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Industrial Radioactive Waste - Bulletin #5

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Industrial Radioactive Wastes
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New Regulations for Radioactive Wastes

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Summary:

This bulletin describes the West Valley Plant of Nuclear Fuel Services, Inc. which extracts and holds the waste products of atomic industries. These operations will have to be altered under a new AEC ruling concerning Buttermilk Creek and may be influenced in the future by the adoption of new standards for radioactive contamination of surface waters in New York State. We explain the resulting changes in the handling of wastes, and find that they are practical and beneficial to the public. In addition, two radioactive substances are apparently released from the West Valley Plant without provisions for treatment: they are radioactive krypton gas (in air) and tritium (in water). The West Valley Plant is neither equipped nor paid to treat these wastes now, but technology and money will have to be found to do so, if atomic industries are to grow as planned in the next decade.

1. The work of the West Valley Plant.

The plant of Nuclear Fuel Services, Inc. in West Valley, New York, reprocesses spent fuel elements for nuclear reactors. The "spent" fuel is not gone, but rather too dirty to work properly. The dirt is a byproduct of nuclear fission and contains unwanted radioactive elements. The plant cleans and sends back the fuel; the radioactive wastes are supposed to be stored on site, partly as buried solids, but mostly as a liquid ("high level radioactive wastes") in leak-proof tanks.

The cleaning process uses various chemicals and water. The chemicals are salvaged and reused. The water is cleaned by distillation and chemical treatment, then collected in a holding lagoon ("low level radioactive wastes"), and eventually released to a creek.

The technical achievement of the plant is impressive and will be explained.

The figures in Table I are in curies except for one entry in counts per minute (cpm)*. They show that the West Valley Plant takes out and stores several hundred thousand curies of long-lasting radioactive wastes every month.

*A popular explanation of units of radiation and their biological effect is found in J. M. Fowler's "Fallout" (Basic Books, N. Y., 1960). A picocurie (pCi) is 10^{-12} curies. The hazard of drinking a given amount of curies varies from one isotope to the next. For example, the difference between the hazard of tritium and that of strontium-90 is the reason for the difference in allowable limits shown in Table III.

(The figure can not be converted more precisely into curies without some additional information.) Only a fraction of the stored material - less than two curies in terms of gross beta activity - is released monthly into the creek. Overall, the plant holds back all the uranium, all the plutonium, and all but one part in one hundred thousand of various other radioisotopes found in the wash water (isotopes of zirconium, columbium, strontium, cesium and others).

There remain three serious problems, also shown in Table I. First, the plant discharges into streams 1.3 curies of long-lasting radioactive substances for each processed batch of 10 tons of fuel (we are looking at emitters of strong beta radiation, such as Sr-90 and Cs.-137, and not at tritium). The plant already processes more than 10 tons of fuel a month, and its production is expected to increase, leading to a continuous and growing radioactive contamination of two streams and a lake.

Second, the cleaning process apparently does nothing to keep tritium out of the discharged water. Initially, tritium is scarce compared to other radioisotopes; at the end, the discharged water has 230 times more curies of tritium than it does of gross beta emitters (tritium radiation is too weak to register on the gross beta count -- this unfortunately does not mean that tritium is harmless when it is in the body, as indicated by the limits shown in Table 3).

Third, the cleaning process releases krypton-85 directly into the air at the time when the fuel cartridges are cut apart. This gas is released at a rate of some 30,000 curies a month, carrying away about 1 part in ten of the radioactive waste taken out of the spent fuel.

We stress that these three types of discharge do not indicate any present hazard to human health, either in the neighborhood of the plant or elsewhere. The real problem is a long range one, of accumulating environmental pollution from a growing industry.

2. What the plant is asked to do by the AEC.

The Division of Licensing of the AEC rules on the principles of operation of the West Valley plant (while the day-to-day safety is supervised by the AEC Division of Compliance, as reported in RCSI Bulletin #4). On May 31, 1968, the Division of Licensing tightened the ground rules. A letter from Mr. McBride advised the N.F.S., Inc., that Buttermilk Creek is to be considered a public stream, where previously it was considered relatively inaccessible to the public. The letter also reminded NFS, Inc. that the official limits for radioactive substances in water must not be used as "normal operating points". Normal discharges of radioactive waste should be below the official limits by a margin that allows for "transient abnormalities".

