SECTION 1. SCOPE

This handbook provides general engineering guidelines suitable for project groups engaged in the design of spacecraft required to operate in regions of space where they will be exposed to significant doses of radiation. The radiation environment is very variable in time and position. The natural level of radiation can be high and cause malfunctions in components. The levels can also be perturbed by man, especially by the use of nuclear or beam weapons. It is necessary for the spacecraft designer to give proper consideration to the radiation environment and its impact on design. This impact may be severe and strong guidelines on radiation effects should be followed, even in the earliest stages of system engineering.

This document brings together much of the information necessary for guidelines. However, because the different circumstances of each project give rise to very different guidelines, no attempt is made here to specify procedures except in the field of effects prediction and radiation testing. It will be up to Project Management, advised by Systems Engineering, Product Assurance and other groups, to develop the guidelines appropriate to a project.

The scope includes detailed discussion of the charged particle environment in geomagnetospheric space, the physics of radiation effects on solid-state devices and materials (including ionisation effects, single-event upsets and bulk displacement damage) in all the designs of devices likely to be used in spacecraft. Methods of assessing the impact of these effects are given, including procedures for calculating the orbital radiation environment, dose-depth curves within electronic enclosures and the end-of-life degradation of devices and circuits.

While no rigid procedures for handling these problems can be set out, special attention is given to methods of alleviating the problems presented. These methods cover trade-off studies of orbit versus shield weight, layout rules for spacecraft, the use of redundancy and housekeeping dosimetry, device selection, device verification and the design of radiation-tolerant circuits.