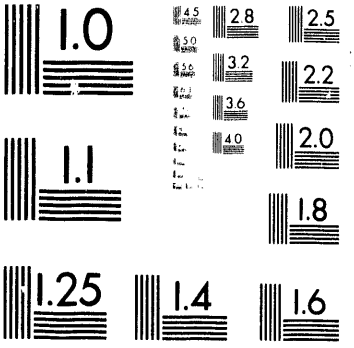
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REVIEW OF EFFLUENT DISPOSAL PRACTICES IN N REACTOR DEPARTMENT

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REVIEW OF EFFLUENT DISPOSAL PRACTICES IN N REACTOR DEPARTMENT

INTRODUCTION

A survey has been conducted of current methods of disposal of radioactive, chemical, and sanitary wastes used both at the 100 Area and 300 Area sites of N Reactor Department Operations. In addition, liquid storage facilities have been surveyed for situations which might result in river water pollution. The survey and this report have been prepared in response to the request of the Manager, Richland Operations Office of the Atomic Energy Commission[1] in accordance with Executive Order 11258.

An audit of N Reactor Department waste disposal procedures and practices was recently made by the RLOO.[2] The audit report provides detailed data on effluent streams, methods, and sampling points. Therefore, this report does not include that information and instead provides a summary of experimental and analytical data which have become available since the audit. It also includes information developed in response to specific provisions set forth in the Executive Order.

CONCLUSIONS

The following conclusions were reached regarding waste disposal as practiced at the 100 and 300 Area Operations of the N Reactor Department.

Radioactive Waste Disposal - 100-N Area

At the point of entry to the Columbia River, no effluent streams contain concentrations of single radionuclides in excess of AECM 0524 limits for release to uncontrolled areas, with one exception. Ground water from the 1301-N waste disposal crib sampled at the river bank contains I-131 in excess of the foregoing limit. However, by the time river water reaches D Reactor Area some two and one-half miles downstream, the I-131 concentration is about one one-hundredth of the limiting concentration.

Chemical Waste Disposal - 100-N Area

The main potential source of stream pollution by chemical discharge from the N-Reactor Plant is the release of spent water treatment chemicals. In general, these materials are diluted with the cooling water discharged to the river. It is concluded that these streams do not normally contain any substances in concentrations which constitute a substantial hazard to health.

However, limiting concentrations have not been clearly established for three release situations. These involve resin regeneration chemicals, backwash from turbidity filters, and spillage of water containing organic corrosion inhibitors. Further evaluation will be made.

All but one of the chemical and fuel storage facilities are diked or otherwise arranged to prevent river pollution in the event of gross spillage. The exception is the 163 Building caustic and sulfuric acid tanks which could drain to the river if accidental spilling occurred. Any possibility of river pollution from these sources can be eliminated by construction of a catchment basin at an estimated cost of $10,000.

Sanitary Waste Disposal - 100-N Area

Sanitary waste disposal performance was surveyed. No contribution to river pollution was found.

Waste Disposal - 300-N Area

The Fuels Section of NRD makes no final disposal of liquid effluents. All liquid waste streams, sanitary, chemical, and radioactive are transported to the Douglas-United Nuclear Plant on the same site for processing and final disposition. Liquid storage tanks are so arranged that tank rupture or accidental drainage would not lead to river water contamination. It is assumed that effects of the final disposition of NRD wastes will be reflected in the response to Executive Order 11258 to be made by the Douglas-United Nuclear Company.

DISCUSSION

Radioactive Effluent

There are two main paths for the release of liquid effluents from the N Reactor site to its surroundings. These are the flow through the ground to the Columbia River and the flow through the main cooling water return to the river. These two flow paths will be discussed in detail in the paragraphs which follow.

Ground Water Flow

In general, all waste water containing significant quantities of radioactivity is discharged to the 1301-N waste disposal crib. It subsequently filters through the earth, joins the ground water, and flows to the Columbia River. This method of disposal provides delay time for radioactive decay of the nuclides present. Some elements are essentially permanently retained in the soil.

The specific streams presently discharged to the 1301-N radioactive waste disposal crib are:

(1) Control rod cooling water

(2) Primary loop purity bleed

(3) Rupture monitor sample water

(4) Primary loop spill

(5) Moderator cooling loop bleed

(6) Fuel storage basin overflow

(7) Miscellaneous flow and hot lab drains

(8) Process tube diversion water

The total input rate averages about 2500 gpm. The radioactivity in these streams is normally from activation products. Following fuel element ruptures fission products are usually present in the crib influent.

