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NDL-TM-45

EFFECTS OF VEHICULAR OPERATION ON CONTAMINATED SLUSHY ROADS

Joseph C. Maloney

July 1968

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OCD Work Unit No. 3213B

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US ARMY
NUCLEAR DEFENSE LABORATORY
Edgewood Arsenal, Maryland
SUMMARY

The objective of this project (WU3213B) was to develop and test radiological countermeasures that are applicable to post-nuclear-attack recovery operations.

The specific objective of this phase of the project was to determine the effects of vehicular traffic on displacing fallout on bare roads and on packed-snow-covered roads, the build-up of activity on vehicle surfaces, and the variation of subsequent roadway decontamination effectiveness along the path of decontamination effort.

Due to weather conditions that developed at the time of both tests, the roads were covered with slush. For vehicular traffic over a radioactively contaminated slushy road and subsequent roadway decontamination, the following conclusions were established:

1. Exposure rates to operating personnel of vehicles were significantly increased due to vehicular contamination.

2. Vehicles required decontamination following operation.

3. The decontamination efforts conducted on slushy roads were much less effective than those conducted during warm or cold dry weather.
This work was authorized under Work Order No. OCD-PS-65-19, Office of Civil Defense. Related subtasks include 04-02 Decontamination, 3212A Cold Weather Decontamination, and 3214C Equipment Decontamination. The field effort was conducted during March 1965.

The author wishes to acknowledge the assistance of General Dynamics/Fort Worth in the field phase of the operation, and the assistance of staff personnel at Camp McCoy, Wisconsin, for support at the experimental site.
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1. INTRODUCTION

1.1 Objective.

The objective of this project was to develop and test radiological countermeasures that are applicable to post-nuclear-attack recovery operations.

The specific objective of this phase of the project was to determine the effects of vehicular traffic on displacing fallout on bare roads and on packed-snow-covered roads, the buildup of activity on vehicle surfaces, and the variation of subsequent roadway decontamination effectiveness along the path of decontamination effort.

1.2 Background.

During previous decontamination experiments at Camp McCoy, Wisconsin, it was observed that vehicular traffic could alter the fallout pattern on a road (Reference 1), and in some cases the decontamination effectiveness decreased along the path of decontamination (Reference 2). These previous observations were made over limited areas.

1.3 Operational Plan.

Two tests were planned at Camp McCoy, Wisconsin; one on a bare macadam road and the other on a packed-snow-covered road. After contamination of a one-half mile lane, a jeep was
to be driven at 30 miles per hour for a total of 50 miles back and forth over the lane. Then, the dry road was to be swept with a street sweeper and the snow-covered road was to be plowed with a motor grader.

2. TEST OPERATIONS

2.1 Fallout Simulant.

The fallout simulant was identical to that used in previous decontamination tests (References 2, 3, 4, and 5). It consisted of silica sand of 150 to 300 microns in diameter, tagged with lanthanum-140, and deposited at the mass level of 50 g ft⁻². A modified 10-foot wide farm seed spreader, towed by a jeep, was used to disseminate this simulant.

Details of simulant production and measurement, including instrumentation description, are contained in the above references.

2.2 Operational Narrative.

A half mile dry stretch of macadam road at Camp McCoy was contaminated according to plan for the dry surface road test, hereafter designated as Test No. 1. To establish the initial road contamination levels, cross-lane radiation intensity scans were made at 100-foot intervals at a height of 1 foot with the collimated anthracene scintillation detector (ASD). At this time, a light freezing rain started.
This turned to wet snow as the 50-mile jeep run started. At first, after each half-mile traverse over the contaminated road, the jeep was monitored in a low-background area for contamination picked up in the operation. Later, monitoring was carried out only after every second or fourth traverse.

After vehicular operations were completed, the slush-covered road was rescanned with the ASD at 100-foot intervals to determine the road contamination level at this time. Then, decontamination was begun with a rotary broom street sweeper and, because of equipment failure, completed with a hopper-type sweeper. Based on limited data from Reference 4, the effectiveness of these two units is estimated to be equal under the test conditions encountered. The final residual radiation levels on the road were again measured by ASD scans at 100-foot intervals.

