RADIATION PROTECTION ASPECTS
OF THE MOVEMENT
OF RADIOACTIVE LIQUID WASTE
IN RAILROAD TANK CARS

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ABSTRACT

Liquid radioactive waste generated in Battelle-Northwest 300 Area operations is collected in storage tanks and subsequently transported to Atlantic Richfield Hanford Company facilities in the 200 Areas, about 30 miles away, for disposal. Prior to 1968, this waste was hauled in tank trucks with a capacity of 5,000 gallons each. Beginning in January, 1968, railroad tank cars with a capacity of 20,000 gallons each were used for transporting the waste. As experience was gained with the railroad tank cars, some radiological control problems arose. Control of contamination on the rail cars and in the loading area became difficult and was complicated by significant dose rates from the cars. These problems and methods devised to cope with them will be discussed.

RADIATION PROTECTION ASPECTS OF THE MOVEMENT
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INTRODUCTION

In 1961, it was recognized that the method for transporting radioactive liquid waste from the 300 Area to the 200 Areas, about 30 miles, for disposal would not be adequate indefinitely. At that time and subsequently, prior to 1968, the intermediate level radioactive liquid waste generated in what are now Battelle-Northwest 300 Area facilities was collected in tanks and trucked in 5,000 gallon loads to the disposal site. The concentration of radioactivity in the waste was constantly increasing and consequently the dose received by the drivers of the trucks was becoming significant. In the spring of 1961, the drivers were routinely receiving more than 50 mrem per trip.¹ Some additional shielding later added to the trucks reduced the dose received by the drivers. The volume of waste generated was increasing steadily and a large number of trips were necessary. As radiation levels and waste volume increased, operating costs increased markedly. Also, as waste volume increased and the number of trips increased, the potential for a contamination spread rose. Fortunately, no serious contamination spreads resulted during the time the trucks were used. On at least one occasion, however, a rather large scale spread was narrowly averted.

This paper is a report on the experience using the rail cars during the period January through September, 1968.

FACILITIES AND PROCESS

Intermediate level radioactive liquid waste generated in Battelle-Northwest facilities in the 300 Area drains from these facilities through stainless steel lines to two 15,000 gallon tanks in the 340 Building. This building consists of an aluminum walled garage area where the truck loadout equipment is located, a transite walled operating gallery, and a below-grade concrete vault containing the 15,000 gallon tanks. Additional storage tanks above grade are located immediately behind the 340 Building in the 340-A building. An open platform covered with a roof is located north of the 340 Building (Figure 1). This platform has on it the necessary lines for loading the railroad tank cars (hereafter called "rail cars"). Concrete pads with drains are located on the east and west sides of the platform. When the rail cars are in position to be loaded, they are located directly over these pads. The drains in the pads run back into the storage tanks.

The two 15,000 gallon tanks located in the underground vault contain pumps which can transfer the waste to the six 8,000 gallon storage

¹P.F.X. Dunigan and C. F. Gabel, AN ANALYSIS OF 300 AREA CRIB WASTE DISPOSAL SYSTEMS, Pgs 4 - 7, (11-15-61).

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FIGURE 1

FIGURE 1

tanks located in 340-A Building as well as into the rail cars. The 15,000 gallon tanks are also equipped with agitators for controlling heat during neutralization.

Pumps raise the neutralized waste into the rail cars. There are four 20,000 gallon capacity stainless steel rail cars. The lines on the loading platform are connected to the loading tower on the rail cars by quick disconnects positioned vertically. Two lines are attached to the cars during loading. One is used to introduce the waste into the rail cars and the other relieves the pressure and handles overflow. A rail car can be filled in approximately 60 minutes.

The dimensions of the rail car vessels are approximately 44 1/2 feet long by 9 feet in diameter. They are constructed of 7/16 inch thick stainless steel and are elliptical on the ends. The interior surfaces of the rail cars are smooth and free of corners and crevices. A system of spray nozzles inside the rail cars is used to wash down the inside as the rail cars are being emptied. Located on top of the rail cars in the middle is the loading tower through which the waste is introduced into and removed from the rail cars.

DOSE RATE PROBLEMS

One of the major problems encountered with the tank trucks was that no system existed for flushing them out. Consequently, there was a buildup of residual radioactivity inside of the tank which generally resulted in higher dose rates from the trucks when empty than when full.

Anticipating this problem, surveys were begun on the rail cars to determine if buildup of activity inside the rail cars would occur. It was quickly determined that the ends of the rail cars on the bottom were the locations where the highest dose rates were encountered. The dose rate from the middle bottom of the rail car, due to the method of loading and unloading, was in general less than that at either end on the bottom. The dose rates from these three locations on the empty rail cars were averaged by month to demonstrate the rate of buildup of radioactivity inside of the rail cars. The results are shown in Figure 2. Some months, surveys were not performed on all of the rail cars and in some cases, the data represents only one survey. However, the magnitude of the buildup is quite evident. As can be seen, since June the level has remained quite stable with the exception of rail car number 79. The reason for its being significantly different is not known.