The concentrations of radionuclides in the 1301-N crib influent are given in Table I based upon radioanalysis of samples taken between July and October, 1965. The mean values in Table I are based on grab samples and therefore reflect the limitations inherent in that sampling method.

TABLE I

Nuclide	Concentration μCi/ml AEC Appendix 0524 Limits	Mean Value Crib Influent	Concen. Range Minimum	Maximum	No. of Samples
I-131	3×10^{-7}	3.5×10^{-5}	6×10^{-7}	3.1×10^{-4}	17
Sr-90	3×10^{-7}	5.2×10^{-7}	1.2×10^{-7}	1.5×10^{-6}	4
Cs-137	2×10^{-5}	4.8×10^{-6}	4.5×10^{-7}	3.2×10^{-5}	18
P-32	2×10^{-5}	1.7×10^{-6}	5.2×10^{-7}	1.6×10^{-6}	5
Ba-140	3×10^{-5}	2.7×10^{-5}	$1. \times 10^{-6}$	$1. \times 10^{-4}$	19
Co-60	5×10^{-5}	1.8×10^{-5}	1.4×10^{-6}	$1. \times 10^{-4}$	19
Fe-59	6×10^{-5}	6.1×10^{-5}	$1. \times 10^{-6}$	2.7×10^{-4}	13
Mn-54	1×10^{-4}	8.2×10^{-5}	$6. \times 10^{-6}$	$9. \times 10^{-4}$	19
Zn-65	1×10^{-4}	5.7×10^{-6}	$2. \times 10^{-7}$	4.5×10^{-5}	13
Zn-95	6×10^{-5}	3.5×10^{-5}	$4. \times 10^{-6}$	1.4×10^{-4}	15
Cr-51	2×10^{-3}	5.2×10^{-5}	$6. \times 10^{-6}$	1.2×10^{-4}	13
As-76	2×10^{-5}	3.4×10^{-4}	$5. \times 10^{-10}$	1.4×10^{-3}	10
Na-24	2×10^{-4}	1.8×10^{-4}	2.3×10^{-6}	3.9×10^{-4}	14

Table I shows that the nuclides reported are present in concentrations which do not exceed permitted levels for release to uncontrolled areas with the exception of I-131, Sr-90, Fe-59, and As-76. Since all other nuclides are within specification in the crib influent, they are assumed to likewise fall within the permissible limits in the ground water drainage to the river and therefore those nuclides will not be considered further. The nuclides with concentrations exceeding the allowable levels at the crib inlet will now be discussed in detail.

Sr-90 is known to be strongly adsorbed on clay minerals in the soil and by the time ground water from the crib reaches the river, the Sr-90 concentration is expected to be reduced by a factor of about four hundred.(3) (4)

The mean iron-59 concentration at the crib inlet is at the limit and filtration in the crib is expected to reduce the concentration well below that level. The pH of the crib influent is on the basic side of neutral, and this is expected to promote the coagulation of iron and improve its filtration properties.

As-76 is generally present as an anion and based upon published adsorption data,(5) sufficient transport time passes so that radioactive decay will eliminate this nuclide before it reaches the river bank. This view is supported by an analysis of river bank effluent from the 1301-N crib in which As-76 could not be positively identified.(6)

The remaining nuclide, I-131 still exceeds the Appendix 0524 limit at the river bank. Because of this, I-131 concentrations in river bank seepage have been extensively monitored. The mean concentration was 2×10^{-6} µCi/ml in 183 samples taken during the period, October 1, 1965, to January 31, 1966. The source of the iodine is mainly fuel element ruptures. It is the only nuclide in N Area effluent which at a point of entry into the Columbia River is known to exceed AEC Appendix 0524 limits for release to uncontrolled areas. When dilution by river water flow is assumed, the I-131 concentration is reduced to levels which are well below the limit. Research personnel of Battelle Northwest Laboratories suggest that for stream bank entry at N Area, adequate dilution may be conservatively assumed by the time the D Area pump intake (about two and one-half miles downstream) is reached.(7) Based upon mixing with 1 percent of the stream and a 14-year average of the Columbia River flow of 132,000 CFS, the river bank concentration would be reduced by a factor of more than one-hundred. This reduces the concentration to less than 2×10^{-8} µCi/ml or more than an order of magnitude below the limit.

In a mixture of radionuclides, the ratios of actual concentrations to maximum permissible concentration must be summed, and this ratio must be equal to or less than unity in order to conform with the limits. The sum ratio formed from the crib influent analysis exceeds unity. Complete analytical data on the ground water are not currently available; however, when the influent concentrations are considered along with same degree of river dilution as assumed for I-131, the ratio will be more than an order of magnitude below the limit.

