

TIMOTHY B. BENDEL

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Professional Experience

March 2005 to Present: President of Frontier Astronautics, LLC

Highlights:

- Frontier Astronautics test fires the Asp™ liquid rocket engine numerous times over our Atlas-E missile base flame trench.
- Frontier's Viper™ cryogenic liquid oxygen (LOX) / Kerosene rocket engine listed as an Invention of the Year by Popular Science (June '08 issue)
- Frontier tests two different hybrid rocket motors for two different clients on our fully instrumented test stand. One is nitrous oxide/HTPB and the other was hydrogen peroxide/polyvinylchloride.
- Managed all finances and contracts with ten companies, several with non-disclosure agreements.
- Oversaw the submission of two patents.
- Frontier Astronautics designs visual navigation guidance system for Stone Aerospace's ENDURACE autonomous robotic submarine on NASA contract. ENDURACE explores a permanently frozen lake in Antarctica and finds its way back to the entrance hole. NASA is funding this project as a precursor to an autonomous submarine lander for Europa.
- Wins a grant for a Feasibility Study to license Frontier's Chugwater site as a FAA licensed spaceport.
- A decommissioned Atlas E Missile Base is acquired and Frontier Astronautics starts the process with the FAA/AST to license the Atlas-E missile base as a suborbital spaceport.

September 2008 to January 2010: Senior Principal Propulsion Engineer for Orbital Sciences' Antares launch vehicle

Identify and assess any issues with using 1960's vintage Russian NK-33 (AJ-26) rocket engines for the Antares launch vehicle:

- Identify any aging damage such as stress corrosion cracking, seal integrity, etc.
- Identify any design issues since the NK-33 was never intended to be gimbaled (such as turbopump cavitation margin, addition of gimbals and flex lines, pogo problems, LOX / Kerosene turbopump gyroscopic moments, installation of American components etc.) Test, Verify and Integrate the engines for flight:
- Designed the cryogenic LOX Chill Down test sequence to be conducted at NASA Stennis Space Center Hot-Fire testing.
- Designed the ConOps for integrating the dual engine assembly onto the launch vehicle at NASA Wallops Flight Facility as well as the single engine testing at NASA Stennis.

1997 – January 2005: Lockheed Martin Astronautics

2003 – 2005: *Spacecraft Exploration Systems, Propulsion Division:*

- Certified Principal Engineer supporting the hypergolic propulsion systems on Mars Reconnaissance Orbiter, Advanced EHF, XSS-11, SBIRS and A2100 spacecraft.
- Responsible for generating the Performance Specification, Statement of Work (SOW) and analyzing the build and testing documentation for various propulsion system components.
- Review the design and performance of several hypergolic engines for possible use in Lockheed Martin spacecraft.

2000 – 2003: *Titan II/IV Launch Vehicle Propulsion:*

January 2002 - **Promoted to Certified Principal Engineer (CPE)**

Lead Engineer responsible for Titan II Attitude Control System (ACS)

- Responsible for all aspects of the ACS, from component procurement from subcontractor, assembling components into system, to preflight testing and monitoring in flight.
- Lead engineer for Rocket Engine Module Re-Acceptance Testing (Hot-Fire Testing) at General Dynamics Facilities. Wrote and managed Statement of Work and testing procedures. All twelve hydrazine engines successfully passed Acceptance Testing.
- Performed CPE duties as CPE Delegate for Titan II Attitude Control System, including all Re-Cycle activities for the Titan G-09 Attitude Control System after G-09's aborted lift-off attempt.
- Designed and implemented new procedures for hydrazine hypergolic propellant off-loading to prevent the formation of carbazic acid.
- Presented the status and all issues with the ACS to Lockheed Martin Senior Management (typically VP level)

December 2000 - **Promoted to Senior Propulsion Engineer**

Duties included:

- Leading Expanded Pedigree Reviews at Aerojet in Sacramento to review design drawings, requirements documents, hardware build papers and all related documentation as a part of Titan LR-87 and LR-91 Hypergolic Liquid Rocket Engine purchase.
- Conducting sequential quality inspections of Titan LR-87 and LR-91 Hypergolic Liquid Rocket Engines at Aerojet, during vehicle integration at Lockheed Martin in Denver, as well as immediately prior to launch at the launch site.
- Manning console during launch to assess system performance and ascertain readiness for launch (go / no-go).
- Analyzing telemetry data for multiple launch vehicle propulsion anomalies (loss of Liquid Rocket Engine lube oil pressure, autogenous pressurization and fuel decomposition problem, Titan IV Stage II hydraulic pressure anomaly analysis).
- Attended and participated in Critical Design Reviews, Engineering Review Boards and Flight Readiness Reviews for the Titan hypergolic LR-87, LR-91 and the cryogenic Titan Centaur RL-10 Liquid Rocket Engines.

1997 – 1999: *Additional Project Experience* (Prior to the Titan Program in 1999):

RD-180 Liquid Rocket Engine Proposal:

Pursued the concept and developed the business strategy for the use of high performance Russian rocket fuel combustion with sub-chilled LOX in RD-180 engines. Presented results to Atlas senior management.

Mars Odyssey Spacecraft:

Designed several manifolds for the attitude control system thruster propellant feed lines using Master Series IDEAS. Odyssey was launched April 7th 2001 and reached Mars October 24th 2001.

Space Shuttle Non-Toxic Upgrade Program Proposal:

Propulsion analysis. Conceived and conducted preliminary design of a cryogenic LOX/Ethanol heat exchanger for use in Space Shuttle Reaction Control System (RCS) upgrade. Wrote the Statement of Work (SOW) to Aerojet to subcontract for fabrication. This proposal was to implement a non-toxic system in lieu of the then current hypergolic system.

Mars Ascent Vehicle Proposal:

Propulsion analysis. Proposed Hypergolic Liquid/Solid configuration for Mars Ascent Vehicle, and helped construct and analyze system level design and ascent trajectory.

Europa Proposal:

Supported the successful Europa spacecraft proposal by assessing Aerojet's deep space technology and recommending possible Lockheed Martin advantages. Lockheed Martin won this contract.

Space Based Laser Proposal:

Performed analysis of hypergolic chemical laser fuel feed system.

Professional Awards

- *November 2001 SPOT Individual Award* For successfully implementing and completing Titan G-09 Re-Cycle activities.
- *October 2001 SPOT Individual Award* For identifying carbazic acid problem and preventing launch vehicle damage.
- *2002 High Performance Work Team Award* For Re-Cycle activities for the Titan G-09 Attitude Control System after G-09's aborted lift-off attempt.
- *2001 High Performance Work Team Award* For analysis and implementation of preventative procedures for Titan II return to flight after G-08 Flight Anomaly.

Education

- May 1997 M.S. Aerospace Engineering, University of Colorado at Boulder, College of Engineering and Applied Sciences.
- May 1995 B.S. Aerospace Engineering, University of Colorado at Boulder, College of Engineering and Applied Sciences.

Patents

- "Liquid propellant rocket engine with pintle injector and acoustic dampening" US7827781B2
- "System and Method for Funding Companies" US 2012/0136807 A1
- "System and Method for Funding Companies" US 8,630,931 B2

Other Recognition and Training

- *Attended the following Lockheed Martin Courses:* Space Operations Training Course, Spacecraft Electric Propulsion Application and Integration Course, RL-10 Familiarization Course, Titan LR-87 and LR-91 Liquid Rocket Engine Familiarization Course, Introduction to Cryogenics, Master Series IDEAS CAD Design Course, Clean Room Certification Course, Foreign Object Elimination Course, Electric Shock Discharge Certification Course and Russian 1, 2 and 3.