Straight Pipe**

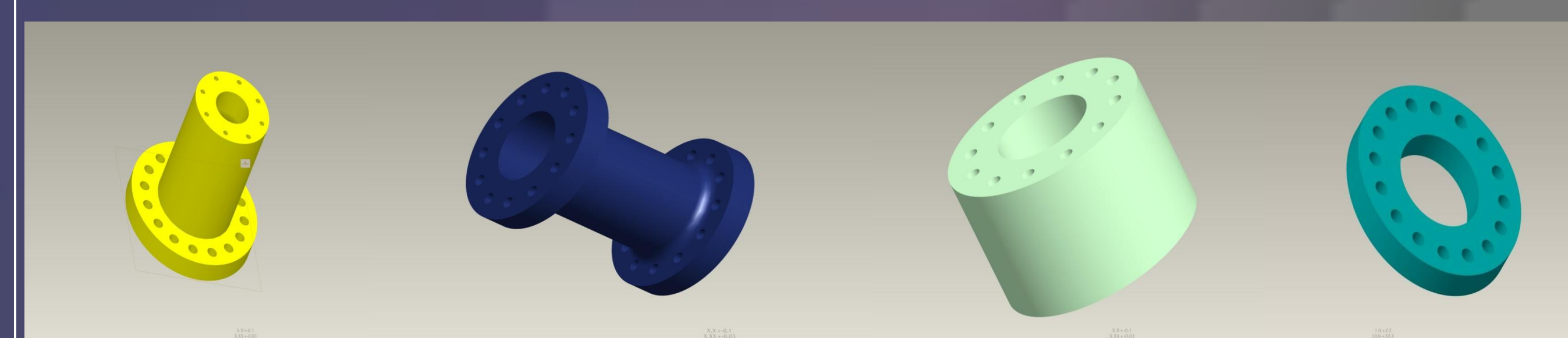


**Chamber Spacer**

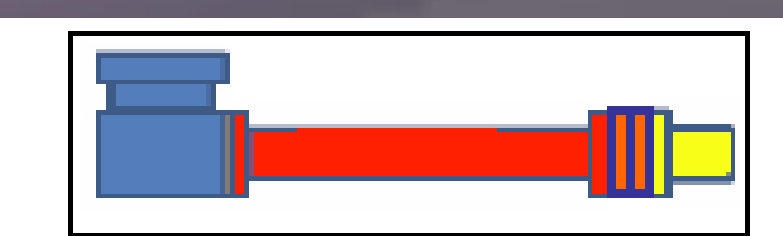


**Chamber Spacer**

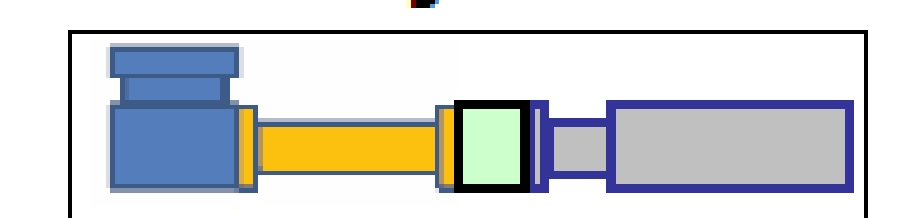
### Modeled Hardware



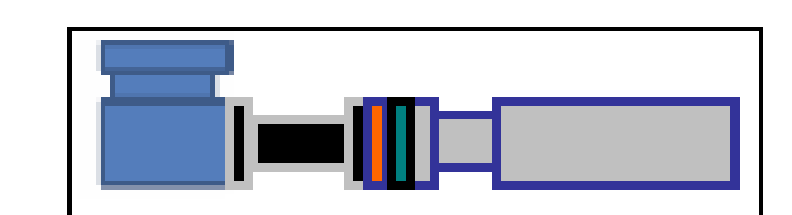
**ProE Models**



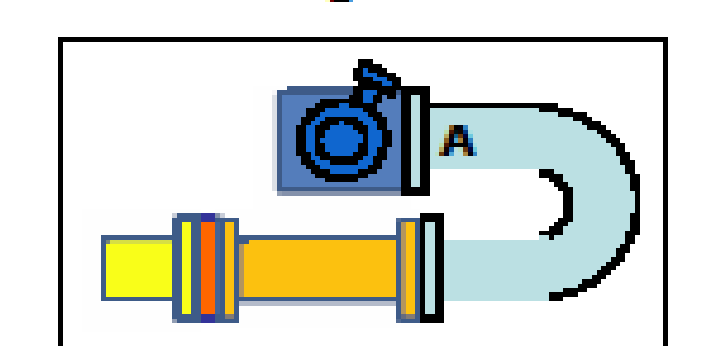
**Ex. Straight Chamber Configuration**



**Ex. Turbine Simulator Configuration**



**Ex. Turbine Simulator Configuration**



**Ex. 180° Duct Configurations**

**Test Configuration Examples**

### OSU Required Information

**Experience with mentor:** My experience with my mentor this year has been quite enjoyable. Joe is very experienced and through him I have learned a lot about how the engineering world operates. He is a nice person and is there to help when I need it.

**Knowledge gained:** Over the course of the summer I have learned how to use the ProEngineer software, an amazing opportunity that will help a great deal if I continue to pursue a career in engineering. This experience has helped to improve my problem solving skills, and this too will benefit me in the future.

**Future plans in STEM and with NASA:** As of now I am considering doing the INSPIRE program next year and participating in the Tier 3 internship.

**INSPIRE's influence on my career interests:** now that I have some insight into what it is like to be an engineer, I am still considering it as part of my career path.

**Exposure to different areas within NASA:** This summer I have been on many tours and have had the chance to see the multiple branches that keep MSFC running. I also toured the historic test areas that have been used to test the Saturn V as well as the space shuttle.

**What I've learned (regarding the NASA workplace):** I learned about the rich history of the MSFC, of all the monumental events that would have never been accomplished without the help of the Marshall Space Flight center.