## Phase 1 Project Summary

**Firm:** Orbital Technologies Corporation

**Contract Number:** NNX12CD97P

**Project Title:** Lattice Regenerative Cooling Methods

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### Purpose of the Research:

ORBITEC is developing novel cooling concepts collectively called Lattice Regenerative Cooling Methods (LRCM) for use in future high thrust in-space propulsion systems. Incorporation of ORBITEC's innovative lattice structures in the fabrication of thrust chambers for expander cycle engine systems will maximize the heat transfer into the coolant fluid, expand design options, enable substantial cost savings, and reduce lead times for component fabrication. Using rapid prototyping technology, the LRCM hybrid fabrication approach allows for the rapid casting of near-net shape metallic thrust chamber components. The lattice passages allow for turbulent flows through the cooling jacket which induces mixing in the coolant. This Phase 1 work responds to NASA SBIR Subtopic X2.02 which requests innovative combustion chamber thermal control technologies for future high thrust in-space propulsion systems.

### Description of the Research Carried Out:

During the Phase 1 effort, monolithic chamber wall sections incorporating two different LRCM lattice structures were designed and analyzed. Attempts were made to fabricate functional prototypes of both of the lattice structures, as well as a conventional chamber wall section incorporating rectangular coolant channels. In addition, preliminary assessments of fabrication cost and system level performance were completed.

### Phase 1 Result:

Transient finite element simulations were sued to identify the two most promising LRCM coolant passage configurations. Laboratory scale demonstration thrust chamber spool sections were designed with each of the LRCM configurations, as well as a spool insert with conventional coolant channels. Attempts were then made to fabricate each of the thrust chamber spool sections using the ORBITEC Hybrid Precision Casting Technique. The fabrication demonstration culminated in the casting of components that were 90% free of defects.

### Justification for Phase 2 Continuation:

The Phase I project demonstrated the technical feasibility of the LRCM concept by meeting the key technical objectives and answering the technical questions. The analysis and modeling of the LRCM coolant passage configurations revealed that the most effective LRCM structures were able to significantly increase the heat transfer efficiency of a coolant circuit while maintaining system pressure drops similar to those encountered in conventional systems. The LRCM fabrication technique was shown to enable the creation of high fidelity near net shape castings of structures that cannot be manufactured using conventional techniques.