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ABSTRACT INFORMATION

Title: CFD Study of the J2-X LOX Two-bladed Inducer in the Presence of a Circumferential Groove

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AUTHOR INFORMATION

Author/Presenter Name: Robert Coker
Affiliation NASA MSFC
Address ER-42 MSFC
City Huntsville
State AL Zip 35812
Telephone 256-544-4686
Telefax
E-mail: Robert.F.Coker@nasa.gov

2nd Author: Jeff West
Affiliation NASA MSFC
Address ER-42 MSFC
City Huntsville
State AL Zip 35812
Telephone 256-544-6309
Telefax
E-mail: Jefferey.S.West@nasa.gov

3rd Author:
Affiliation
Address
City
State Zip
Telephone
Telefax
E-mail:

Additional Author(s):
Affiliation
Address
City
State Zip
Telephone
Telefax
E-mail:
**MANAGEMENT APPROVAL**

The individual below certifies that the required resources are available to present this paper at the above subject JANNAF meeting.

Responsible Manager authorizing presentation: Lisa Griffin  
Title/Agency: ER-42 NASA MSFC Branch Chief  
Telephone Number: 256-544-8972  
e-mail: Lisa.W.Griffin@nasa.gov  
Date: 6/6/2011
Results are presented of a computational fluid dynamics (CFD) study done in support of water flow experiments of the J-2X Oxidizer Turbopump (OTP) 2-bladed inducer with a circumferential groove that were conducted at Marshall Space Flight Center (MSFC). Sub-scale water flow testing results indicate that the circumferential groove greatly reduces synchronous cavitation and subsequent bearing loads at a minimal performance cost, but the energy reappears as high order cavitation (HOC) that spans a relatively large frequency range. Thus, HOC may have implications for the full-scale OTP inducer in terms of reduced structural margin at higher mode frequencies. Simulations using the LOCI-Stream CFD program were conducted in order to explore the root physical cause of the HOC. It was found that the axial recirculation pattern in the circumferential groove causes high-swirl fluid to interact with the nearly-axial incoming fluid just above the inducer blades. The high-shear interface between the fluids is Kelvin-Helmholtz unstable, resulting in trains of low pressure regions or 'pearls' forming near the upstream edge of the groove. When the pressure in these regions becomes low enough and they get cut by the blade leading edge, HOC is thought to occur. Although further work is required, the numerical models indicate that the root cause of HOC is hydrodynamic. That is, the pearls are always present, even when cavitation is not. Comparisons to ongoing water flow experiments will be discussed, as well as predictions for the full-scale OTP inducer.