The dose rate at ten feet from the side of the rail cars is often used as a reference. The monthly average of the dose rates at ten feet when the rail cars were empty and when full is shown in Table 1. As time has passed, the dose rates have become somewhat higher when the rail cars are empty than when they are full.

There is one situation in which the dose rate is limiting and that occurs when it is necessary to decontaminate the loading tower. If decontamination of the loading tower is difficult, the dose received by the individual performing the decontamination may be significant. Table 2 shows the monthly

FIGURE 2
Dose Rates from Empty Rail Cars #79-82 (Average of Three Measurements - Both Ends at Bottom and Middle at Bottom)

TABLE 1
Average Dose Rate at 10 Feet from Railroad Tank Cars

		<u>Empty</u> mR/hr	<u>Full</u> mR/hr
January:	Car 79	*	6
	80	*	*
	81	24	10
	82	30	38
February:	Car 79	6	4
	80	10	31
	81	20	25
	82	16	19
March:	Car 79	12	18
	80	*	12
	81	28	14
	82	22	20
April:	Car 79	24	*
	80	13	25
	81	19	24
	82	11	25
May:	Car 79	*	*
	80	*	*
	81	30	160
	82	*	100
June:	Car 79	75	26
	80	*	48
	81	*	28
	82	90	120
July:	Car 79	150	75
	80	64	51
	81	58	80
	82	85	65
August:	Car 79	126	30
	80	60	22
	81	90	60
	82	28	30
September:	Car 79	90	38
	80	35	16
	81	55	34
	82	*	*

*No Measurements made

TABLE 2

Average Dose Rate at Contact with Top of Railroad Tank Cars

		<u>Empty mR/hr</u>	<u>Full mR/hr</u>
January:	Car 79	*	65
	80	*	*
	81	180	1500
	82	260	25
February:	Car 79	50	50
	80	100	443
	81	255	40
	82	195	75
March:	Car 79	40	13
	80	*	7
	81	150	115
	82	135	38
April:	Car 79	50	*
	80	130	7
	81	80	5
	82	60	10
May:	Car 79	*	*
	80	*	*
	81	230	60
	82	*	115
June:	Car 79	700	37
	80	460	*
	81	*	50
	82	750	75
July:	Car 79	1500	*
	80	450	39
	81	365	100
	82	750	20
August:	Car 79	1100	30
	80	343	83
	81	750	105
	82	28	20
September:	Car 79	800	35
	80	300	192
	81	575	45
	82	*	*

*No measurements made

average dose rate at contact with the top of the rail cars when the rail cars were empty and when full. As can be seen, the dose rate is significantly lower when the rail cars are full except for a few early cases.

Located approximately 150 feet west of the loadout platform is the 3718 Building in which a number of individuals have offices. One of the early concerns was that the level of activity in the rail cars would be such that individuals working in the 3718 Building would experience a significant increase in radiation dose. A review of the film badge dosimeter results for a number of the individuals working in the 3718 Building during 1967 and through September, 1968, indicates that the average dose measured for 3718 Building personnel has increased by a factor of 3 or 4 but remains very low, averaging about 100 mrem/quarter. Table 3 lists the dosimeter results. All of the individuals exchange their film badge dosimeters quarterly.

The background on the side of the 3718 Building facing the 340 Building was measured periodically using film badge dosimeters placed on the side of the building. Some of the film badge dosimeters were in place 24 hours a day for an entire work week, others were put up only during day shift. Table 4 shows the results of these measurements. The results are, of course, a function of the activity taking place during the time the dosimeters were exposed.

TABLE 4

Average Background Dose Rate Measurements
on the East Side of the 3718 Building*

	<u>Day Shift Only</u> mR/hr	<u>Entire Week</u> mR/hr
1) November, 1967	.5	.6
2) November, 1967	.5	.3
3) December, 1967	.1	.2
4) February, 1968	0	0
5) March, 1968	.1	.2
6) August, 1968	.8	.7
7) September, 1968	.3	.3

*Rail car shipments began in January, 1968

Considering collectively the data in Tables 3 and 4 and Figure 2, it appears that the background dose rates in the 3718 Building may be higher with the rail cars than the trucks and that the higher dose rates may be sustained for longer periods of time.

The dose received by three members of the waste disposal group in 1967 and through September, 1968, is shown in Table 5. While the doses for

TABLE 3

Whole Body Dose Received by Selected 3718 Building Personnel*

(Dose in mrem)

<u>Employee</u>	<u>Years</u>	<u>1st Quarter</u>	<u>2nd Quarter</u>	<u>3rd Quarter</u>	<u>4th Quarter</u>
1	1967	0	20	20	0
	1968	0	40	80	
2	1967	30	40	40	60
	1968	120	140	200	
3	1967	0	20	40	30
	1968	0	70	100	
4	1967	20	30	60	80
	1968	60	150	170	
5	1967	**	20	40	90
	1968	80	210	160	
6	1967	20	50	70	20
	1968	0	150	120	
7	1967	0	40	30	100
	1968	20	60	90	
8	1967	0	0	40	20
	1968	60	110	100	
9	1967	0	0	30	20
	1968	70	70	90	
10	1967	0	50	70	30
	1968	50	80	90	
Total	1967	70	270	440	450
	1968	160	1080	1200	

*Rail car shipments began in January, 1968.

