SpaceOps 2010 Abstract Form

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Refractory concrete, ground operations, flame trench, launch pad.

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Launch Pad Flame Trench Refractory Materials

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The launch complexes at NASA's John F. Kennedy Space Center (KSC) are critical support facilities for the successful launch of space-based vehicles. These facilities include a flame trench that bisects the pad at ground level. This trench includes a flame deflector system that consists of an inverted, V-shaped steel structure covered with a high-temperature concrete material five inches thick that extends across the center of the flame trench. One side of the "V" receives and deflects the flames from the orbiter main engines; the opposite side deflects the flames from the solid rocket boosters. There are also two movable deflectors at the top of the trench to provide additional protection to shuttle hardware from the solid rocket booster flames. These facilities are over 40 years old and are experiencing constant deterioration from launch heat/blast effects and environmental exposure. The refractory material currently used in launch pad flame deflectors has become susceptible to failure, resulting in large sections of the material breaking away from the steel base structure and creating high-speed projectiles during launch. These projectiles jeopardize the safety of the launch complex, crew, and vehicle. Post launch inspections have revealed that the number and frequency of repairs, as well as the area and size of the damage, is increasing with the number of launches.

The Space Shuttle Program has accepted the extensive ground processing costs for post launch repair of damaged areas and investigations of future launch related failures for the remainder of the program. There currently are no long term solutions available for Constellation Program ground operations to address the poor performance and subsequent failures of the refractory materials. Over the last three years, significant liberation of refractory material in the flame trench and fire bricks along the adjacent trench walls following Space Shuttle launches have resulted in extensive investigations of failure mechanisms, load response, ejected material impact evaluation, and repair design analysis (environmental and structural assessment, induced environment from solid rocket booster plume, loads summary, and repair integrity), assessment of risk posture for flame trench debris, and justification of flight readiness rationale.

Although the configuration of the launch pad, water and exhaust direction, and location of the Mobile Launcher Platform between the flame trench and the flight hardware should protect the Space Vehicle from debris exposure, loss of material could cause damage to a major element of the ground facility (resulting in temporary usage loss); and damage to other facility elements is possible. These are all significant risks that will impact ground operations for Constellation and development of new refractory material systems is necessary to reduce the likelihood of the foreign object debris hazard during launch.

KSC is developing an alternate refractory material for the launch pad flame trench protection system, including flame deflector and flame trench walls, that will withstand launch conditions without the need for repair after every launch, as is currently the case. This paper will present a summary of the results from industry surveys, trade studies, life cycle cost analysis, and preliminary testing that have been performed to support and validate the development, testing, and qualification of new refractory materials.