

December 2011 MSS/LPS/SPS Joint Subcommittee Meeting ABSTRACT SUBMITTAL FORM

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ABSTRACT INFORMATION

Title: Ground Vibration Testing Options for Space Launch Vehicles Submitted for consideration to: ⋈ MSS ☐ LPS For inclusion in Technical Area: 1 2 \square 3 \square 4 \square 5 \square 6 Security Classification of Presentation: Unclassified Security Classification of Paper: □ Unclassified Contract Number(s) Under Which Work was Performed: NNM05AB50C, Task Order 45-000001-CJ ☐ IR&D Is this paper an update? ☐ Yes ☒ No Has it been presented elsewhere? ☐ Yes ☒ No Is this a student paper? ☐ Yes ☐ No **AUTHOR INFORMATION** 2nd Author: Robert K. Smith Author/Presenter Name: Alan Patterson Affiliation NASA MSFC Affiliation Analytical Mechanics Associates Address Mail Code: JP60 Address 1500 Perimeter Parkway, Ste 285 City Huntsville City Huntsville Zip 35806 State AL Zip 35812 State Telefax Telephone 256-544-1116 256-544-4103 Telephone 256-830-4811, X110 Telefax 256-830-4812 e-mail: alan.f.patterson@nasa.gov e-mail: k.smith@ama-inc.com

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

New NASA launch vehicles will require development of robust systems in a fiscally-constrained environment. NASA. Department of Defense (DoD), and commercial space companies routinely conduct ground vibration tests as an essential part of math model validation and launch vehicle certification. Although ground vibration testing must be a part of the integrated test planning process, more affordable approaches must also be considered. A study evaluated several ground vibration test options for the NASA Constellation Program flight test vehicles. Orion-1 and Orion-2, which concluded that more affordable ground vibration test options are available. The motivation for ground vibration testing is supported by historical examples from NASA and DoD. The approach used in the present study employed surveys of ground vibration test subject-matter experts that provided data to qualitatively rank six test options. Twenty-five experts from NASA, DoD, and industry provided scoring and comments for this study. The current study determined that both element-level modal tests and integrated vehicle modal tests have technical merits. Both have been successful in validating structural dynamic math models of launch vehicles. However, element-level testing has less overall cost and schedule risk as compared to integrated vehicle testing. Future NASA launch vehicle development programs should anticipate that some structural dynamics testing will be necessary. Analysis alone will be inadequate to certify a crew-capable launch vehicle. At a minimum, component and element structural dynamic tests are recommended for new vehicle elements. Three viable structural dynamic test options were identified. Modal testing of the new vehicle element and an integrated vehicle test on the mobile launcher provided the optimal trade between technical, cost, and schedule.