Several days later the weather and snow conditions were ideal for the packed-snow road test, Test No. 2. The same stretch of road had been covered by a snowfall, and was packed by vehicular traffic. Residual activity from Test No. 1 at this time was negligible. Operations proceeded according to plan until the first vehicle runs started, at which time rising temperatures melted the hard snow surface into slush. The test continued in the slush in the same manner.
as Test No. 1. The decontamination operation, however, had to be changed from the snow plowing originally planned to sweeping with the hopper-type street sweeper.

Due to the unpredictable gross changes in the weather, the tests deviated from the plan to the effect that they became similar. The position of the contaminant - below or above the slush layer - was the only difference between the tests.

3. RESULTS AND DISCUSSION

3.1 Results.

The road contamination levels, initial, after traffic, and after decontamination, are presented in Tables A.3 and A.4. Reference 2 provides details of this data treatment and subsequent computations. The results are summarized in Table 3.1.

It should be noted that detector current is a linear function of radiation intensity, and that the shielding of deposited radioactive material by slush is estimated to be negligible. Figures 3.1 and 3.2 illustrate the road surface conditions after Test No. 1 and Test No. 2 traffic, respectively.

A statistical linear regression analysis of the data scans produced no significant evidence of anything other than random decontamination effectiveness variations.
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Figure 3.1 Road surface after Test No. 1 traffic.
Figure 3.2 Road surface after Test No. 2 traffic.

Table A.1 in the Appendix contains exposure rates due to contamination of the vehicle at several vehicle locations for Test No. 1. Table A.2 contains the exposure rates for Test No. 2. These exposure rates have been normalized from experimental conditions to a road contamination level of 1 mCi ft⁻² for direct comparison and are graphically presented in Figures 3.3 and 3.4. (Normalization of experimental data was based on data contained in Tables A.5 and A.6.) The following vehicle-location exposure rate data and other radiation exposure data of interest are presented in these figures:

A- Operator position, due to vehicle contamination.
B- Maintenance position (over front of hood), due to vehicle contamination.
C- Contamination levels at fenders and frame due to vehicle contamination.
Figure 3.3 Exposure rates for Test No. 1 normalized to 1 mCi ft$^{-2}$ contamination level.
Figure 3.4 Exposure rates for Test No. 2 normalized to 1 mCi ft$^{-2}$ contamination level.
3.2 Discussion.

From Table 3.1 it is apparent that traffic had little effect in decontaminating slush-covered roads, and decontamination by sweeping was only marginally effective. This is verified by an analysis of variance which gives no significant differences between initial and final contamination levels. The combination of traffic and sweeping effected a factor of only two in reduction of the initial contamination level. This is contrasted to the sweeping of bare roads or packed snow-covered roads under dry conditions where contamination removal by sweeping was well over 90 percent (References 4 and 6). The contamination removal was slightly better for Test No. 2 than for Test No. 1, probably because the simulant was on top of the slush layer where it was more accessible to displacement by vehicle tires.

Figures 3.3 and 3.4 show that after about 25 miles, the exposure rates from contamination on the jeep seemed to stabilize or only change slightly with time. Test No. 2 exposure rates were higher than those for Test No. 1, probably because the contaminant was more accessible to displacement by the vehicle tires. The operator exposure rate due to simulant being
retained on the vehicle was significant, particularly for Test No. 2 where it was always a significant fraction of the exposure rate expected from the surrounding infinite field. The exposure rates at the engine maintenance position were lower than those at the operator position but approached 10 percent of the unprotected open infinite field exposure. In any case, decontamination of the vehicle is indicated to be a requirement following operation on slush-covered roads.

