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RADIOACTIVE EFFLUENT REDUCTION

FROM 200 AREA FACILITIES

PHASE II

By

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Waste Management Process Engineering

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FROM 200 AREA FACILITIES

PHASE II

A. INTRODUCTION

A comprehensive study of radioactive wastes discharged to the environs in the 200 Areas was made in 1967⁽¹⁾. A follow-up study was completed in 1971⁽²⁾. Both studies found that gaseous waste emission guides⁽³⁾ were being met for the discharge of radioiodine, mixed fission products, ^{238}U , ^{239}Pu , and ^{90}Sr from the 200 Area facilities.

Significant reductions of radioactivity to the ground have also been realized by changes in operating procedures and minor expenditures of funds for process and equipment improvements. However, several waste streams continue to discharge the major quantity of plutonium and/or total beta emitters to the ground. Recommendations have been made to provide facilities and/or modifications to existing facilities which will reduce the radioactivity discharged via these streams.

B. SUMMARY

It is recommended that funding be provided to:

1. Stop discharges of plutonium to the ground in liquid wastes from the Plutonium Finishing Plant (Z Plant). Aqueous wastes would be routed to the 242-T waste evaporator facility, neutralized and evaporated to salt cake. Carbon tetrachloride would be recovered from Z Plant spent organic extractant and the degraded organic phosphate residue stored for subsequent disposal by incineration. Funds have been appropriated for the capabilities above. Additional funds will be required to provide a liquid waste organic incinerator to dispose of Z Plant and other liquid organic wastes.
2. Route Purex Plant ammonia scrubber wastes to an existing waste concentrator for decontamination by evaporation. The waste concentrator bottoms would be routed to underground storage tanks. The overhead condensates, containing less than one percent of the initial radioactivity, would be routed to an existing crib.

3. Prevent abnormal radioactivity discharges via selected low-level, high-risk effluent streams. Funds would be used to provide radiation monitoring, flow measurement, sampling and diversion to underground tank storage for 244-AR Vault cooling water, and B Plant steam condensate, process condensate and cooling water.

Further major reductions in the radioactivity discharged to the ground could be realized if funding were available to provide routine recycle of Purex Plant process condensate, and for radiation monitoring, volume measurement, sampling and diversion to underground storage tanks of Purex Plant steam condensate. Cost to benefit ratios are high since the period of beneficial use, prior to scheduled shutdown of certain facilities, is short.

C. GASEOUS WASTE REVIEW

Annual discharges of radionuclides to the atmosphere in gaseous wastes from 1967 through 1971 are presented in the table below.

TABLE I
RADIOACTIVITY IN GASEOUS WASTES
DISCHARGED TO THE ATMOSPHERE
IN THE 200 AREAS

	Volume ($\times 10^{11}$ Ft ³)	Total Beta (Curies)	Total* Alpha (Curies)	Total** Alpha (Curies)	¹³¹ I (Curies)
CY 1967	~ 4.0	1.51	0.353	7.20×10^{-4}	29.9
CY 1968	4.44	1.67	9.38×10^{-3}	7.50×10^{-4}	5.62
CY 1969	4.04	4.29	≤ 0.037	$< 8.60 \times 10^{-4}$	1.58
CY 1970	4.48	1.93	≤ 0.161	$< 1.4 \times 10^{-3}$	0.492
CY 1971	4.33	1.33	< 0.0417	$< 1.25 \times 10^{-3}$	0.204

*Assumed source ²³⁹Pu; **Assumed source ²³⁸U

Reference 1 indicated that nitrogen oxides (NO_x) emitted from the UO₃ Plant, the Purex Plant, and the 244-AR Vault stacks could be a problem. A recent study⁽⁴⁾ found that "NO_x from the Purex Plant stack, at maximum emission rates and fumigating weather conditions, might exceed the ambient air standard of 100 micrograms per cubic meter (0.05 parts per million) at

the 200 East Area perimeter fence for short periods of time, a few times per year." Similarly, NO_x emissions from the 244-AR Vault stack might also exceed the ambient air standard for short periods of time, a few times per year. Funding of NO_x removal capability is not recommended for any waste gas stream at this time.

D. LIQUID WASTE REVIEW

Annual discharges of radionuclides to the ground in liquid wastes from 1965 through 1971 are presented in Table II.

