Technical Report No. 32-439

Flux to Dose Rate Conversion Factors for Gamma Ray Exposure

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April 27, 1963

Prepared Under Contract No. NAS 7-100
National Aeronautics & Space Administration

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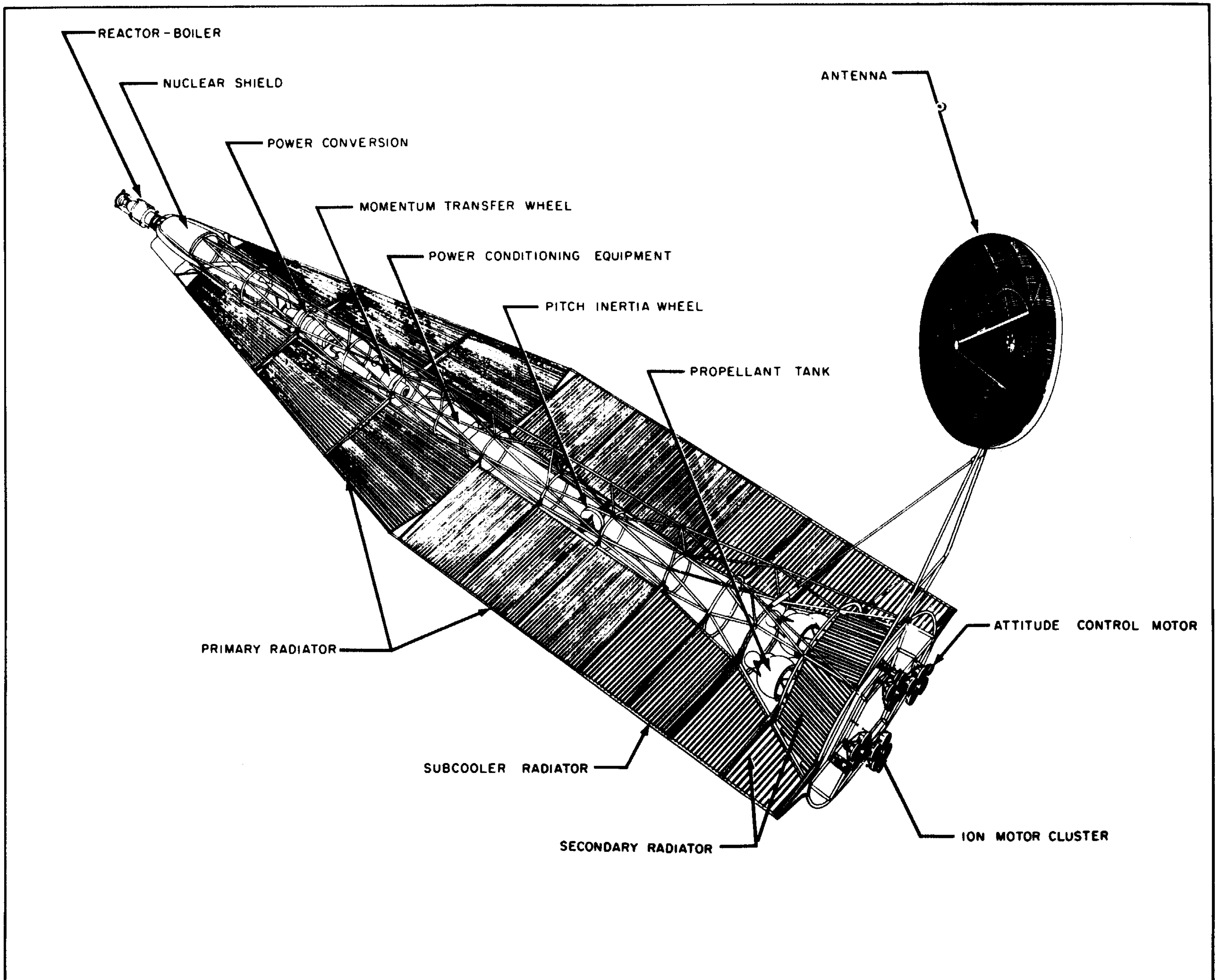

A Typical Nuclear-Powered Unmanned Spacecraft

ABSTRACT

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Conversion factors are presented in graphical form for the convenient calculation of gamma ray field strength in terms of the recommended units of exposure dose: ergs per gram, referenced to carbon.