Direct Discharge to the Columbia River

The major quantity of liquid discharged from the N Reactor is the cooling water returned to the river through the outfall system. Some of the flow is released near river bank, but most of it is discharged into the main channel of the river. The latter stream contains some radioactivity because 109-N steam generator blowdown is mixed with it. The source of the activity is weepage of primary coolant at the tube sheets in the steam generators. Analyses of samples taken at the south seal well in the main outfall line are given in Table II. It will be seen that individual concentrations of all reported nuclides are within the permissible limits for unrestricted drinking water usage. However, the sum of the ratios of actual concentration to maximum permissible concentration for each nuclide was found to exceed unity. But the individual concentrations are very low and the test data in almost every case was reported by the analytical laboratory as "less than" the stated numerical value. Because of this limitation in the analytical data and because it is not reasonable to expect significant activity in this stream, it is our conclusion that the activity contribution above background made by this stream does not exceed the AECM 0524 limits for unrestricted usage.

TABLE II

Nuclide	Concentration μCi/ml AEC Appendix 0524 Limits	Mean Value River Effluent	No. of Samples
I-131	3×10^{-7}	2.4×10^{-7}	9
Sr-90	3×10^{-7}	4.3×10^{-8}	2
Cs-137	2×10^{-5}	$4. \times 10^{-7}$	6
P-32	2×10^{-5}	2.6×10^{-7}	3
Ba-140	3×10^{-5}	1.7×10^{-6}	9
Co-60	5×10^{-5}	3.4×10^{-6}	9
Fe-59	6×10^{-5}	$5. \times 10^{-7}$	6
Mn-54	1×10^{-4}	2.3×10^{-7}	5
Zn-65	1×10^{-4}	3.2×10^{-7}	9
Zn-95	6×10^{-5}	7.6×10^{-7}	5
Cr-51	6×10^{-5}	$1. \times 10^{-5}$	8
As-76	2×10^{-5}	5.8×10^{-6}	5
Na-24	2×10^{-4}	8.2×10^{-6}	7

Chemical Discharges

The liquid discharge streams from the N-Area Plant to the environs have been surveyed for their potential for creating a chemical pollution hazard.[8] Liquid streams can discharge into the Columbia River at four locations. These

locations are: (1) at the end of the flume from the outfall structure, (2) through a 102-inch pipe from the outfall structure, (3) through a 36-inch overflow pipe and flume from water storage tanks, and (4) a 42-inch gravity drain line from the 182 Building basement. The first and last two streams terminate at the shoreline of the river; the second pipe line ends in the main channel of the river.

Streams (3) and (4), the 36-inch overflow and 42-inch gravity drain would only be used intermittently and present no pollution potential. The 36-inch line is an overflow drain from four water tanks, and its use is infrequent. Small, intermittent raw water discharges are also released through this stream from the 182 Building, a water pumphouse. The only appreciable source of chemicals which might enter this stream are those present in treated water in an afterheat removal water storage tank, and only if the tank overflows or is drained, an infrequent occurrence. Therefore, this stream will be discussed in a later section of this report, which treats spillage from storage.

The 42-inch pipe is an emergency drain line furnished to prevent flooding of critical equipment in the unlikely event of the rupture of a major raw water line in the 182 Building basement. The drain is also used for small intermittent discharges from 182-N sumps. Only incidental trace chemicals are normally present in this stream, and concentrations are considered too low to constitute pollution.

The remaining two streams, the flume and pipe line, do receive appreciable chemical discharges. The major source of potential chemical pollutants are those generated in the water treatment plant. Spent chemicals drain to these lines and are diluted by the plant cooling water effluent which is returned to the river through these lines. The 102-inch line normally returns about 300,000 gpm of cooling water, mainly from the 109 Building dump condensers. The concrete flume releases about 100,000 gpm of cooling water from the primary pump drive turbine condensers and the turbine generator set. The make-up of these two streams has been reviewed and the conclusion reached that no chemicals are routinely or continuously discharged in concentrations cited as hazardous in the Public Health Service Drinking Water Standards.[9]

There are, however, two intermittent discharge streams about which certain qualifications are indicated. These streams are spent regeneration chemicals from water treatment resin beds and the backwash from turbidity filters.