TABLE II
RADIOACTIVITY IN LIQUID WASTES
DISCHARGED TO GROUND IN THE 200 AREAS

<u>Calendar Year</u>	<u>Total Beta (Curies)</u>	<u>Plutonium* (Grams)</u>	<u>⁶⁰Co (Curies)</u>	<u>⁹⁰Sr (Curies)</u>	<u>¹³⁷Cs (Curies)</u>
1965	141.000	3730	-	2730	732
1966	101.000	2773	-	521	854
1967	17.430	8343	<79.7	<263	290
1968	11,162	9385	<40.3	162	1685 ⁽¹⁾
1969	3,915	6126	<15.7	171	441 ⁽²⁾
1970	14,151 ⁽³⁾	5721	<11.2	1272 ⁽⁴⁾	248
1971	5,622	6771	< 9.5	60	<117

*The major contribution of plutonium to the ground is from processing operations at Z Plant.

It is readily apparent that substantial reductions in the quantity of total beta, ⁹⁰Sr and ¹³⁷Cs have been achieved. Explanations for the fluctuations of total beta, ⁹⁰Sr and ¹³⁷Cs are as follows:

- (1) Increased ¹³⁷Cs losses resulted from B Plant waste concentrator pressurizations and no process condensate recycle capability.
- (2) Decreased ¹³⁷Cs losses following installation and beneficial use of B Plant process condensate recycle.
- (3) Increased total beta discharge resulted from an operating error. Abnormal radioactivity was discharged via the Purex ammonia scrubber waste.

- (4) Increased ^{90}Sr losses resulted from the release of stored strontium to the chemical sewer when temporary equipment failed.

The discharge of plutonium to ground fluctuated rather widely during the period calendar year 1965 through calendar year 1971. The major causes for this fluctuation are listed below, by calendar years.

<u>Calendar Year</u>	<u>Activity</u>	<u>Effect on Waste Loss</u>
1965	Incinerator down six months. Test ash processing, starting in May.	300-500 gram decrease Increase indeterminate
1966	Weapons fabrication ceased Decem- ber 1965. Incinerator down ten months. Ash processing continued - low rate	Decrease 500-1000 gram decrease Increase indeterminate
1967	Incinerator operated eight months. New ash-leaching hood - eight months. Test charge of ash to slag-and- crucible dissolver. Analytical method changed to meas- ure plutonium-bearing solids.	400-800 gram increase Increase Increase Increase
1968	Continuous testing of ash and other difficult-to-dissolve lean scrap. Centrifuge for waste stream oper- ated intermittently.	Increase Decrease
1969	Centrifuge operated well while pro- cessing ash.	Decrease
1970	Production throughput dropped. Test Pu-U partitioning flowsheet. Centrifuge operated well.	Decrease Increase Decrease
1971	Waste treatment system down for installation of continuous solvent extraction and for removal of solids. Production increased 2.6 times 1970 rate.	Increase for year Increase

Liquid wastes from the 200 Area facilities are discharged to ditches, ponds and cribs. Those cribs receiving the major quantities of plutonium-bearing wastes are operated as "specific retention" sites. Specific retention limits the volume of liquid discharged to that which can be retained by the soil, above the ground water. The remaining disposal sites utilize the soil ion exchange properties or soil filtration to retain radionuclides which tend to persist in the environment (e.g., ^{90}Sr , ^{137}Cs), above the water table. Tritium and ^{106}Ru are two radionuclides which are not retained by the soil. Ground waters at the disposal sites and throughout the Hanford project are periodically sampled and analyzed for their radionuclide content.

Maps showing total beta concentrations, expressed as percent of the ^{106}Ru concentration guide, and tritium, expressed as percent of the ^3H concentration guide are periodically made and presented in reports titled, "Radiological Status of the Groundwater Beneath the Hanford Project." A study of these maps shows that the ^{106}Ru front is receding and that the concentrations in the ground water are decreasing as a result of the reduction in total beta curies discharged. The few locations for which average ground water concentrations exceed the ^{106}Ru guide (10 pico Ci/ml) are all within the 200 East or 200 West Areas. Although it is possible that some radionuclides do reach the river, the concentrations are too low to be measured by current analytical techniques, either in the ground water or the river^(5,6).

Liquid waste streams discharged from facilities operated by the Atlantic Richfield Hanford Company in the 200 Areas have been reviewed. It is recommended that facilities be provided to reduce radioactive discharges from the following streams.

