December 1970

Brief 70-10648

NASA TECH BRIEF

A Computer Program for Evaluating Propellant Heating and Radiation Dosage to Crews of Nuclear-Powered Rocket Vehicles

In nuclear vehicles, special problems that require evaluation are the propellant heating and the radiation dosage emitted to the crew during the operation of the reactor. Excessive heating of the propellant may produce pumping problems so that shielding, additional pressurization, or venting of the propellant may be required. In a manned stage, the radiation dosage to the crew can control the shielding requirements. In many configurations, the propellant can serve as a shield between the crew and the engine. During engine operation, however, the consumption of propellant results in a continuous reduction of this shielding.

A FORTRAN IV computer program, QADHD, was written to evaluate the propellant heating in a nuclear rocket stage and to calculate the gamma and fast neutron dosages received by a crew from the radiation emitted by the nuclear engine during the operating period. The code uses the Los Alamos Scientific Laboratory (LASL) point-kernel line-of-sight code QAD4 as a basis for its calculations. The QADHD is a combination of three codes: QAD4, QADH, and QADD. The LASL QAD4 is a general purpose program written to calculate gamma and fast neutron dosages due to a volume-distributed source in a complex source-shield geometry that is generally describable by quadratic surfaces. QAD4 employs infinite-medium buildup factors to calculate the gamma dosage and employs the Albert-Welton kernel to calculate the fast neutron dosage. The QAD4 included here was revised slightly from the LASL version to facilitate its use in the QADHD, as well as to simplify data input.

QADH utilizes the QAD4 routines to evaluate local heating throughout the propellant (and tank wall) and then integrates these heating rates over the entire volume of the propellant. Assuming that this heat is distributed uniformly throughout the propellant by natural convection, the complete-mix model enables the rate of temperature rise of the propellant to be determined. QADH then determines the total temperature rise and accumulative heat input to the propellant as a function of reactor operating time. In some nuclear rocket configurations, the propellant may serve to shield the crew from radiation emitted by the engine. In these cases, QADD utilizes the QAD4 routines to calculate biological dosage rates to the crew during engine operation, while the propellant depth in the tank (or amount of shielding the propellant provides) changes with time. QADD 10 integrates these dosage rates over engine operating time to obtain a total dosage time history.

Notes:

1. This program is written in FORTRAN IV for use on the IBM 7094 11/7044 Direct Coupling System.
2. Inquiries may be directed to:
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