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A HISTORY AND DISCUSSION OF SPECIFIC RETENTION DISPOSAL OF RADIOACTIVE LIQUID WASTES IN THE 200 AREAS

By

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Chemical Effluents Technology
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Hanford Laboratories Operation
GENERAL ELECTRIC COMPANY
Richland, Washington

April 18, 1958

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A HISTORY AND DISCUSSION OF SPECIFIC RETENTION DISPOSAL OF RADIOACTIVE LIQUID WASTES IN THE 200 AREAS

INTRODUCTION

Disposal on a specific retention basis of certain radioactive liquid waste solutions emanating from separation plants has been practiced at Hanford since 1944. The employment of this type disposal has been limited to wastes which are not suitable for disposal by conventional cribbing techniques or to small volumes of non-routine wastes where construction of a crib cannot be conomically justified. In some instances (e.g. the uncribbable supernatant liquid from scavenged TBP wastes) disposal on a specific retention basis was practiced to provide tank storage space that safeguarded the continuity of operation of prime chemical processing plants.

Specific retention disposal, which utilizes the moisture retention capacity of the relatively dry soils above the regional ground-water table, has several objectionable and unevaluated features (these are discussed in detail later). For this reason, the routine use of this method for disposing of wastes containing appreciable concentrations of radioisotopes is discouraged and not recommended for any but "emergency-type" disposals. By "emergency-type" disposals is meant the disposal of any waste of marginal character that is for some reason not suitable for cribbing but for which tank storage is not readily available or cannot be justified. The practice is not applied to so-called "high level" wastes that are obviously not proper for ground disposal, but only to marginal "intermediate level" wastes that have such a chemical composition or low volume that normal cribbing practice is not feasible. Proper regulation is necessary to avoid the temptation to free expensive tank space by discharging non-cribbable wastes to relatively [illegible]p specific retention trenches. The most effective method of achieving regula-[illegible] of specific retention disposal is to acquaint personnel responsible for waste

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handling with the inherent uncertainties of this method. Such is the intention of this report.

HISTORY OF SPECIFIC RETENTION DISPOSAL AT HANFORD

The earliest instance in which a significant quantity of radioactive waste solution was discharged to a trench at Hanford involved the disposal of start-up waste containing unirradiated uranium to a trench adjacent to T-Plant in 1944. Unfortunately the volume and uranium content of the waste and size of the trench are not noted in records kept during that period. At that time it was very unlikely that specific retention came into consideration when it was suggested that this material be discharged to ground. More than likely the consequences and probability of unirradiated natural uranium reaching the regional ground water were estimated, and the disposal was found to entail little or no risk of developing into a hazard.

From 1944 until late 1953, small volumes of slighly contaminated organic solutions, retention basin sludges, and uranium-bearing start-up wastes were discharged to trenches. It was probably near the end of this period that the specific retention capacities of Hanford soils were determined and considered in appropriately sizing trenches for the volumes of wastes they were to receive.

The first large specific retention disposal of intermediate level radioactive wastes was begun in December, 1953. Several million gallons of evaporator bottoms and supernatant liquid from first cycle wastes were discharged to trenches to make tank space available for current wastes from separation plants.

The next large scale specific retention disposal was begun in August, 1956. Scavenged supernatant liquid from TBP plant wastes containing non-cribbable concentrations of Co^{60} were discharged to trenches immediately south of 200 East Area. Continued operation of the Metal Recovery Facility was dependent upon obtaining waste storage tank space within three months. The problem, however, was eliminated in early 1957 when operations at the Metal Recovery Plant were discontinued. Specific

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retention disposal of 9,000,000 gallons of "in-farm" scavenged wastes has been made since shutdown of the Metal Recovery Plant. These disposals were made to free tank space for future storage of Purex wastes. Justification for disposing of 9,000,000 gallons was based on laboratory testing of these wastes to assure the safety of the practice and to release an estimated three to four year capacity of tank storage space.