1. Purex Ammonia Scrubber Waste
(Aluminum and Zirconium Clad Fuels)

a. Discharges	Volume ($\times 10^6$ Gal)	Total Beta (Curies)	Pu (Grams)	^{60}Co (Curies)	^{90}Sr (Curies)	^{137}Cs (Curies)
CY 1969	4.696	1791	7.2	6.6	99.1	110.2
CY 1970	2.59	11330	3.49	6.3	228.9	131
CY 1971	5.987	4304	<14.9	<7.1	<21.0	<70.0

b. Average Concentrations

CY	Total Beta Emitters $\mu\text{Ci/ml}$	^{239}Pu $\mu\text{Ci/ml}$	^{60}Co $\mu\text{Ci/ml}$	^{90}Sr $\mu\text{Ci/ml}$	^{137}Cs $\mu\text{Ci/ml}$
1969	1.0×10^{-1}	2.5×10^{-5}	3.7×10^{-4}	5.6×10^{-3}	6.2×10^{-3}
1970	1.15	2.19×10^{-5}	6.42×10^{-4}	2.34×10^{-2}	1.34×10^{-2}
1971	1.90×10^{-1}	$< 4.04 \times 10^{-5}$	$< 3.13 \times 10^{-4}$	$< 9.29 \times 10^{-4}$	$< 3.09 \times 10^{-3}$
*	-	5×10^{-6}	5×10^{-5}	3×10^{-7}	2×10^{-5}

*AECM-0524 Table 2, Column 2 limits.

It is recommended that facilities be provided to route this stream to an existing Purex Plant concentrator for decontamination by evaporation. The concentrator bottoms would be routed to underground storage and the condensates discharged to an existing crib. Reduction of the radioactivity discharged via this stream to less than one percent of that currently discharged should be achieved.

- 1) Estimated time from authorization to beneficial use of the facilities 18 months
- 2) Estimated capital cost \$250,000
- 3) Estimated annual operating cost \$150,000
- 4) Cost to benefit ratio ~ \$30/curie
(Based on potential release of
~ 10,000 beta curies/year)

2. Plutonium Reclamation Facility Wastes

a. Discharges	Volume ($\text{nx}10^6$ Gal)	Pu (Grams)
CY 1969	0.208	5560
CY 1970	0.211	5005
CY 1971	0.234	5531

b. Average Concentrations

<u>CY</u>	<u>²³⁹Pu μCi/ml</u>
1969	4.34×10^{-1}
1970	3.89×10^{-1}
1971	3.84×10^{-1}
*	5×10^{-6}

*AECM-0524 Table 2, Column 2 limits

FY 1972 funds have been authorized to provide facilities and modifications which would stop discharges of plutonium-bearing liquid wastes to the ground from the Plutonium Finishing Plant (Z Plant). Carbon tetrachloride would be recovered from the Z Plant spent organic extractant and the degraded organic phosphate residue would be stored for later disposal by incineration. A liquid organic waste incinerator should also be provided by CY 1975. Aqueous wastes would be routed to the 242-T waste evaporator facility, neutralized and evaporated to salt cake. Data for Case 1 are presented below(7).

1) Estimated time from authorization to beneficial use of facilities (except incinerator)	12 months
2) Estimated capital costs (excluding incinerator)	\$1,400,000
3) Estimated annual operating costs (1973 - 1975)	\$ 260,000
4) Cost to benefit ratio
(Based on potential release of ~ 6000 grams Pu/yr to the 216-Z-18 and 216-Z-12 cribs, 1973 - 1975)	\$120/gram

3. 234-5, 236 and Laboratory Wastes

a. <u>Discharges</u>	<u>Volume</u> <u>(nx10⁶ Gal)</u>	<u>Pu</u> <u>(Grams)</u>
CY 1969	1.699	517
CY 1970	0.911	650
CY 1971	2.162	1066

b. Average Concentrations

<u>CY</u>	<u>²³⁹Pu</u> <u>uCi/ml</u>
1969	5.0×10^{-3}
1970	1.16×10^{-2}
1971	8.00×10^{-3}
*	5×10^{-6}

*AECM-0524 Table 2, Column 2 limits

The discharge of plutonium to the ground via this stream would also be stopped by the facilities and modifications proposed for Plutonium Reclamation Facility wastes. In addition, the volume of this waste stream would be reduced to approximately 500,000 gallons per year by the use of a closed loop on the Z Plant fluorinator jet. Beneficial use, costs, etc., shown for Plutonium Reclamation Facility wastes, include the 234-5, 236, and laboratory wastes.

FY 1973 funding in the amount of \$1,000,000 has been requested to provide radiation monitoring, flow measurement, sampling and diversion of the following low-level, high-risk effluents: 244-AR Vault cooling water and the cooling water, steam condensate and process condensate from B Plant. Although these streams have discharged only small quantities of radioactivity, the potential for large, uncontrolled discharges is ever present.