**No measurement

TABLE 5
Whole Body Dose Received by Waste Disposal Personnel
(Dose in mR)

<u>Employee</u>	<u>Years</u>	<u>Jan.</u>	<u>Feb.</u>	<u>Mar.</u>	<u>April</u>	<u>May</u>	<u>June</u>	<u>July</u>	<u>Aug.</u>	<u>Sept.</u>	<u>Oct.</u>	<u>Nov.</u>	<u>Dec.</u>	<u>Total</u>
1	1967	50	140	260	110	170	190	100	150	130	140	120	290	1860
	1968	670	110	150	60	70	120	60	50	0				
2	1967	40	70	120	70	80	210	50	130	70	180	180	140	1330
	1968	150	190	140	100	180	130	360	160	50				
3	1967	40	130	160	110	90	190	170	80	70	180	120	230	1570
	1968	270	260	200	110	170	270	100	230	160				
Total	1967	130	340	540	280	340	590	320	360	270	500	420	660	4760
	1968	1090	560	490	270	420	520	520	440	210				

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any period cannot be compared directly since these individuals work in many different situations, it does show that no large increase in dose has been experienced, except for the dose received in January--some of which is directly attributable to the use of the rail cars.

One of the more troublesome results of the dose rates existing in the area is the masking of contamination levels and the difficulty of performing release surveys. To alleviate the problem it was decided to position only one rail car at a time for loading. Also, the building containing the change room is to be moved to a lower background area and additional shielding placed around the survey station.

CONTAMINATION CONTROL

Both alpha and beta-gamma contamination are present in the waste water. The primary cause of contamination is the spilling or dripping of water during the uncoupling of the lines from the loading tower. Even though precautions are taken to assure that the proper valves are opened to allow the waste to drain out of the coupling, it has not been possible to eliminate the loss of some water occasionally when the lines are disconnected. As the lines are disconnected, the ends of the lines are placed in plastic bags containing absorbent material. The connectors are subsequently decontaminated but are left bagged in plastic at all times when not in use.

One of the methods used to externally decontaminate the rail cars is to spray them with water or steam. This washes contamination onto the concrete pads below the cars. Smearable contamination levels of 10 mrad/hr beta-gamma and 1,000 d/m alpha, and direct measurements of 25 mrad/hr beta-gamma and 20,000 d/m alpha have been encountered on these pads. Whenever contamination of the pads occurs, to ensure that contamination will not be spread by the wind, the pads are filled with water until they can be decontaminated.

One complicating factor is that the dose rates that exist make it necessary to take contamination smears into the 340 Building in order to determine the level of the activity. This is very time consuming and there does not appear to be a simple solution. Another problem is that the exterior surface of the tank part of the rail cars is rough. The rough surface tears up the media used to take a smear. In general, the rail cars are kept non-smearable on all accessible surfaces and the loading towers are maintained at less than 1,000 c/m beta-gamma and less than 500 d/m alpha, smearable.

The area around the 340 Building is designated as a Radiation Zone. Protective clothing including coveralls and shoe covering, usually rubbers, is worn when working on the rail cars. No personal clothing, other than shoes and underclothes, is worn during this work. Shoe covering is required on the grating on the east and west sides of the platform. Stepoff pad procedures for protective clothing removal are followed. Other areas on the platform and ground areas around the pads do not require protective clothing.

Because the potential for a serious spread of contamination does exist, an enclosure is to be built around the loading area on the east, south and west. This will protect the area from the prevailing winds and greatly improve contamination control.

SUMMARY

While there has been a buildup of residual radioactivity in the rail cars, it has not increased significantly during the months of July through September with the exception of rail car number 79. The reason for this increase is not known. The dose rates on the tops of the rail cars are now significantly greater when the rail cars are empty than when they are full. Since most decontamination is required when the rail cars are full, this situation is desirable. The background dose rate in the 3718 Building has increased slightly and personnel dosimeter results have increased by approximately factors of 3 or 4 but still remain less than 20 percent of the annual control of 4 rem per year when extrapolated to the end of the year.

Contamination control is complicated by the dose rates from the rail cars. Smears have to be surveyed behind a shielded enclosure inside the 340 Building. The change room is scheduled to be moved and additional shielding added so adequate personnel release surveys can be performed. The loading area is to be covered and enclosed on three sides to control contamination washed onto the concrete catch pads under the rail cars and contamination that may be spilled onto the car exterior.

The problems with the rail cars themselves include the vertical hose coupling arrangement which results in dripping and loss of some contaminated waste, and the rough exterior on the cars which makes surveys and decontamination difficult. Also, the internal decontamination spray system is not removing all of the contamination on the inside of the cars, either because it is inadequate, or because the type of decontaminating agent used is not of a type which will remove the residual contamination.

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