Table I lists major specific retention disposal sites in the vicinity of the 200 Areas. Other data pertinent to the disposals are also tabulated. Several minor sites have been omitted because of a lack of information on location, volumes, or radioactivity content. A summation of these omission would probably increase the totals shown by less than one percent. This table does not list disposals to ground resulting from spills, ruptured transfer lines, or other accidental causes, but is restricted to planned specific retention disposals to preconstructed pits or trenches.

The total curies of fission products put to ground on a specific retention basis represents about 28% of the total sent to all ground disposal sites in the 200 Areas. The total disposal area (3.3 acres) is the actual bottom area of the pits and trenches; the total ground surface area enclosed as radiation-zones will nominally be ten times this area.

MONITORING OF WASTES FOLLOWING SPECIFIC RETENTION DISPOSAL

Ground-water monitoring wells have been located near specific retention trenches which received large volumes of intermediate level wastes. Although this is not an infallible method for detecting contamination which might enter the regional ground water, it is the best method presently available.

A well monitoring the 241-BX-8 Grave in 200 East Area showed detectable beta-gamma contamination in ground-water samples for a period of about one month, after which the level returned to background. This is the single instance that contamination in the regional ground water can probably be attributed to specific retention

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disposal. A well to ground water was drilled through the 241-BX-2 specific retention trench within the last year. Survey instrument readings on soil samples obtained during drilling varied from 50,000 counts per minute at the bottom of the trench to zero counts per minute at the eighty-foot level. This does not necessarily indicate that contamination did not penetrate past the eighty-foot level as lateral diversion of the waste away from the well by relatively impermeable soil layers is possible, and has been noted in other instances.

DISCUSSION OF WASTE DISPOSAL BY SPECIFIC RETENTION

The term "specific retention" has been somewhat confusing because of conflicting definitions applied by the several geo-sciences. As used at Hanford, the term may be defined as that volume of water that may be disposed to the soil and be held against the force of gravity by the surface tension characteristic of the soil surfaces and pores, when expressed as percent of packed soil volume. In practice it represents the volume of liquid that may be discharged to a pit of known dimensions without leakage to the ground water, expressed as percent of the total volume of a column of soil with the same cross-section as the pit, and extending from the bottom of the pit to the water table. It is recognized that some degree of lateral spreading will occur which has the effect of enlarging the volume of soil contacted by the liquid. This is a benefit of unknown magnitude that is accepted as a safety factor.

Actually, the above definition is only applicable to a short range view of the processes involved. The most significant of the radioactive fission products with respect to hazard require a long time interval to decay to safe concentrations. For example, Sr^{90} is present in wastes disposed by specific retention in concentrations that frequently are 10^4 to 10^5 times the local limit for release to the public domain. Thus, decay alone would require as much as 400 years to reduce Sr^{90} concentrations to acceptable limits. This should be included in the definition of

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waste disposal by specific retention. That is, the volume of waste discharged to a trench should be limited to that which will not drain to the ground water for a period of time, which in some cases may be as long as 400 years. Since other processes, such as ion exchange, are active in retarding the movement of long-lived radioisotopes the actual time interval used as a basis may properly be shorter than 400 years. For example, the long lived cesium and strontium radioisotopes which constitute the major hazard in scavenged wastes are essentially completely removed by ion-exchange mechanisms. The actual period accepted for such a definition will probably be determined by Co^{60}, which shows little inclination for ion-exchange with soils from most waste solutions. On this basis a minimum retention period of about 30 years would be required.

Thus, the rate of migration of solutions through the soil for period of many years must be determined to adequately define the soil capacity for specific retention. The absence of such data requires that a conservative approach be used in applying specific retention as a waste disposal mechanism.