The AEC limits are shown in Table II, and the impact of the new ruling on the West Valley plant is shown in Columns 2 and 3, Table III. The flow rates of streams in Table III are the average annual flows of Buttermilk Creek and Cattaraugus Creek, which were given in the original license application for the construction of the West Valley plant. Some of the current readings (Table I) suggest that Buttermilk Creek may reach this rate of flow (41 cu.ft/sec) in the spring, and average less for the rest of the year, but the figures are certainly correct within a factor of two. Table III shows that the new AEC ruling forces the plant to make only small changes in operations for the present, but makes a major change necessary for future expansion.

It would be possible for the plant to discharge wastes at the 1967 rate and still comply with the standards, simply by mixing the wastes more evenly with Buttermilk Creek water. The Office of Atomic and Space Development, which manages the state lands around Buttermilk Creek, can easily convert a stretch of the creek into a dammed, securely fenced mixing pond attached to the West Valley plant. Mixing and dilution are always the cheap answer to waste disposal.

This answer is not enough in the long run. a) It is useless from the standpoint of conservation, since it does not change the total amount of pollution; b) The resulting concentrations are already impractically close to the limit; c) When production increases, as it must, there will not be enough water in Buttermilk Creek to dilute the wastes. The alternate answer is to clean up the wastes before dumping them. Fortunately, this is precisely the business of the plant.

The fluid presently discharged from the West Valley plant into Frank's Creek and hence into Buttermilk Creek is probably a direct discharge of the low-level wastes stored in the plant lagoon (Table I). It seems that some cleaning process will have to be inserted between the lagoon and the outlet pipe. We found that exactly such a process was described by N.F.S., Inc. in their application to build the plant. We quote (Par. II, 1.414):

> "A general purpose evaporator is provided in the tank farm area for reducing the volume of low level wastes. It is backed up by an ion exchange unit for the condensate. The overhead product is expected to be water, sufficiently pure to be discarded to Buttermilk Creek".

The new AEC directive apparently asks only for the kind of performance that was included in the planned design of the West Valley plant. If the plant adds a standard process for taking Sr-90 and similar beta emitters out of the low-level radioactive wastes, and the process is only 95% effective (the usual effectiveness is better than 99.9%), then production can be increased tenfold and there will still be a margin of safety for the discharge of radioactive wastes during periods of low water flow (Table III). Under such conditions, the discharge of wastes into the creek would probably be limited only by the concentration of tritium.

3. <u>What the plant is asked to do by the New York State Department of Health.</u>

New standards for the control of radioactive materials in surface waters were proposed on June 6, 1968 by Dr. Ingraham, Commissioner of Health of New York State, (Table II). The proposal was submitted to the State Water Resources Commission, and if adopted will put the Commission on the job of controlling the radioactive contamination of the environment independently of the A.E.C. It is the opinion of the R.C.S.I. that Dr. Ingraham's proposal fills a pressing need. R.C.S.I. Bulletin #4 showed that two distinct tasks go under the label of control of radioactive wastes. One is the industrial safety task of protecting public health, which is done by the AEC. The other is the conservationist task of preserving a clean environment. This is provided for by Dr. Ingraham's proposal, which would provide for the control of radioactive pollution by the New York State Water Resources Commission.

The proposed standards for New York State surface waters (Table II) permit more radioactive contamination at the peak of fallout than that which was found in the state at the peak from nuclear weapons tests, but are lower than the current AEC standards for the discharge of wastes. State and Federal standards would not be in conflict, but would rather supplement each other. AEC standards apply to the effluent in an area where public access is unrestricted - such as water flowing out of a power plant culvert into Lake Ontario. The State standards, in turn, apply to the open public water - such as Lake Ontario. We expect the State proposals to spell out provisions for a mixing zone for radioactive materials, just as they do for hot water discharges.