1. 244-AR Vault Waste Waters

a. Discharges	Volume ($\times 10^6$ Gal)	Total Beta (Curies)	Pu (Grams)	^{60}Co (Curies)	^{90}Sr (Curies)	^{137}Cs (Curies)
CY 1969	137.44	<0.157	<0.450	<0.039	<0.049	<0.087
CY 1970	152.89	<0.087	<0.199	-	-	-
CY 1971	158.8	<0.032	<0.003	-	-	-

b. Average Concentrations

CY	Total Beta Emitters $\mu\text{Ci/ml}$	^{239}Pu $\mu\text{Ci/ml}$	^{60}Co $\mu\text{Ci/ml}$	^{90}Sr $\mu\text{Ci/ml}$	^{137}Cs $\mu\text{Ci/ml}$
1969	$<3.02 \times 10^{-7}$	$<5.31 \times 10^{-8}$	$<7.50 \times 10^{-8}$	$<9.42 \times 10^{-8}$	$<1.67 \times 10^{-7}$
1970	$<1.50 \times 10^{-7}$	$<2.11 \times 10^{-8}$	-	-	-
1971	$<5.28 \times 10^{-8}$	$<3.05 \times 10^{-10}$	-	-	-
*	-	5×10^{-6}	5×10^{-5}	3×10^{-7}	2×10^{-5}

2. B Plant Cooling Water

a. Discharges	Volume ($\times 10^6$ Gal)	Total Beta (Curies)	Pu (Grams)	^{60}Co (Curies)	^{90}Sr (Curies)	^{137}Cs (Curies)
CY 1969	621.8	1.62	<3.37	<0.10	<0.14	1.71
CY 1970	521.9	10.05	<0.075	-	0.696	1.276
CY 1971	623.8	1.09	<0.025	-	-	-

b. Average Concentrations

CY	Total Beta Emitters $\mu\text{Ci/ml}$	^{239}Pu $\mu\text{Ci/ml}$	^{60}Co $\mu\text{Ci/ml}$	^{90}Sr $\mu\text{Ci/ml}$	^{137}Cs $\mu\text{Ci/ml}$
1969	6.88×10^{-7}	$<8.79 \times 10^{-8}$	$<4.25 \times 10^{-8}$	$<5.95 \times 10^{-8}$	$<7.27 \times 10^{-7}$
1970	5.32×10^{-6}	$<2.33 \times 10^{-9}$	-	3.52×10^{-7}	6.46×10^{-7}
1971	$<4.62 \times 10^{-7}$	$<6.58 \times 10^{-10}$	-	-	-
*	-	5×10^{-6}	5×10^{-5}	3×10^{-7}	2×10^{-5}

*AECM-0524 Table 2, Column 2 limits

3. Bilant Steam Condensate

a. Discharges	Volume ($\times 10^6$ Gal)	Total Beta (Curies)	Pu (Grams)	^{60}Co (Curies)	^{90}Sr (Curies)	^{137}Cs (Curies)
CY 1969	22.99	16.8	<0.163	<0.011	0.25	4.61
CY 1970	23.36	2.74	<0.022	<0.0053	0.088	1.17
CY 1971	40.37	3.21	<0.0067	<0.011	1.12	0.29

b. Average Concentrations

CY	Total Beta Emitters μCi/ml	^{239}Pu μCi/ml	^{60}Co μCi/ml	^{90}Sr μCi/ml	^{137}Cs μCi/ml
1969	1.9×10^{-4}	$<1.2 \times 10^{-6}$	$<1.3 \times 10^{-4}$	2.8×10^{-6}	5.3×10^{-5}
1970	3.09×10^{-5}	$<1.53 \times 10^{-8}$	$<6.02 \times 10^{-8}$	9.85×10^{-7}	1.33×10^{-5}
1971	2.10×10^{-5}	$<2.69 \times 10^{-9}$	$<7.11 \times 10^{-8}$	7.33×10^{-6}	1.91×10^{-6}
*	-	5×10^{-6}	5×10^{-5}	3×10^{-7}	2×10^{-5}

Reductions in the radioactivity discharged to the ground via the following streams are possible; however the cost to benefit ratios are high.

