Technical Comments

Comment on "Radiation Shielding of Manned Mars Vehicles"

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THE solar particle radiation assumed by French[1] for a Mars mission follows a common approach of designing for the most severe conditions that have been observed. Given a sufficiently large set of observations, such an approach results in a conservatism that is desirable for factors affecting the astronaut's safety. However, rather simple considerations show that for Mars mission environments, such an approach is not valid.

To give a low probability of a dangerous radiation dose, a Mars spacecraft should have sufficient shielding to withstand a solar flare particle event of a size occurring once in several hundred years. Since data are only available for the past sunspot cycle, it is unlikely that we have seen such a large event.

The lack of data requires an approach of determining distribution functions for solar particle event frequencies, fluxes, and spectra so that extrapolations can be made to probabilities of interest. An attempt at such an analysis is given in Ref. 2. The results show that much thicker shields are required than indicated by French. Because of the thicker shields, secondaries become important, and the rem-rad relation becomes more complex. It also develops that the reliability is governed by large individual events, rather than a number of smaller events in one mission, so that the recovery factor is less significant.

References

[1] French, F. W., "Radiation shielding of manned Mars vehicles," J. Spacecraft Rockets **3**, 1544–1546 (1966).

[2] Modisette, J. L., Vinson, T. M., and Hardy, A. C., "Model solar proton environments for manned spacecraft design," NASA TN D-2746 (April 1965).

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MODISETTE'S comments point up a basic difficulty in stipulating a realistic radiation environment for long-duration missions, namely, the lack of observations over a statistically meaningful period. Extrapolation of event occurrence probabilities (such as given in Modisette's Ref. 2) to rare, giant events would appear risky, especially because the largest observed event, that of February 23, 1956, does not seem to fit standard distribution functions. Further, a criterion based on the possibility of encountering an event "of a size occurring once in several hundred years" that has never been observed, and for which there is no positive evidence of its existence, is open to some question.

I feel that with the facts at hand, it is not possible to define a "correct" approach to stipulating a radiation environment, and that each approach reflects the author's interpretation of the existing, limited data. Hopefully, by the time it is necessary to carry out more detailed planning for manned interplanetary missions, further observations will place the subject on a firmer footing.

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