GPU Service

TECHNICAL DATA REPORT

TDR NO. 163	REVISION NO. 0
PROJECT NO. 0021	PAGE 1 OF 8
PROJECT: TMI-2 Containment Assessment Program	DEPARTMENT/SECTION 323
	RELEASE DATE 9/8/80 REVISION DATE

DOCUMENT TITLE: Krypton Response of the Containment Entry Suit and Breathing Air System Utilizing Penetration R-626

ORIGINATOR SIGNATURE	DATE	APPROVAL(S) SIGNATURE.	DATE
M. Bryer M. Bryer	8/20/80	J.W. Langenbach	9/4/80
E. Walker E/Walker	8/20/80	J.F. Mowell	9/4/80
		APPROVAL FOR EXTERNAL DISTRIBUTION	DATE
			9/14/80

*	DISTRIBUTION
	J. Brasher P. Ruhter D. Croneberger R. Keaten G. Hovey R. Wilson J. DeVine B. Elam T. Menzel External E. Walker (Bechtel) R. Rudolph (Bechtel) R. Rider (Bechtel) M. Bryer (EB) J. T. Collins (NRC)

ABSTRACT:

An experiment was performed in the glovebox attached to TMI Unit-2 penetration R-626 to determine the krypton diffusion potential through the material of construction of the Viking Drysuit and the Bio-pack 60 breathing system. The drysuit has been selected for Unit-2 containment entry for its krypton-85 beta particle shielding characteristics. The Bio-pack 60 has been tested as the respiratory protection system for the entry team members.

Beta particle shielding experiments were performed for the drysuit and for "Beta-Guard" suit material. For the 0.670 MeV krypton-85 beta particles, both materials indicated 100% attenuation.

The Biopack 60 hose and face mask material indicated no measurable krypton diffusion for a 30 min. exposure time. The Viking drysuit material indicated a diffusion rate of approximately 2% for a one hour exposure period, assuming a concentration of .5μCi/cc krypton-85 in the glove box.

*COVER PAGE ONLY

Krypton Response of the Containment Entry Suit and Breathing Air System Utilizing Penetration R-626

TABLE OF CONTENTS

1.0 INTRODUCTION

The initial entry into TMI Unit-2 containment has been planned on the basis that the containment atmosphere will not have been cleansed either chemically or radiologically. Beta Guard, a 307 mg/cm^2 hydrocarbon compound and the Viking Drysuit, a 250 mg/cm^2 rubber coated tricot were selected to provide shielding from the krypton-85 beta radiation for the reentry team members. The Bio-pack 60 oxygen regeneration breathing air system has been considered to provide respiratory protection for the entry.

A series of experiments were performed using the facilities at penetration R-626 of the reactor building to determine the beta shielding effectiveness of the drysuit, and to determine krypton diffusion behavior through the protective suits and breathing apparatus materials.

The experiments were performed utilizing the services of the following individuals:

B&W - Lee Porter

Rad Services - Mike Pavelek,
Ralph Jacobs

Gen. Dynamics - Mark Bryer

NSS - Chip Chretien

Bechtel - Ed Walker

2.0 TEST RESULTS

2.1 Beta Shielding Factor for Protective Suits

The krypton-85 beta shielding factor for the protective

suit materials was established by inserting a series of Harshaw TLD badges encased within the material into the Unit-2 containment through penetration R-626[1]. These badges were mounted to a wire frame at distances ranging from 32 inches to 72 inches from the operating deck - elevation 347 ft. The beta doses measured through the suit materials is summarized in Table 1.

Table 1: Beta Shielding of Protective Suit Materials

Suit Material	Vertical Distance from Floor (in.)	Beta Dose Rate thru Material (Rad/Hr)
Beta Guard	32	0.0
Viking Drysuit	62	0.0
Beta Guard	72	0.0
Beta Guard	72	0.0

These results imply a beta shielding effectiveness of 100%.

2.2 Krypton Diffusion through Protective Materials.

Samples of the Viking drysuit and Bio-pack 60 materials were sealed in the lid of a special gas sample chamber. This configuration permitted the atmosphere outside the sample chamber to diffuse through the material into the chamber. The atmosphere inside the chamber was then analyzed at the end of a preselected exposure time to determine the krypton diffusion rate through the material.