The impact of such standards on the West Valley plant can be estimated from Table III, Column 4. Let us assume first that the State regulating agencies classify a stretch of Buttermilk Creek as a mixing zone for wastes, so that the standards are applied to the confluence of Buttermilk and Cattaraugus Creeks. This would put the outlet of Buttermilk Creek within the AEC limits for radioactive contamination, as was suggested in previous RCSI bulletins, and Cattaraugus Creek under the new State limits. The amounts of waste material that could be carried away by Cattaraugus Creek under such rules (Column 4, Table III) are practically the same as those permitted by the AEC rules. This imposes no special burden on the West Valley plant, as explained in Par. 3 of this report.

Can the lower end of Buttermilk Creek rate a special classification by the State? RCSI Report #4 shows that this would not be proper unless some work were done on the creek banks and fences. The operators of the New York State Western Nuclear Service Center, which owns the creek, would have to control the overflows, channel or otherwise confine the outlet, and secure the mixing zone water against public access.

If these measures are not taken and the new State standards are applied to Buttermilk Creek, the West Valley plant may have to close. The limits on radioactive wastes discharged into the creek would then be the ones in Table III, Column 5. The West Valley plant could probably keep Sr-90 down to such standards, as explained above (See Page 3), but excessive discharge of tritium would become a problem. The plant is not equipped to remove and store tritium. Plant operations would have to be kept at or below the 1967 level, and this could put the plant out of business.

4. Grounds for future action.

A big share of electrical energy produced in the state of New York will soon come from nuclear fuel. This fuel has to be either reprocessed or buried. From the standpoint of conservation, fuel reprocessing is high on the list of the most desirable industrial operations. The engineering criteria for this judgement were developed by A. Spilhaus (Scientist and Citizen, Nov.-Dec. '67, p. 219). Spent nuclear fuel is reprocessed by a waste-recycling industry, as contrasted to waste-releasing industries. The industry operates in the most desirable way, by collecting wastes at the source. It helps keep the environment clean in two ways: by salvaging fuel and by storing pollutants. This not only cleans up the wastes from atomic piles, but also reduces two other sources of radioactive pollution - the mining and refining of uranium fuel. The RCSI points out the need for the reprocessing of spent nuclear fuels by the best possible process (in terms of environmental contamination) which is feasible. We have not looked into the much broader question of nuclear power versus coal power, and do not take a stand on this question.

The cost of containing radioactive wastes is an essential part of the cost of nuclear fuel, and will have to be paid by the users and the promoters of this fuel: the power companies, the AEC, the New York State Office of Atomic and Space Development and ultimately the consumer.

We suggest that the following additional waste-disposal services are in the public interest, and should be purchased from Nuclear Fuel Services, Inc. as soon as feasible:

1) An improvement in the extent of removal of Sr-90 and related radioactive wastes, which is described in this bulletin. We note that equipment and know-how are already available, and we endorse Federal and State regulations which make this improvement mandatory.

2) In the next few years, provisions should be made to capture and hold the radioactive noble gases which are now released into the air. Only prototype processes are now available (charcoal adsorption, cryogenics), and commercial equipment and processes have yet to be developed.

3) If at all possible, tritium should be taken out of the spent fuel. It appears economically hopeless to separate tritium from waste water. We do not know how much tritium is concentrated in the fuel element and what can be done to contain it. As shown in this report, the answer to this question will determine the maximum size to which the West Valley plant may grow.

We note that answers to (2) and (3) must be found before the world-wide growth of atomic industries puts a new kind of fallout into all the air and all the oceans, and cancels the gains of the atomic test ban.

