

## ASTRONAUT BONE MEDICAL STANDARDS DERIVED FROM FINITE ELEMENT [FE] MODELS OF QCT SCANS FROM POPULATION STUDIES

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### ABSTRACT

This work was accomplished in support of the Finite Element [FE] Strength Task Group, NASA Johnson Space Center [JSC], Houston, TX. This group was charged with the task of developing rules for using finite-element [FE] bone-strength measures to construct operating bands for bone health that are relevant to astronauts following exposure to spaceflight. FE modeling is a computational tool used by engineers to estimate the failure loads of complex structures. Recently, some engineers have used this tool to characterize the failure loads of the hip in population studies that also monitored fracture outcomes [1, 2]. A Directed Research Task was authorized in July, 2012 to investigate FE data from these population studies to derive these proposed standards of bone health as a function of age and gender. The proposed standards make use of an FE-based index that integrates multiple contributors to bone strength [3], an expanded evaluation that is critical after an astronaut is exposed to spaceflight [4]. The current index of bone health used by NASA is the measurement of areal BMD. There was a concern voiced by a research and clinical advisory panel [4] that the sole use of areal BMD would be insufficient to fully evaluate the effects of spaceflight on the hip. Hence, NASA may not have a full understanding of fracture risk, both during and after a mission, and may be poorly estimating in-flight countermeasure efficacy. The FE Strength Task Group - composed of principal investigators of the aforementioned population studies and of FE modelers –donated some of its population QCT data to estimate of hip bone strength by FE modeling for this specific purpose. Consequently, Human Health Countermeasures [HHC] has compiled a dataset of FE hip strengths, generated by a single FE modeling approach [5], from human subjects (~1060) with ages covering the age range of the astronauts. The dataset has been analyzed to generate a set of FE strength cutoffs for the following scenarios: a) Qualify an applicant for astronaut candidacy, b) Qualify an astronaut for a long-duration (LD) mission, c) Qualify a veteran LD astronaut for a second LD mission, and d) Establish a non-permissible, minimum hip strength following a given mission architecture. This abstract will present the FE-based standards accepted by the FE Strength Task Group for its recommendation to HHC in January 2015.

### REFERENCES

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