1. Purex Steam Condensate

a. Discharges	Volume ($\times 10^6$ gal)	Total Beta (Curies)	Pu (Grams)	^{60}Co (Curies)	^{90}Sr (Curies)	^{137}Cs (Curies)
CY 1969	64.22	342	1.91	1.66	13.0	14.4
CY 1970	47.9	83.1	<1	<0.168	3.4	4.16
CY 1971	69.5	117.1	<2.84	<0.137	3.65	1.80

*AECM-0524 Table 2, Column 2 limits

b. Average Concentrations

<u>CY</u>	<u>Total Beta Emitters μCi/ml</u>	<u>²³⁹Pu μCi/ml</u>	<u>⁶⁰Co μCi/ml</u>	<u>⁹⁰Sr μCi/ml</u>	<u>¹³⁷Cs μCi/ml</u>
1969	1.4×10^{-3}	4.8×10^{-7}	6.8×10^{-6}	5.4×10^{-5}	5.9×10^{-5}
1970	4.57×10^{-4}	3.39×10^{-7}	$< 9.27 \times 10^{-7}$	1.88×10^{-5}	2.29×10^{-5}
1971	4.45×10^{-4}	$< 6.64 \times 10^{-7}$	$< 5.22 \times 10^{-7}$	1.39×10^{-5}	6.86×10^{-6}
*	-	5×10^{-6}	5×10^{-5}	3×10^{-7}	2×10^{-5}

*AECM-0524 Table 2, Column 2 limits

Radioactivity discharges to this stream result from failure of heating or cooling coils in Purex process vessels. Reductions in radioactivity discharges would require radiation monitoring and diversion facilities not now available. Reductions to approximately ten percent of current discharges would be possible.

- 1) Estimated time from authorization < 24 months to beneficial use of monitoring and diversion capabilities
- 2) Estimated capital cost \$500,000
- 3) Estimated annual operating cost \$100,000
- 4) Cost to benefit ratio \$1750/curie
(Based on release of ~ 200 beta curies/year)

2. Purex Process Condensate

a. Discharges	Volume ($\times 10^6$ Gal)	Total Beta (Curies)	Pu (Grams)	^{60}Co (Curies)	^{90}Sr (Curies)	^{137}Cs (Curies)
CY 1969	30.84	731	6.05	5.24	40.4	44.9
CY 1970	12.9	254	26.7	<0.216	2.96	3.99
CY 1971	17.65	1139	87.65	<0.227	32.06	25.84

b. Average Concentrations

CY	Total Beta Emitters uCi/ml	^{239}Pu uCi/ml	^{60}Co uCi/ml	^{90}Sr uCi/ml	^{137}Cs uCi/ml
1969	6.3×10^{-3}	3.2×10^{-6}	4.5×10^{-5}	3.5×10^{-4}	3.9×10^{-4}
1970	5.20×10^{-3}	3.36×10^{-5}	$<4.41 \times 10^{-6}$	6.05×10^{-5}	8.16×10^{-5}
1971	1.71×10^{-2}	8.06×10^{-5}	$<3.40 \times 10^{-6}$	4.80×10^{-4}	3.87×10^{-4}
*	-	$\text{rx}10^{-6}$	5×10^{-5}	3×10^{-7}	2×10^{-5}

*AECM-0524 Table 2, Column 2 limits

Reduction of the radioactivity discharged via this stream to less than ten percent of that currently discharged can be achieved by installation of facilities to allow routine recycle of all in-canyon process condensate streams except that from the uranium process concentrator.

1) Estimated time from authorization to beneficial use of routine re-cycle capability	< 18 months
2) Estimated capital cost	\$250,000
3) Estimated increased annual operating cost	None
4) Cost to benefit ratio (Based on potential release of ~1000 beta curies/year)	\$125/curie

3. B Plant Process Condensate

a. Discharges	Volume ($\times 10^6$ Gal)	Total Beta (Curies)	Pu (Grams)	^{60}Co (Curies)	^{90}Sr (Curies)	^{137}Cs (Curies)
CY 1969	5.582	540	<0.310	<0.117	13	164
CY 1970	5.94	41.4	0.407	<0.527	2.32	14.2
CY 1971	8.691	14.3	<0.0029	<0.015	0.927	3.67

b. Average Concentrations

CY	^{239}Pu μCi/ml	Tot. Beta Emitters μCi/ml	^{60}Co μCi/ml	^{90}Sr μCi/ml	^{137}Cs μCi/ml
1969	$<9.0 \times 10^{-7}$	2.6×10^{-2}	$<5.6 \times 10^{-6}$	6.1×10^{-4}	7.8×10^{-3}
1970	1.11×10^{-6}	1.84×10^{-3}	$<2.34 \times 10^{-5}$	1.03×10^{-4}	6.31×10^{-4}
1971	$<5.42 \times 10^{-9}$	4.36×10^{-4}	$<4.44 \times 10^{-7}$	2.82×10^{-5}	1.11×10^{-4}
*	5×10^{-6}	-	5×10^{-5}	3×10^{-7}	2×10^{-5}

*AECM-0524 Table 2, Column 2 limits

Reduction of the radioactivity discharged via this stream to less than ten percent of AECM-0524 Table 2, Column 2 limits can be achieved by evaporation of the process condensate⁽⁸⁾.