I. INTRODUCTION

The design of a nuclear-powered space vehicle includes as an essential component, a radiation shield. The performance of such a shield must be specified both to the shield designer and to the payload designer. In the past, a wide variety of terms and methods have been employed to describe radiation and radiation effects. In an attempt to render the technical radiation effects data to be published in the future intelligible to all concerned, the Radiation Effects Information Center (REIC) at Battelle Memorial Institute has published a standard terminology for use in all REIC publications (Ref. 1). This standard is consistent with the recommendations of the ANP Advisory Committee for Nuclear Measurements and Standards (Ref. 2).

Use of the REIC standard terminology for specifying the design performance of reactor shields and also for specifying the radiation tolerance of spacecraft components will contribute to the orderly development of the nuclear-powered unmanned spacecraft required for planetary exploration.

II. REIC STANDARD TERMINOLOGY

The terminology adopted by REIC for specification of gamma ray data is as follows:

"(1) All gamma ray exposures will be reported in terms of the field, through its interaction with a reference material. The unit agreed upon is ergs per gram, referenced to carbon. The exposure dose is designated as ergs g^{-1}(C).

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"(4) Where the total energy absorption in the sample has been calculated, it will be reported.

"(5) The terms 'absorbed dose' and 'absorbed-dose rate' will be used in those cases in which the energy absorbed in a material is reported. Otherwise, the terms 'exposure dose' or 'exposure-dose rate' will be used (Ref. 1—p. 2)."

The exposure dose unit ergs g^{-1} (C) is precisely defined as "equivalent to the energy absorbed from an x- or gamma-ray field per unit mass of a limitingly small volume of carbon under conditions of electronic equilibrium. A graphite-wall CO_2 filled ion chamber is the recommended working standard for measuring radiation fields in terms of this unit (Ref. 1—p. 4).

III. FLUX TO DOSE RATE CONVERSION FACTORS

The most useful flux to dose rate conversion factors are those which relate either the number flux or the energy flux directly to exposure dose rate in terms of the standard unit.

Figure 1 is a plot of the value of the energy flux to dose rate conversion factor, ergs g^{-1}(C)/Mev cm^{-2}, as a function of gamma ray photon energy. Figure 2 is a plot of the value of the number flux to dose rate conversion factor, ergs g^{-1}(C)/photon cm^{-2}, as a function of the gamma ray photon energy.

The curves shown in Figures 1 and 2 were drawn through point values calculated from the erg g^{-1}(C) equivalent of a roentgen given by Burris (Ref. 2) and by Goldstein (Ref. 3—p. 13), and from the tabulation of the energy dependent Mev cm^{-2} equivalents of a roentgen given by Goldstein (Ref. 3—p. 17). Consistent units for time are assumed in both the flux and the dose rate, hence time units do not appear in the conversion factors.

REFERENCES

1. Radiation Effects Information Center, *Format for Reporting Radiation-Effects Data*, REIC Memorandum 10, Battelle Memorial Institute, Columbus 1, Ohio, May 15, 1959.

2. Burris, W. H., *Standard Instrumentation Techniques for Nuclear Environmental Testing*, WADC TN 57-207, WADC Materials Laboratory, Wright-Patterson Air Force Base, Dayton, Ohio, December 1957.