The local soils at Hanford, with the exception of a thin bed of wind-blown soil, were all deposited by water. At the time of deposition these materials were all saturated with water which has since drained or evaporated to leave them in their present "dry" condition. If it is possible to construct a specific retention-time relationship, the present condition of the soil must be considered as the final equilibrium condition which the soil approaches after extensive draining. The upper zone of sediments is locally called the "glacio-fluviatile formation", the fine phase of which is referred to as the "Touchet formation". The fine uniform Touchet silt comprises a major part of the soil profile under the 200-East Area, where major specific retention disposal sites are located. Special drive samples taken from this formation were analyzed for moisture content and found to contain an average of 1.95% water by weight. This represents 4.16% expressed as percent of general soil volume. It is estimated that this material was laid down about 5,000 years

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ago. The average porosity of the material was determined to be about [illegible] during the past 5,500 years the moisture content of the soil has changed from [illegible] (saturated) to its present 4.16% by volume as a result of processes of gravity drainage and evaporation. The relative importance of each of these processes is not known, but it is felt that the major part of the water movement, particularly from the lower zones, was by drainage. The small average rainfall received at Hanford is probably entirely dissipated by evaporation and utilization by plants.

In summary, the moisture retention capability of the soil varies with the time interval allowed for drainage. The relating curve must pass through the soil porosity (volume %) at zero time and approach an equilibrium moisture level after a great interval of time. The shape of the intervening curve is undoubtedly different for soils with different chemical and grain-size characteristics. The relationship would probably have to be determined empirically for each soil type. Furthermore, there is no method immediately obvious for realistically speeding up or slowing down the draining process, indicating the need for long-range investigation of the problem. If the "specific retention for thirty-year's capacity" is desired, it would take at least an interval of five to ten years to obtain data that could be reasonably extrapolated. It is felt that research of this kind is needed to define general ranges of specific retention values for the region, but it will not be practical to attempt specific measurements for each site to define exact values. It will therefore be necessary to use always a slightly conservative value in recognition of this uncertainty. In any case, results from such tests cannot be forthcoming for several years.

CONCLUSION

The present value used for specific retention capacity (1% by volume) is certainly too high to avoid the appearance of any waste material at the [illegible] if retention for a minimum of 30 years is required. Although the [illegible]

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of wastes underground very probably increases the trench capacities to increase the safety of present practices, the difficulties in evaluating the extent of spreading and the variations in spreading at different sites present a degree of uncertainty in this disposal method which dictates the use of a more conservative capacity factor. Therefore, a value of 5% by volume is recommended for specific retention application until unknowns associated with this disposal method can be more completely evaluated. This 5% volume is felt to be a generally conservative value that recognizes the uncertainties resulting from poorly defined physical characteristics and lack of more certain information regarding the mechanism. In addition, continued discrimination against disposing of wastes by this method, even under the more restrictive conditions, is recommended.