The gas sample chambers were placed inside the glovebox connected to penetration R-626. Containment atmosphere was

introduced into the glovebox by opening a gate valve. The containment environment then diffused into the glovebox. Since this process was a time dependent variable, it was necessary to measure the krypton concentration at various times. This was accomplished by taking 5 ml atmosphere grab samples and measuring the krypton-85 concentration by analyzing the gamma spectrum in the sample vial. The time variation of the krypton-85 concentration inside the glovebox is shown on Figure 1.

The krypton diffusion rates through the various materials tested were based upon the time varying concentration in the glovebox.

The results of the krypton-85 diffusion measurements for the various materials are summarized in Table 2.

Table 2: Krypton Concentration thru Drysuit and Biopack Materials

Test Material	Exposure Time To Krypton-85	kr-85 Concentration thru Test Material (a)
Drysuit	10 .	< LLD
Drysuit	22	2.99×10^{-3} $\mu Ci/cm^3$
Drysuit	32.5 min.	< LLD
Bio-pack Mask	32.5 min.	< LLD
Bio-pack Hose	32.5 min.	< LLD
Drysuit	64.5 min.	$1.38 \times 10^{-2} \mu Ci/cm^3$

(a) LLD - Lower Limit of Detection

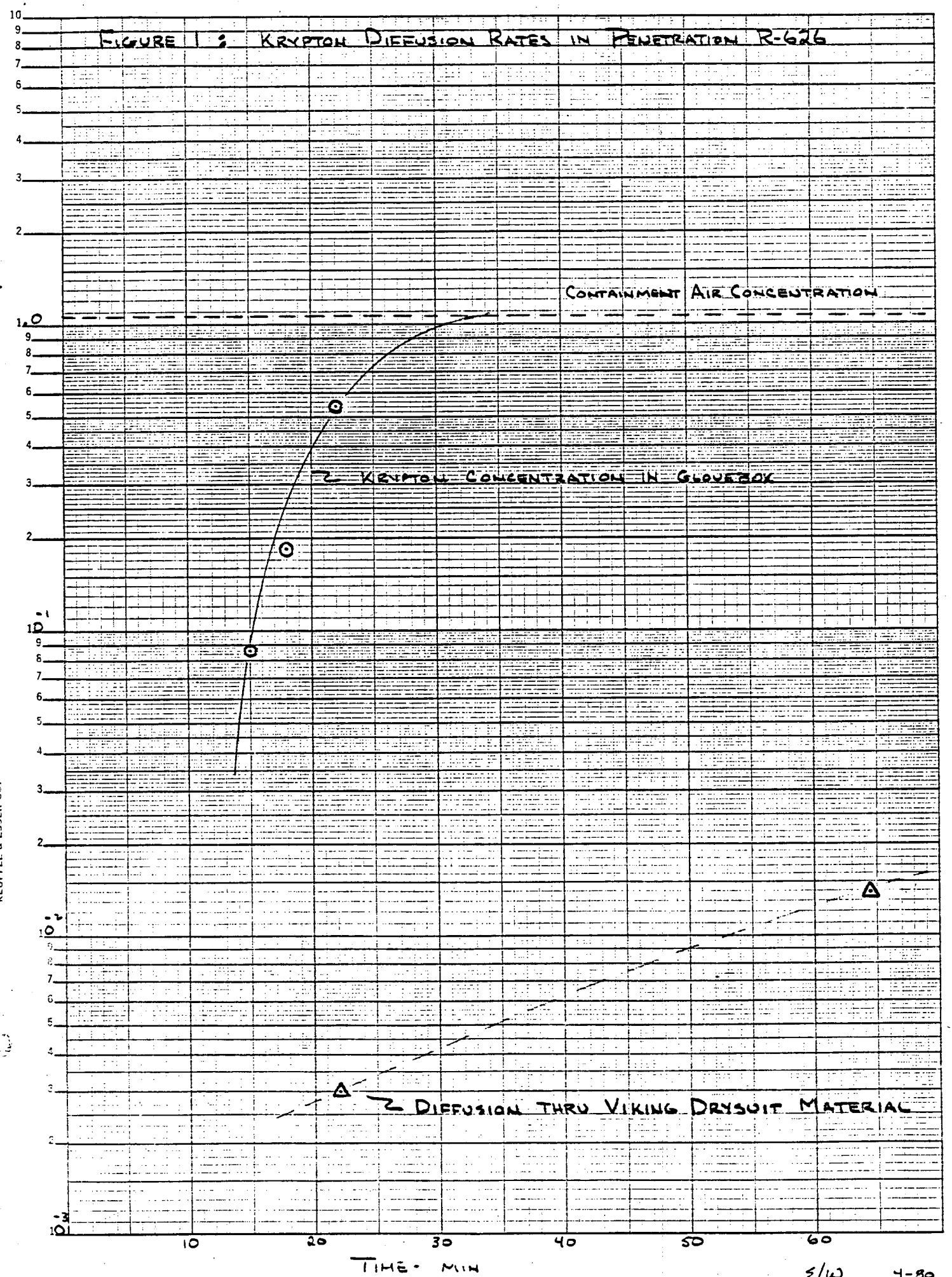
FIGURE 1: KRYPTON DIFFUSION RATES IN PENETRATION R-626
KRYPTON CONCENTRATIONS - μCi/cm³
CONTAINMENT AIR CONCENTRATION
KRYPTON CONCENTRATION IN GLOVEBOX
DIFFUSION THRU VIKING DRYSUIT MATERIAL
TIME - MIN
10
20
30
40
50
60
S/W 4-80