3. Goldstein, H., *Fundamental Aspects of Reactor Shielding*, Addison-Wesley Publishing Company, Reading, Mass., 1959.

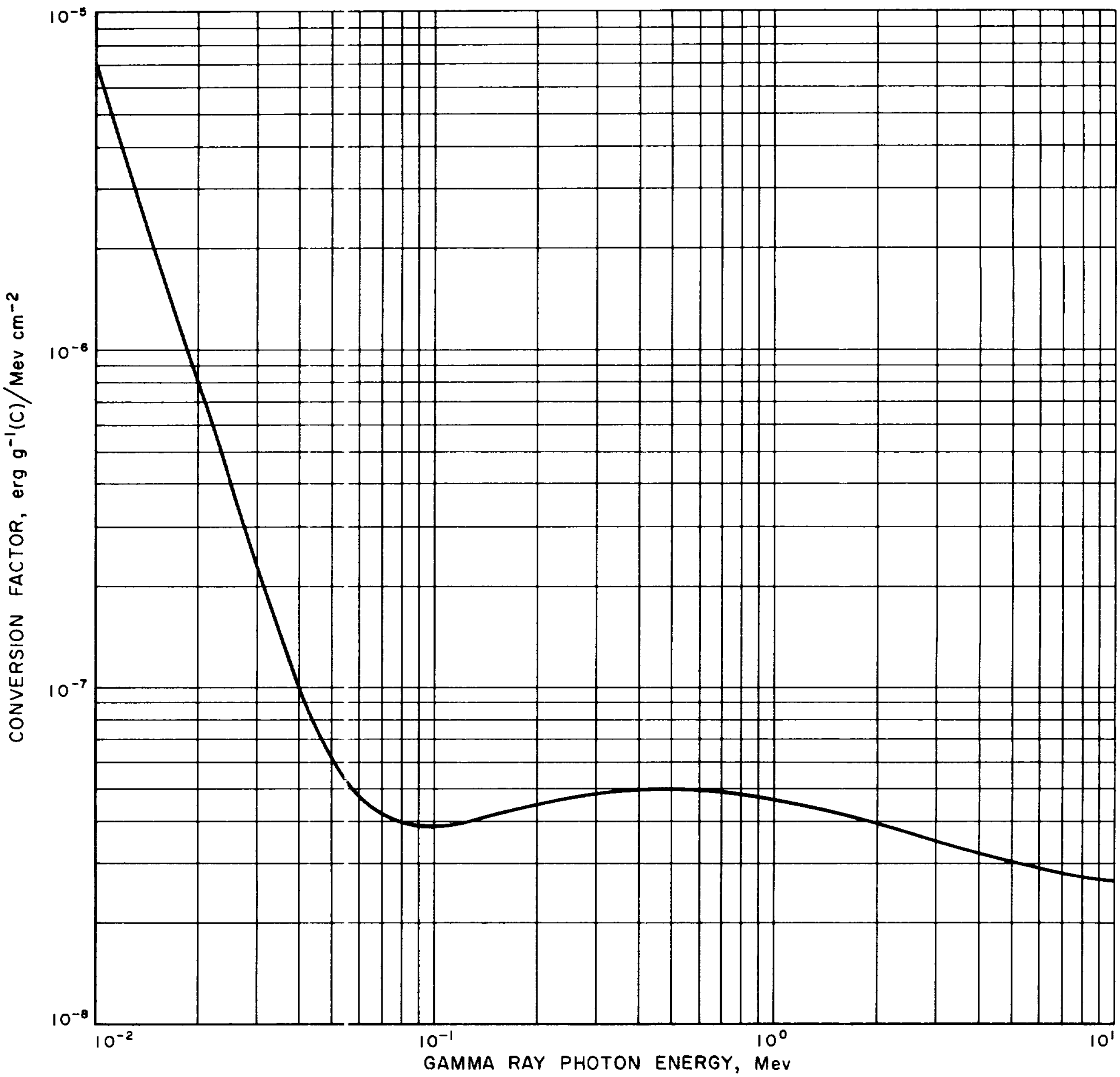