- 1) Estimated time from authorization to beneficial use of the condensate evaporator < 24 months
- 2) Estimated capital cost \$500,000 - \$600,000
- 3) Estimated annual operating cost \$200,000
- 4) Cost to benefit ratio (Based on release of ~ 25 beta curies/year) \$20,000/curie

4. ITS-1 Process Condensate

a. Discharges	Volume ($\times 10^6$ Gal)	Total Beta (Curies)	Pu (Grams)	^{60}Co (Curies)	^{90}Sr (Curies)	^{137}Cs (Curies)
CY 1969	2.378	21.4	<0.035	<0.01	0.01	13.2
CY 1970	2.23	0.594	<0.00172	<0.0004	0.011	0.299
CY 1971	1.595	1.40	<0.00087	<0.00042	0.017	0.883

b. Average Concentrations

<u>CY</u>	<u>Total Beta Emitters μCi/ml</u>	<u>²³⁹Pu μCi/ml</u>	<u>⁶⁰Co μCi/ml</u>	<u>⁹⁰Sr μCi/ml</u>	<u>¹³⁷Cs μCi/ml</u>
1969	2.4×10^{-3}	$< 2.4 \times 10^{-7}$	$< 1.1 \times 10^{-6}$	1.1×10^{-6}	1.5×10^{-3}
1970	7.03×10^{-5}	$< 1.25 \times 10^{-8}$	$< 4.78 \times 10^{-8}$	1.30×10^{-6}	3.54×10^{-5}
1971	2.32×10^{-4}	$< 8.85 \times 10^{-9}$	$< 6.89 \times 10^{-8}$	2.84×10^{-6}	1.47×10^{-4}
*	-	5×10^{-6}	5×10^{-5}	3×10^{-7}	2×10^{-5}

The ITS-1 waste evaporator was converted to bottoms cooling service in July 1972. The volume of process condensate is now approximately thirty percent of that previously discharged. All or part of this stream can be treated via the prototype ion exchange facility when it is reactivated.

5. ITS-2 Process Condensate

<u>a. Discharges</u>	<u>Volume ($\times 10^6$ Gal)</u>	<u>Total Beta (Curies)</u>	<u>Pu (Grams)</u>	<u>⁶⁰Co (Curies)</u>	<u>⁹⁰Sr (Curies)</u>	<u>¹³⁷Cs (Curies)</u>
CY 1969	5.292	29.3	< 0.096	< 0.01	0.02	16.5
CY 1970	5.107	52.4	< 0.003	< 0.015	0.091	32.2
CY 1971	3.432	14.9	< 0.0022	< 0.0020	0.017	9.83

b. Average Concentrations

<u>CY</u>	<u>Total Beta Emitters μCi/ml</u>	<u>²³⁹Pu μCi/ml</u>	<u>⁶⁰Co μCi/ml</u>	<u>⁹⁰Sr μCi/ml</u>	<u>¹³⁷Cs μCi/ml</u>
1969	1.5×10^{-3}	$< 3.0 \times 10^{-7}$	$< 5.0 \times 10^{-7}$	1.0×10^{-6}	8.3×10^{-4}
1970	2.72×10^{-3}	$< 9.54 \times 10^{-9}$	$< 7.71 \times 10^{-7}$	4.73×10^{-6}	1.66×10^{-3}
1971	1.15×10^{-3}	$< 1.05 \times 10^{-8}$	$< 1.54 \times 10^{-7}$	1.34×10^{-6}	7.57×10^{-4}
*	-	5×10^{-6}	5×10^{-5}	3×10^{-7}	2×10^{-5}

*AECM-0524 Table 2, Column 2 limits

FY 1972 funding to provide ion exchange treatment for removal of ¹³⁷Cs from this waste stream was dropped. Reactivation of the ITS-1 prototype ion exchange system to provide treatment of the ITS-2 process condensate is planned; however, higher priority work has delayed implementation.