The regeneration chemicals are sulfuric acid for cation resins and sodium hydroxide for anion resins. At the peak sulfuric acid flow, the acid concentration at the 102-inch river discharge is conservatively estimated to be about 60 ppm. The sodium hydroxide concentration would be about 8 ppm. The chemical discharges occur four to eight times daily for periods of 30 to 90

minutes each time. The maximum range of pH is 5.5 to 9.0 and should be near the extremes for only a few minutes. McKee and Wolf in "Water Quality Criteria"[10] report that a pH range of 6.5 to 8.5 is safe for all forms of life, but do not delineate pH values clearly known to be hazardous. The effects of very brief intermittent discharges are not discussed.

The solids backwashed from the water filter plant result in a temporary turbidity level at the end of the effluent flume which exceeds finished drinking water standards. The filter plant backwash is released to the river at the shore for about seven minutes, once per shift. The solids are an alum produced floccule along with solid matter removed from the river water by the filtration process. The concentrations of dissolved chemicals, mainly aluminum sulfate, are within Public Health Service limits.[9]

Neither of these discharges are believed to constitute a substantial hazard to health, and therefore do not conflict with the requirements of Executive Order 11258. However, a more specific interpretation of the regulations as applied to this matter will be sought.

In the course of making the survey for this report, three additional sources of intermittent chemical discharge were found. The actual health hazard has not been clearly established, but preventative action can be taken at a relatively small cost. The first source is a chemical sump in the 108 Building. This 1000 gallon sump is emptied by an eductor once every two weeks. This is accomplished in about 20 minutes. Under the worst circunstances with the pit full of concentrated sulfuric acid, the effluent from the shore discharge could contain about 1000 ppm of the acid. The installation of a simple orifice restriction to reduce the rate of discharge will eliminate the problem. The second source is the dummy decontamination tanks. These tanks may be drained to the river about once per month. Simple operational procedures can prevent any pollution problem and these procedures will be instituted. The third source is once through cooling water which is used during certain infrequent reactor maintenance operations. Sodium sulfite is added for corrosion control, and the water could contain up to 120 ppm. By dilution with other cooling water streams, the level can readily be reduced to less than 10 ppm.

Spillage From Storage

A complete survey of the potential for stream pollution by spillage of chemicals and fuels has been made.[8] All fuel tanks are properly diked. All chemical storage is done in such a manner that gross spillage would not result in pollution hazardous to health with the exception of caustic and sulfuric acid storage in the 163 Building. One 10,000 gallon tank of 50 percent caustic and one 10,000 gallon tank of 93 percent sulfuric acid are involved. In case of accidental spillage, these chemicals would drain to a sump and automatically be pumped into the outfall line to the center of the river. In order to eliminate the possibility, drainage could be provided from the tank area to a new catch basin constructed west of the 163 Building. The estimated cost of the facility is $10,000.

Accidental spillage of large quantities of secondary system condensate might be regarded as a potential pollutant. This water is stored in a one-half million gallon tank. Overflow or spillage would drain to the river through a 36-inch overflow pipe and flume. Corrosion inhibiting chemicals are present in the water in the amount of 1 to 2 ppm morpholine and 50 to 100 ppb hydrazine. An occasional, temporary, process control upset could result in the doubling or tripling of the foregoing concentrations, but the entire tank would not be subject to such fluctuations. Owing to the toxic nature of this class of organic compounds, there is a possibility that spillage from this tank would be hazardous to some aquatic life. Safe concentration limits for these compounds were not available at the time of the preparation of this report. Considering the circumstances and low concentrations, it is doubtful if a substantial pollution hazard exits; however, a further investigation will be made.

Sanitary Waste Disposal

The sanitary wastes from 100-N Area discharge to three septic tanks and associated drainage systems. Table III shows the required capacity using the standard design criteria of 50 gallons/person in a 24-hour period and the existing installed capacity.[11]

TABLE III

Building	Required Capacity	Installed Capacity
182-N	250 gallons	1000 gallons
163-183-B	250 "	1000 "
1903-N	8750 "	10,000 "

Ground water samples have been analyzed for coliform bacteria, and results are given in Table IV. The sample points are located on the river bank and intercept the drainage route from the sanitary tile field.

TABLE IV

Sample Point	Coliform
N-SP-1	0
N-SP-2	0
N-SP-3	0

Based upon these data, it was concluded that sanitary waste disposal at N Area does not cause pollution of the Columbia River.

300 Area Operations of NRD

The Fuels Section of NRD makes no final disposal of liquid effluents.[12] All liquid waste streams: sanitary, chemical and radioactive are transported to the Douglas-United Nuclear Plant on the same site for processing and final disposition. Liquid storage tanks are so arranged that tank rupture or accidental drainage would not lead to river water contamination. A detailed discussion of final disposal methods is assumed to be part of the response to Executive Order 11258 to be made by the Douglas-United Nuclear Company.

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