9. S. O. Schriber, J. S. Fraser, and P. R. Tunnicliffe, "Future of High Intensity Accelerators in Nuclear Energy," Proc. 1977 High Energy Accelerator Conference, Serpukhov, USSR and Atomic Energy of Canada Limited, Report No. AECL-5903.

10. B. G. Chidley, et. al., "The Chalk River High Current Test Facility," Proc. 1972 Prot. Lin. Accel. Conf., Los Alamos, NM, LA-5115 (1972) p. 218.

11. J. S. Fraser, et. al., "The Chalk River Electron Test Accelerator," ibid., p. 226.

H. The TRIUMF Thermal Neutron Facility, I. M. Thorson, TRIUMF

The primary purpose of the TRIUMF Thermal Neutron Facility (TNF) is to stop the residual proton-beam downstream of the meson production targets in the main TRIUMF beamline. The nominal full current from the 500-MeV isochronous cyclotron is 100 μA; as much as 35% of this beam current is removed by the meson production targets. The remaining beam is used to produce a steady-state neutron source in a 13-cm-diam by 25-cm-long lead target of ~ 3 x 10^{15} n/s^{-1}, giving thermal flux levels of ~ 3 x 10^{12} $cm^{-2} \cdot s^{-1}$ in the surrounding H_2O and D_2O moderators. The target heat is dissipated by convection of the molten lead and nucleate water boiling at the outside of the 0.3-cm-thick stainless steel container.

The TNF is intended for use as both a neutron-beam and irradiation facility with hardware provisions for both having been installed. Two of the four neutron-beam tubes view the D_2O moderator below the lead target offset 15 cm from target centerline and at angles to the incident proton beam of 60° and 120°. The other two are offset by 30 cm from the target centerline and form a through-tube at the interface between the D_2O moderator and H_2O reflector. The access to the D_2O moderator compartment is through a 5-cm by 13-cm vertical tube from the top of the 45-cm diam by ~350-cm high H_2O moderator coolant column.

The thermal and epithermal neutron-flux distribution in the D_2O moderator has been measured by activation of gold foils, with integral proton-beam current estimated from the ^{24}Na activity induced in a thin aluminum foil mounted directly ahead of the target. The results are shown on the lateral cross-section view of the assembly in Fig. I.H-1. Measurements were also made with H_2O in the D_2O moderator tank. The comparison of these experimental results with previous calculations using the multigroup reactor code EXTERMINATOR presuming a zircalloy target canister and more recent ones for the stainless steel canister actually used, are shown in Table I. A tentative explanation for the wider distribution of thermal flux in the H_2O case and the lower flux in D_2O moderator is a harder original neutron spectrum than the fission spectrum assumed in the calculations.

The worst problem encountered during commissioning of the TNF was the evolution of radioactive mercury species from the evacuated expansion space at the top of the lead target (when the target is operated above the lead melting temperature). The saturated mercury activities of all species from mass 206 to 188 for continuous operation with a 100 μA, 500-MeV proton beam is estimated to be ~ 3 kCi. Most of the species involved have half lives of 10's of hours or less; two high yield exceptions are ^{195}Hg whose daughter ^{195}Au has a half life of 183 days and represents ~ 25% of the saturated activity inventory and ^{194}Hg with a half life of 1.3 years and ~ 10% of the total yield. Because we value the comprehensive target canister integrity monitoring capability that the vacuum condition provides, we have implemented a liquid nitrogen temperature cold trap to remove the mercury species ahead of the mechanical vacuum pump. The output of the pump is exhausted to one of two holding tanks to allow the noble gas species to decay before release to the atmosphere. Only very rough experimental measurements of the active species produced in the target have been possible so far because of the complications imposed by fluctuating proton beam intensities. As soon as steady-beam current conditions are available for extended periods, measurements will be made to confirm the empirical production cross-section values used in making the activity estimates cited above and to establish the evolution times from the molten target.

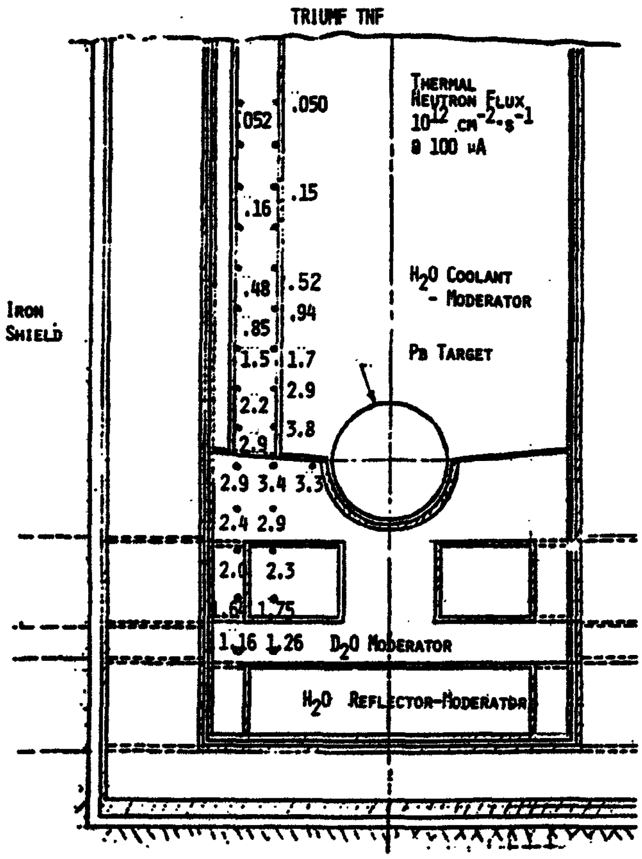

Fig. I.H-1. Measured thermal and epithermal neutron flux distributions with D_2O moderator.

TABLE I

TNF THERMAL NEUTRON FLUX

(10^{12} cm^{-2} s^{-1} @ 100 μA)

r(cm)	Calculated				Experimental	
	Al Target Can		SS Target Can		SS Target Can	
	H_2O	D_2O	H_2O	D_2O	H_2O	D_2O
11	6.6	6.6	6.2	5.1	5.5	3.3
16	2.1	6.3	2.0	4.6	4.4	3.4
21	0.56	5.1	0.55	3.9	2.1	2.9