Abstract: Orion Lighting Workaround for Maintaining Crew Circadian Entrainment

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Introduction. Light is the major environmental time cue of our endogenous circadian pacemaker. Suboptimal crew circadian entrainment (CCE) is common and associated with acute and chronic medical symptoms. Additionally, fatigue from suboptimal CCE promotes problematic use of sleep medications. The Orion Cabin Lighting System (OCLS) consists of monochromatic light-emitting diode (LED) lamps. However, light is a powerful suppressor of melatonin and it is a disruptor of CCE if used at incorrect times. A commercial off the shelf (COTS) dynamic lighting system (COTS-DLS) is a potential workaround for maintaining CCE.

Methods: A literature review aided selection of appropriate COTS-DLS for maintaining CCE. Our team conducted preliminary testing utilizing COTS lighting and developed recommended concept of operations for COTS implementation.

Results: A tunable and dimmable COTS-DLS can reduce 480 nm light peak wavelength and alter lighting temperature and intensity close to desired pre-sleep lighting specifications.

Concept of Operations: Three concept of operations were recommended based on existing studies suggesting 3 hours of pre-sleep is desired.

Discussion: COTS-DLS is a potential workaround to maintaining CCE. However, implementation requires formal testing to ensure illumination goals are met while achieving optimal lighting design and placement versus operational demands. Power capability with power utility panels (PUPs) must be achieved, and PUP use must be weighed against other competing power needs to meet operational requirements. Further testing in visual performance/color discrimination, flammability, frangibility, and off-gassing must be achieved.

Recommendation: Concept of operations 1, providing 3-hours of pre-sleep lighting with an automated COTS-DLS is recommended for optimal crew circadian entrainment due to terrestrial studies that indicate capture of the entire wake maintenance zone.