Fig. 1. Energy flux to dose rate conversion factor

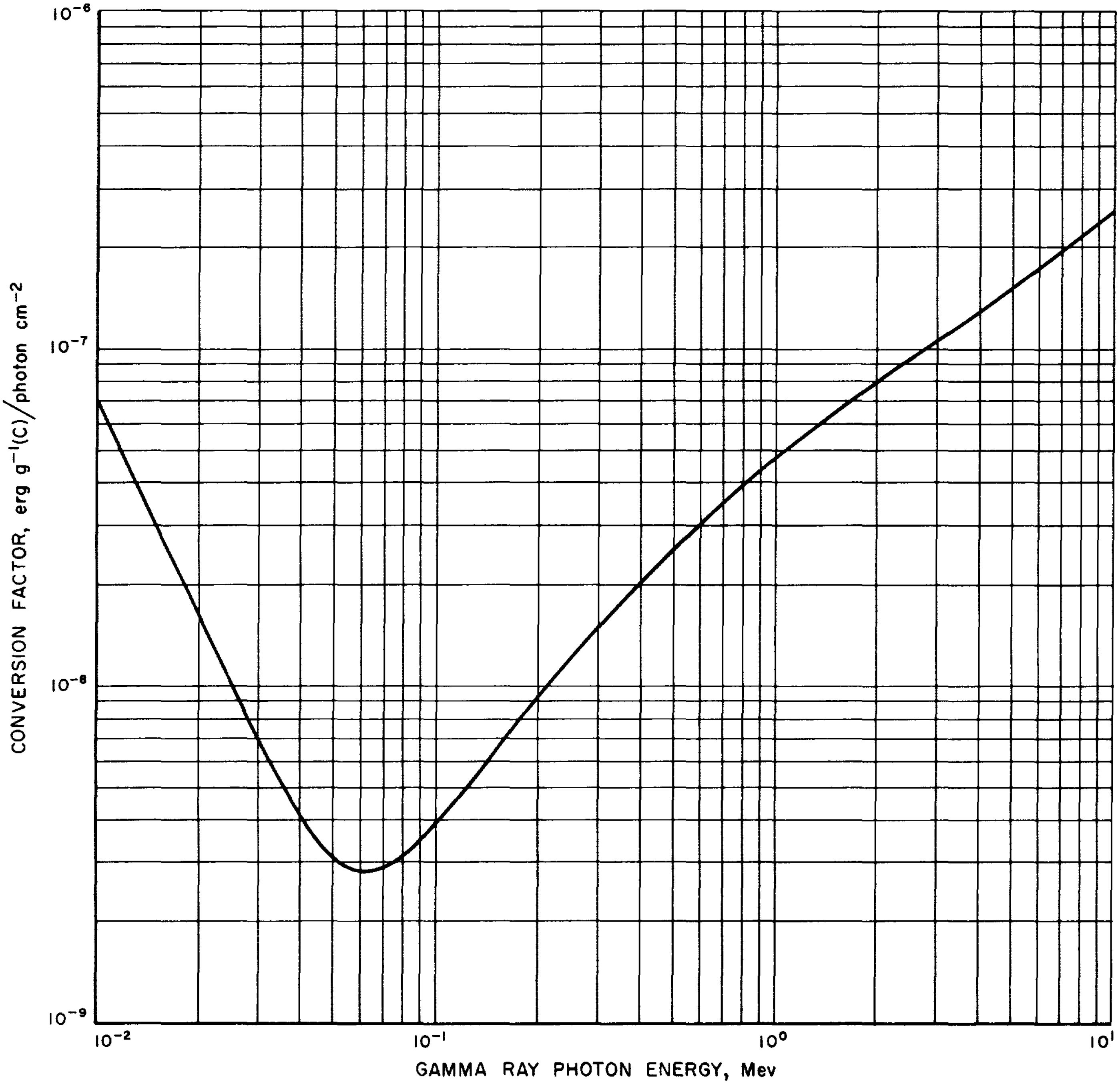

Fig. 2. Number flux to dose rate conversion factor