4. CONCLUSIONS

Under the conditions of these tests, it is concluded that:

1. Exposure rates to operating personnel of vehicles were significantly increased due to vehicular contamination.

2. Vehicles required decontamination following operation.

3. The decontamination efforts conducted on slushy roads were much less effective than those conducted during warm or cold dry weather.
REFERENCES


5. Maloney, J. and Meredith, J.; Simple Decontamination of McCoy III Residential Areas; NDL-TR-33, September 1962; US Army Nuclear Defense Laboratory, Edgewood Arsenal, Maryland.

APPENDIX
FIELD DATA

TABLE A.1 VEHICLE EXPOSURE RATES FROM CONTAMINATION DURING TEST NO. 1

Note: All measurements are in mR h⁻¹.

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All exposure rates corrected for decay and normalized to contamination level of 1 mCi ft<sup>-2</sup>
TABLE A.2  VEHICLE EXPOSURE RATES FROM CONTAMINATION DURING
TEST NO. 2
Note: All measurements are in mR h⁻¹.

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All exposure rates corrected for decay and normalized to contamination level of 1 mCi ft⁻².
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VARIANCE 188.30  300.58  119.04
STD. DEV. 13.72   17.34   10.91

RATIOS
TBAR1 = AFTER TRAF / CONTAMINATED = 0.90 ± 0.403
TBAR2 = AFTER DECON / AFTER TRAF = 0.67 ± 0.301
TBAR3 = AFTER DECON / CONTAMINATED = 0.60 ± 0.259
## TABLE A-4 ASD CROSS-LANE SCANS FOR TEST NO. 2 IN UNITS OF CURRENT

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**TOTALES** 5905.50 3672.77 2712.92

**AVERAGE** 210.91 131.17 96.89

**VARIANCE** 1465.53 1260.85 604.86

**STD. DEV.** 38.28 35.51 24.59

**RATIOS**

\[ T \bar{B}_{A1} = \frac{AFTER \ TRAFFIC}{CONTAMINATED} = 0.62 \pm 0.203 \]

\[ T \bar{B}_{A2} = \frac{AFTER \ DECON}{AFTER \ TRAFFIC} = 0.74 \pm 0.286 \]

\[ T \bar{B}_{A3} = \frac{AFTER \ DECON}{CONTAMINATED} = 0.46 \pm 0.143 \]
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<th>MC/FT SQ.</th>
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**TOTALS**  | 845.20     | 102.36 | 4.40      |
**AVERAGES** | 44.48      | 8.53   | 0.38      |
**VARIANCE** | 135.25     | 0.05   | 0.01      |
**DEVIATION**| 44.48 ± 11.63 | 8.53 ± 0.23 | 0.38 ± 0.10 |
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<th>UC/GM</th>
<th>MC/FT SQ.</th>
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**TOTALS**  
748.00  110.86  3.46

**AVERAGES**  
39.37  22.17  0.87

**VARIANCE**  
94.30  0.60  0.05

**DEVIVATION**  
39.37 ± 9.71  22.17 ± 0.78  0.87 ± 0.22
EFFECTS OF VEHICULAR OPERATION ON CONTAMINATED SLUSHY ROADS

The objective of this project (WU3213b) was to develop and test radiological countermeasures that are applicable to post-nuclear-attack recovery operations. The specific objective of this phase of the project was to determine the effects of vehicular traffic on displacing fallout on bare roads and on packed-snow-covered roads, the buildup of activity on vehicle surfaces, and the variation of subsequent roadway decontamination effectiveness along the path of decontamination effort. Due to weather conditions that developed at the time of both tests, the roads were covered with slush.

For vehicular traffic over a radioactively contaminated slushy road and subsequent roadway decontamination, the following conclusions were established:

1. Exposure rates to operating personnel of vehicles were significantly increased due to vehicular contamination.
2. Vehicles required decontamination following operation.
3. The decontamination efforts conducted on slushy roads were much less effective than those conducted during warm or cold dry weather.
### Decontamination

- Roads, decontamination of
- Slushy surfaces, decontamination of
- Fallout displacement
- Vehicular contamination