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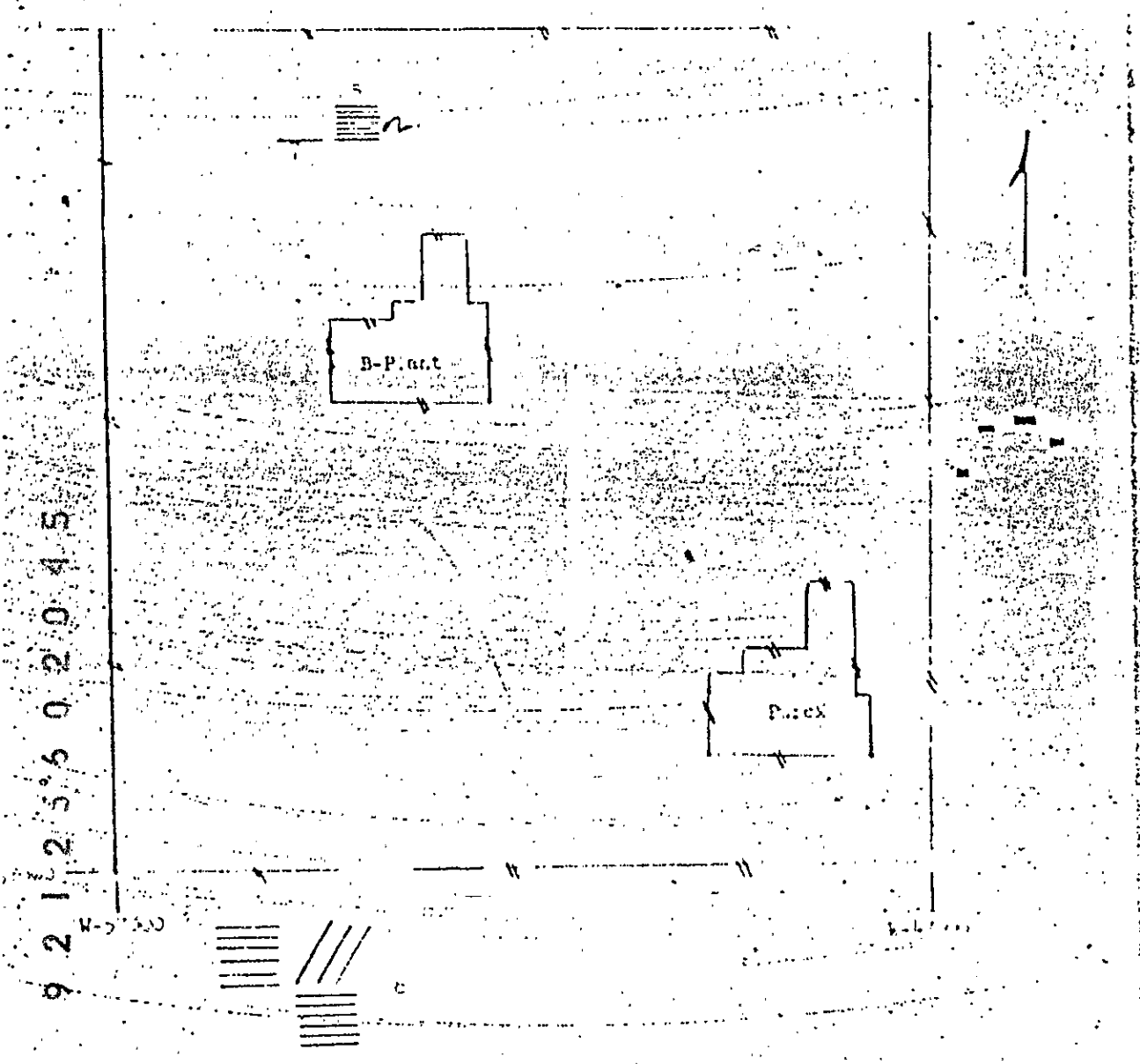