The radioactivity content in the following streams is considered to be at its lowest practical level; requests for funding to provide further reductions are not presently being considered.

1. Purex Cooling Water

a. Discharges	Volume ($\times 10^6$ Gal)	Total Beta (Curies)	Pu (Grams)	^{60}Co (Curies)	^{90}Sr (Curies)	^{137}Cs (Curies)
CY 1969	1933	<11.1	<2.16	<0.13	<0.324	8.9
CY 1970	2585	<32.9	<15.7	<2.17	<0.88	<4.12
CY 1971	3402	< 5.53	<20.8	<0.653	<0.348	<1.09

b. Average Concentrations

CY	Total Beta Emitters $\mu\text{Ci/ml}$	^{239}Pu $\mu\text{Ci/ml}$	^{60}Co $\mu\text{Ci/ml}$	^{90}Sr $\mu\text{Ci/ml}$	^{137}Cs $\mu\text{Ci/ml}$
1969	$<1.52 \times 10^{-6}$	$<1.81 \times 10^{-8}$	$<1.78 \times 10^{-8}$	$<4.43 \times 10^{-8}$	1.22×10^{-6}
1970	$<3.36 \times 10^{-6}$	$<9.85 \times 10^{-8}$	$<2.22 \times 10^{-7}$	$<8.89 \times 10^{-8}$	$<4.21 \times 10^{-7}$
1971	$<4.30 \times 10^{-7}$	$<9.94 \times 10^{-8}$	$<5.07 \times 10^{-8}$	$<2.70 \times 10^{-8}$	$<8.46 \times 10^{-8}$
*	-	5×10^{-6}	5×10^{-5}	3×10^{-7}	2×10^{-5}

2. Purex Chemical Sewer

a. Discharges	Volume ($\times 10^6$ Gal)	Total Beta (Curies)	Pu (Grams)	^{60}Co (Curies)	^{90}Sr (Curies)	^{137}Cs (Curies)
CY 1969	162.6	26	<2.56	1.36	1.15	1.28
CY 1970	73.5	2.75	<0.93	<0.15	<0.013	<0.183
CY 1971	145.3	1.21	<5.95	<0.036	0.040	<0.068

b. Average Concentrations

CY	Total Beta Emitters $\mu\text{Ci/ml}$	^{239}Pu $\mu\text{Ci/ml}$	^{60}Co $\mu\text{Ci/ml}$	^{90}Sr $\mu\text{Ci/ml}$	^{137}Cs $\mu\text{Ci/ml}$
1969	4.22×10^{-5}	$<2.55 \times 10^{-7}$	2.21×10^{-6}	1.87×10^{-6}	2.08×10^{-6}
1970	9.88×10^{-6}	$<2.05 \times 10^{-7}$	$<5.39 \times 10^{-7}$	$<4.67 \times 10^{-8}$	$<6.58 \times 10^{-7}$
1971	2.20×10^{-6}	$<6.64 \times 10^{-7}$	$<6.46 \times 10^{-8}$	$<7.19 \times 10^{-8}$	$<1.24 \times 10^{-7}$
*	-	5×10^{-6}	5×10^{-5}	3×10^{-7}	2×10^{-5}

*AECM-0524 Table 2, Column 2 limits

3. B Plant Chemical Sewer

a. Discharges	Volume ($\times 10^6$ Gal)	Total Beta (Curies)	Pu (Grams)	^{60}Co (Curies)	^{90}Sr (Curies)	^{137}Cs (Curies)
CY 1969	34.8	<0.429	<0.111	<0.005	<0.038	<0.226
CY 1970	44.24	1655	<0.046	<0.0047	1003	14.4
CY 1971	42.38	0.939	<0.013	<0.0014	0.153	0.128

b. Average Concentrations

CY	Total Beta Emitters $\mu\text{Ci/ml}$	^{239}Pu $\mu\text{Ci/ml}$	^{60}Co $\mu\text{Ci/ml}$	^{90}Sr $\mu\text{Ci/ml}$	^{137}Cs $\mu\text{Ci/ml}$
1969	$<3.26 \times 10^{-6}$	$<5.17 \times 10^{-8}$	$<3.80 \times 10^{-8}$	$<2.88 \times 10^{-7}$	$<1.72 \times 10^{-6}$
1970	9.88×10^{-3}	$<1.69 \times 10^{-8}$	$<2.81 \times 10^{-8}$	5.99×10^{-3}	8.60×10^{-5}
1971	5.85×10^{-6}	$<5.03 \times 10^{-9}$	$<9.02 \times 10^{-9}$	9.55×10^{-7}	8.01×10^{-7}
*	-	5×10^{-6}	5×10^{-5}	3×10^{-7}	2×10^{-5}

