April 2011 JPM / CS / APS / EPSS /PSHS Joint Subcommittee Meeting
ABSTRACT SUBMITTAL FORM

The submission of an abstract is an agreement to complete a final paper for publication and attend the meeting to present this information. In order to ensure receipt of paper selection notification and the meeting invitation, please be sure to complete all information requested in the author and co-author information sections. Abstracts must be submitted electronically; please see submittal instructions located in the call for papers. **The deadline date for the receipt of abstracts is October 11, 2010.**

ABSTRACT INFORMATION

Title: CLVTOPS Liftoff and Separation Analysis Validation Using Ares I-X Flight Data

Submitted for consideration to: ☒ JPM ☐ CS ☐ APS ☐ EPSS ☐ PSHS

For inclusion in Technical Area: ☐ 1 ☐ 2 ☒ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8

Security Classification of Presentation: ☐ Secret ☒ Unclassified

Security Classification of Paper: ☐ Secret ☒ Unclassified

Contract Number(s) Under Which Work was Performed: Prime Contract # NNM06AA10Z Task Order #18 (NNM08AA23T)

☐ IR&D

Is this paper an update? ☐ Yes ☒ No Has it been presented elsewhere? ☐ Yes ☒ No

AUTHOR INFORMATION

Author/Presenter Name: Ben Burger

Affiliation Dynamic Concepts, Inc. (DCI) / NASA MSFC EV41

Address EV41, George C. Marshall Space Flight Center (MSFC)

City Huntsville State AL Zip 35812

Telephone 256-544-6320 Telefax

e-mail: ben.burger@nasa.gov

2nd Author: Kristina Schwarz

Affiliation Dynamic Concepts, Inc. (DCI) / NASA MSFC EV41

Address EV41, George C. Marshall Space Flight Center (MSFC)

City Huntsville State AL Zip 35812

Telephone 256-961-2313 Telefax

e-mail: kristina.d.schwarz@nasa.gov

3rd Author: Young Kim

Affiliation NASA Marshall Space Flight Center, EV 40

Address EV41, George C. Marshall Space Flight Center (MSFC)

City Huntsville State AL Zip 35812

Telephone 256-544-1438 Telefax

e-mail: young.k.kim@nasa.gov

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: Mark West

Title/Agency: EV41 Control Systems Branch Chief / NASA MSFC

Telephone Number: 256-544-1443 e-mail: mark.e.west@na Date: 10/07/10

April 2011 JPM / CS / APS / EPSS / PSHS Joint Subcommittee Meeting
ABSTRACT SUBMITTAL FORM

Unclassified Abstract
(250-300 words; do not include figures or tables)

CLVTOPS is a multi-body time domain flight dynamics simulation tool developed by NASA's Marshall Space Flight Center (MSFC) for a space launch vehicle and is based on the TREETOPS simulation tool. CLVTOPS is currently used to simulate the flight dynamics and separation/jettison events of the Ares I launch vehicle including liftoff and staging separation. In order for CLVTOPS to become an accredited tool, validation against other independent simulations and real world data is needed.

The launch of the Ares I-X vehicle (first Ares I test flight) on October 28, 2009 presented a great opportunity to provide validation evidence for CLVTOPS. In order to simulate the Ares I-X flight, specific models were implemented into CLVTOPS. These models include the flight day environment, reconstructed thrust, reconstructed mass properties, aerodynamics, and the Ares I-X guidance, navigation and control models. The resulting simulation output was compared to Ares I-X flight data. During the liftoff region of flight, trajectory states from the simulation and flight data were compared. The CLVTOPS results were used to make a semi-transparent animation of the vehicle that was overlaid directly on top of the flight video to provide a qualitative measure of the agreement between the simulation and the actual flight. During ascent, the trajectory states of the vehicle were compared with flight data. For the stage separation event, the trajectory states of the two stages were compared to available flight data. Since no quantitative rotational state data for the upper stage was available, the CLVTOPS results were used to make an animation of the two stages to show a side-by-side comparison with flight video. All of the comparisons between CLVTOPS and the flight data show good agreement.

This paper documents comparisons between CLVTOPS and Ares I-X flight data which serve as validation evidence for the eventual accreditation of CLVTOPS.