SPECIFIC RETENTION DISPOSAL SITES
200 EAST AREAS

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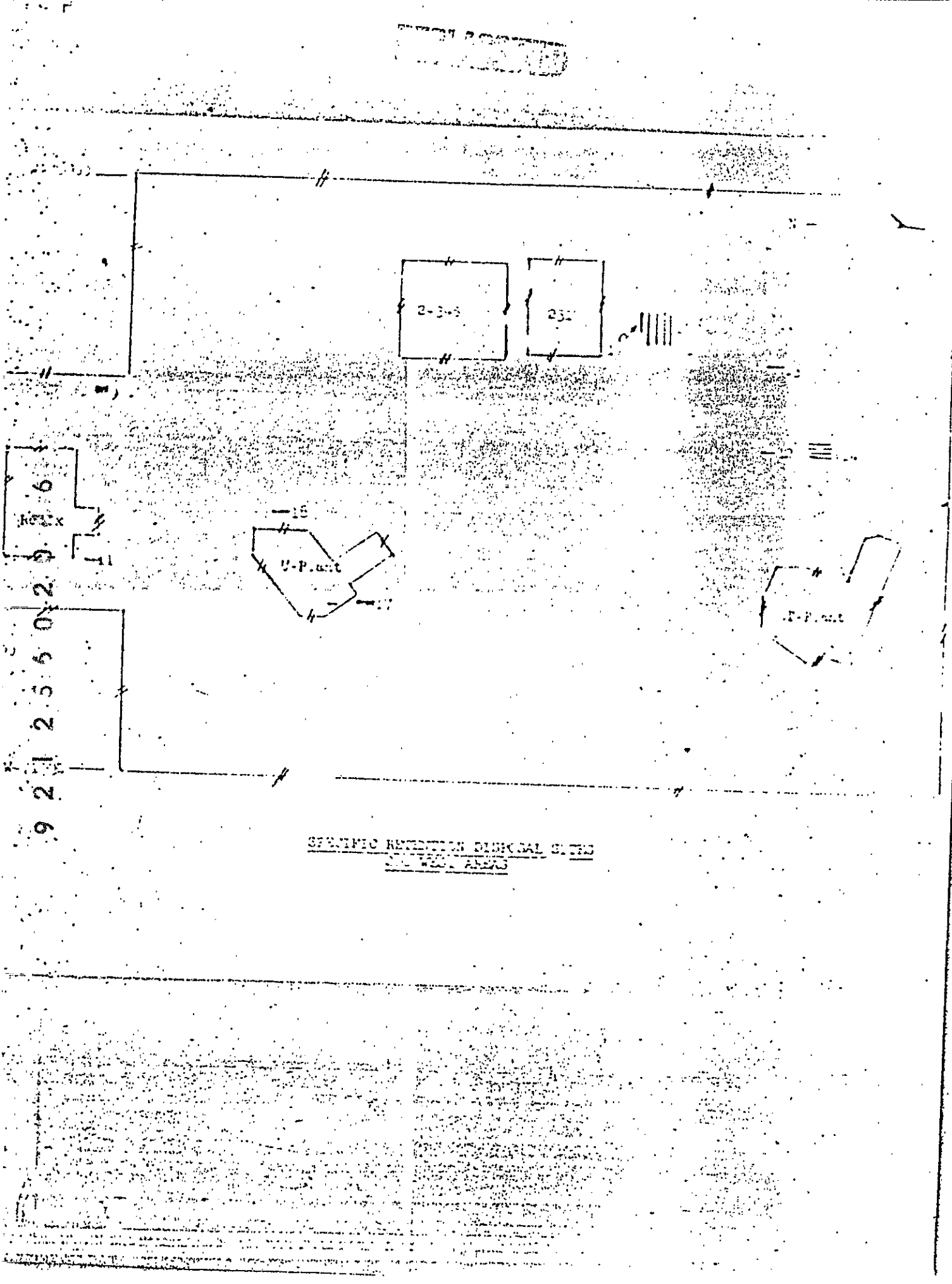

SPECIFIC RETENTION DISPOSAL SITES

TABLE I

SPECIFIC RETENTION DISPOSALS OF SEPARATI

Map Code	Year	Disposal Site(1)	Type Of Waste	Disposal Volume (gallons)	Disposal Area (ft^2)	Bottom Loading (gal/ ft^2)	De G W (
1.	1955	216-A-1 crib (abandoned)	Cold start-up uranium	26,400	400	66	
2.	1955	216-A-18 Grave	Cold start-up uranium	130,000	625	208	
3.	1955	216-A-19 Grave	Cold start-up uranium	300,000	6,400	47	
4.	1955	216-A-20 Grave	Cold start-up uranium	25,400	625	40	
5.	1953 -54	241-BX-1,2,4,5,6,7 Graves	First-cycle supernatant liquid	2,380,000	15,000	159	
6.	1954	241-BX-3 Grave	First cycle bottoms	1,130,000	2,500	450	
7.	1955	241-BX-8 Grave	TBP scavenged supernatant liquid	400,000	4,000	100	
8.	1956 -57	216-BC-7 thru 22 trenches	TBP scavenged supernatant liquid	17,213,000	75,000	230	
9.	1951	Redox "cold" aqueous grave	Cold start-up uranium	81,500	6,000	14	
10.	1952	Redox "cold" organic grave	Uranium-contaminated solvent	20,000	800	25	
11.	1954	291-S-stack-wash grave	Stack-wash water	20,000	1,800	11	
12.	1954	207-T sludge grave	Retention basin sludge	--	150	--	
13.	1955	216-T-5 grave	Second-cycle supernatant liquid	700,000	500	1,400	
14.	1954	216-T-1,2,3,4, graves	First-cycle supernatant liquid	1,000,000	11,000	91	
15.	1954	216-TX-1,2,3,4, graves	First-cycle supernatant liquid	1,330,000	11,000	121	
16.	1954	216-TX-5 grave	First-cycle bottoms	793,000	1,800	440	
17.	1952	221-U uranium grave	Cold start-up uranium	1,190,000	6,270	190	
18.	1957	221-U organic grave	Contaminated solvent	21,000	300	70	
			TOTALS	26,700,300	144,170 (3.3 acres)		