TABLE I

OPERATION OF THE WEST VALLEY REPROCESSING PLANT IN 1967

Sources of spent fuel	Four nuclear reactor installations	Indian Point, New York Dresden in Morris, Ill. Yankee in Rowe, Mass. New Production Reactor in Richland, Wash.
Amount of spent fuel processed	12-15 tons per month (b,d)	
Solid radioactive wastes stored	2,200 curies per month (b)	1,900 curies per 10 tons of fuel
Additional radioactivity in liquid storage	3.5×10^{17} cpm/month (c) Hundreds of kilocuries per month (c)	
Releases into the environment:		
radioactive gas (Kr-85)	29 to 33 kilocuries per month (a,b)	28 kilocuries per 10 tons of fuel (b)
liquid effluent	2.6 - 2.8 million gallons per month (b,a)	1 million gallons per 10 tons of fuel (b)
tritium in the liquid effluent	410 curies per month (a)	
gross beta emitters in the liquid effluent	1.6 - 1.8 curies per month (b, a)	1.3 curies per 10 tons of fuel (b)
Average concentrations of "low level radioactive wastes" held on site:		
- gross beta emitters		110,000 - 200,000 pCi/1 (a)
- strontium-90		49,000 - 60,000 pCi/1 (a)
- tritium		50×10^6 - 56×10^6 pCi/1 (a)
Concentrations of released beta emitters (gross beta):		
- computed average concentration in released liquid effluent		0.6 curies per million gallons 170,000 pCi/1 (b,a)
- computed average concentration added to Buttermilk Creek, based on estimated flow of 41 cu. ft. per sec.*		500 - 640 pCi/1 (b,a)
- measured total concentration in Buttermilk Creek (N.Y. State Survey)		average - 606 pCi/1 (b) high - 2,600 pCi/1 (b)

TABLE I (Part 2)

Concentrations of released beta emitters (gross beta) (Continued)	
- computed average concentration added to Cattaraugus Creek, based on estimated flow of 358 cu. ft./sec.*	60 - 70 pCi/l (b,a)
- measured total concentration in Cattaraugus Creek downstream from Buttermilk Creek (NFS data)	average - 98 pCi/l (a) high - 250 pCi/l (a)
- measured total concentration further downstream at Springville Reservoir (N.Y. State Survey)	average - 75 pCi/l (b), 108 pCi/l (e) high - 315 pCi/l (e)
Concentrations of Strontium-90	
- measured in Cattaraugus Creek downstream from Buttermilk Creek (NFS data)	average - 31 pCi/l (a)
- measured further downstream at Springville Reservoir (NFS data)	140 pCi/l (a)
(N.Y. State Survey)	average - 44 pCi/l (f) high - 93 pCi/l (f)

Periods Covered

(a) January through September '67
(b) April 20 through June '67
(c) July through December '67
(d) October through December '67
(e) January through March '67
(f) December '66 through April '67

References

Nuclear Fuel Services, Inc. documents, AEC Public Document Room, Docket No. 50-201:

- Quarterly Report, Aug. 14, 1967 (b)
- Quarterly Report, Jan. 29, 1968 (c,d)
- Environmental Report, January 24, 1968 (a)
- License Application Parts I and II (*)

R.C.S.I. Industrial Radioactive Waste Report #2 (summary of N. Y. State Radiological Health Survey Bulletins) (e,f)

TABLE II

OFFICIAL LIMITS FOR AVERAGE CONCENTRATIONS OF RADIOACTIVE MATERIALS IN WATER

Material	AEC limit for discharge in an uncontrolled area*	Proposed N.Y. State limit for surface waters
Tritium	3×10^6 pCi/l	2×10^5 pCi/l
Strontium-90	300 pCi/l	20 pCi/l
Gross beta emitters (other)	3000 pCi/l	1000 pCi/l

*The limit for single samples is two times the limit for the average.

TABLE III

DISPOSAL OF RADIOACTIVE WASTES IN PUBLIC WATERS

1. Radioactive isotope in water	2. Discharge from West Valley Plant in '67 (Table I)	3. AEC limit for disposal in water flowing at 41 cu. ft. per sec.	Proposed N.Y. State limit maximum amount that can be carried away by stream	
			4. flowing at 358 cu.ft. per sec.	5. flowing at 41 cu.ft. per sec.
Tritium	540 curies/month	8,500 curies/month	4,900 curies/month	560 curies/month
Strontium-90	0.4 - 0.6 curies/month	0.85 curies/month	0.5 curies/month	0.056 curies/month
Gross beta emitters	1.6 - 1.8 curies/month	8.5 curies/month	24 curies/month	2.8 curies/month

Columns 3 and 5 represent Buttermilk Creek
Column 4 represents Cattaraugus Creek