The Biopack-60 hose and facemask indicated no measurable krypton diffusion for a 30 minute exposure. The krypton diffusion for the drysuit is shown on Figure 1. At the end of a 22 minute exposure test, from the 22 minute to 64 minute point, the krypton-85 concentration through the drysuit material was approximately 2% of concentration in the glovebox based upon the glovebox concentration of $\sim 0.5\ \mu Ci/cm^3$ krypton-85.

3.0 DISCUSSION

The results of the beta shielding test indicated that either the beta guard (ρ=307 mg/cm^2) or the drysuit (ρ= 250 mg/cm^2) would provide effective shielding for krypton-85 beta particles. For both materials, the indicated shielding effectiveness was 100%. This is consistent with the maximum range for beta particles with endpoint energy of 0.670 MeV of ρ=240 mg/cm^2.[2]

The drysuit was chosen as the protective suit for re-entry based upon the following additional considerations:

(a) The drysuit is lighter (compare thickness)

(b) The drysuit is more flexible

(c) The drysuit is sealable for water which will minimize krypton in-leakage.

The krypton diffusion experiments indicate that beta radiation exposure to the face should not be a factor to containment re-entry personnel so long as positive pressure is maintained inside the breathing mask. No significant krypton exposure through the mask would be expected for a 20 minute stay time inside the containment building. Krypton diffusion through the drysuit should be less than 2% for the 20 minute exposure

period. A dose assessment performed assuming krypton in leakage between the drysuit and the skin resulted in a skin exposure rate of:[3]

$$D_{\beta}\ (skin) = 8.0\ Rad/HR$$

If the concentration between the suit and skin is assumed to be 2% of the concentration outside the suit the resulting dose rate would be:

$$D_{\beta}\ (skin) = 0.160\ Rads/HR$$

4.0 CONCLUSIONS

The beta shielding tests showed that either the Beta Guard material or the Viking Drysuit would be 100% effective for attenuating the 0.670 MeV krypton-85 betas.

For a 20 minute containment entry, the krypton diffusion through the Bio-pack 60 material would be negligible. The beta exposure to the skin of the face would be negligible so long as positive pressure were maintained inside the mask.

For a 20 minute containment entry, the krypton diffusion through the Viking drysuit would be approximately 2%. This would result in a maximum beta dose rate to the skin of 160 mRad/Hr during the entry program.

5.0 REFERENCES

(1) E. Walker, "Radiological Measurements of Environment Above 347' Elevation Utilizing Penetration R-626," TDR-(Draft), TMI-2 Containment Assessment Program, GPUSC, Three Mile Island Nuclear Station, July ___ 1980.

(2) Radiological Health Handbook - Revised Ed.; US Dept. of Health Education, and Welfare; Public Health Service, Rockville, Md., January, 1970., p. 123

(3) E. Walker, "Dose Rates to Individuals in Reactor Building", Bechtel Nuclear Staff Calculation No. 1020-42-13587, Bechtel Power Corp, Gaithersburg, Md., Feb. 13, 1980.