(1) Site terminology corresponds to that used in HW-43121, "Tabulation Of Radioac
(2) 100% specific retention corresponds to a bottom loading of 0.75 gallons/ft^2/f normally referred to as a specific retention of 10% of the soil volume.
(3) Where no entry is made in a column, the value was not reported, the analysis
(4) These wastes were evaluated for ground disposal prior to trenching, and a bet
(5) This waste was routinely cribbed, therefore a bottom loading greatly exceedi

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TABLE I

SPECIFIC RETENTION DISPOSALS OF SEPARATION'S WASTE

Waste	Disposal Volume (gallons)	Disposal Area (ft^2)	Bottom Loading (gal/ft^2)	Depth To Ground Water (ft.)	Percent(2) Specific Retention Capacity	Beta Curies	Plutonium (grams)	Uranium (lbs.)	Cs^{137} (curies)	Sr^{90} (curies)
uranium	26,400	400	66	268	33.	--(3)	--	335	--	--
uranium	130,000	625	208	256	109.	--	--	3,050	--	--
uranium	300,000	6,400	47	252	25.	--	--	56,000	--	--
uranium	25,400	625	40	252	21.	--	--	886	--	--
pernatant	2,380,000	15,000	159	250	85.	7,800	4.75	218	3,700	2,150
ottoms	1,130,000	2,500	450	250	240.(4)	3,190	.91	8	3,070	16
super-	400,000	4,000	100	250	54.	4,800	--	--	96	1,040
super-	17,213,000	75,000	230	320	96.	590,000	28.	4,500	7,000	5,380
uranium	81,500	6,000	14	180	10.	--	--	430	--	--
inated	20,000	800	25	215	15.	--	--	1	--	--
ter	20,000	1,800	11	200	8.	5	--	--	--	--
in sludge	--	150	--	220	--	1	--	--	--	--
supernatant	700,000	500	1,400	200	932.(5)	125	175	--	--	--
upernatant	1,000,000	11,000	91	220	55.	3,30	3	212	2,350	38
upernatant	1,330,000	11,000	121	200	80.	19,300	6	27	4,990	136
ottoms	793,000	1,800	440	200	293.(4)	14,200	1	2	8,890	4
uranium	1,190,000	6,270	190	230	110.	--	--	1,600	--	--
solvent	21,000	300	70	220	42.	7	--	--	.031	.023
	26,760,300	144,170 (3.3 acres)				642,728	218.66	97,269	30,096	8,764

t used in HW-43121, "Tabulation Of Radioactive Liquid Waste Disposal Facilities", by H.V. Clukey
to a bottom loading of 0.75 gallons/ft^2/ft. of soil above ground water. This value is
retention of 10% of the soil volume.
the value was not reported, the analysis was not run, or the concentration was below detection limits.
und disposal prior to trenching, and a bottom loading of 1,000 gal/ft^2 was determined to be permissible.
therefore a bottom loading greatly exceeding the specific retention capacity was permissible.