4. 241-A-AX-AY Tank Farm Condensate

a. Discharges	Volume ($\times 10^6$ Gal)	Total Beta (Curies)	Pu (Grams)	^{60}Co (Curies)	^{90}Sr (Curies)	^{137}Cs (Curies)
CY 1969	6.370	276	<0.081	0.058	2.14	53.5
CY 1970	3.05	3.2	<0.00099	<0.0013	0.134	0.90
CY 1971	4.824	2.33	<0.00099	<0.0111	0.130	1.29

b. Average Concentrations

CY	Total Beta Emitters $\mu\text{Ci/ml}$	^{239}Pu $\mu\text{Ci/ml}$	^{60}Co $\mu\text{Ci/ml}$	^{90}Sr $\mu\text{Ci/ml}$	^{137}Cs $\mu\text{Ci/ml}$
1969	1.1×10^{-2}	2.1×10^{-7}	2.4×10^{-6}	8.9×10^{-5}	2.2×10^{-3}
1970	2.77×10^{-4}	$<5.27 \times 10^{-9}$	$<1.10 \times 10^{-7}$	1.17×10^{-5}	7.79×10^{-5}
1971	1.27×10^{-4}	$<3.32 \times 10^{-9}$	$<6.11 \times 10^{-7}$	7.13×10^{-6}	7.09×10^{-5}
*	-	5×10^{-6}	5×10^{-5}	3×10^{-7}	2×10^{-5}

*AECM-0524 Table 2, Column 2 limits

5. ITS-1 Cooling Water

a. Discharges	Volume ($\times 10^6$ Gal)	Total Beta (Curies)	Pu (Grams)	^{60}Co (Curies)	^{90}Sr (Curies)	^{137}Cs (Curies)
CY 1969	85.47	<0.331	<0.469	<0.016	<0.027	<0.028
CY 1970	80.30	<0.751	<0.217	-	0.0088	0.45
CY 1971	96.15	<0.077	<0.007	-	-	-

b. Average Concentrations

CY	Total Beta Emitters $\mu\text{Ci/ml}$	^{239}Pu $\mu\text{Ci/ml}$	^{60}Co $\mu\text{Ci/ml}$	^{90}Sr $\mu\text{Ci/ml}$	^{137}Cs $\mu\text{Ci/ml}$
1969	$<1.02 \times 10^{-6}$	$<8.90 \times 10^{-8}$	$<4.95 \times 10^{-8}$	$<8.35 \times 10^{-8}$	$<8.66 \times 10^{-8}$
1970	$<2.47 \times 10^{-6}$	$<4.38 \times 10^{-8}$	-	2.90×10^{-8}	1.48×10^{-6}
1971	$<2.11 \times 10^{-7}$	$<1.17 \times 10^{-9}$	-	-	-
*	-	5×10^{-6}	5×10^{-5}	3×10^{-7}	2×10^{-5}

6. ITS-2 Cooling Water

a. Discharges	Volume ($\times 10^6$ Gal)	Total Beta (Curies)	Pu (Grams)	^{60}Co (Curies)	^{90}Sr (Curies)	^{137}Cs (Curies)
CY 1969	133.6	<1.10	<0.789	<0.018	<0.056	<0.813
CY 1970	126.5	<0.35	<0.274	-	-	-
CY 1971	118.5	<0.092	<0.0055	-	-	-

b. Average Concentrations

CY	Total Beta Emitters $\mu\text{Ci/ml}$	^{239}Pu $\mu\text{Ci/ml}$	^{60}Co $\mu\text{Ci/ml}$	^{90}Sr $\mu\text{Ci/ml}$	^{137}Cs $\mu\text{Ci/ml}$
1969	$<2.18 \times 10^{-6}$	$<9.58 \times 10^{-8}$	$<3.56 \times 10^{-8}$	$<1.11 \times 10^{-7}$	$<1.61 \times 10^{-6}$
1970	$<7.31 \times 10^{-7}$	$<3.51 \times 10^{-8}$	-	-	-
1971	$<2.03 \times 10^{-7}$	$<7.52 \times 10^{-10}$	-	-	-
*	-	5×10^{-6}	5×10^{-5}	3×10^{-7}	2×10^{-5}

*AECM-0524 Table 2, Column 2 limits

7. 242-T Steam and Process Condensates

a. Discharges	Volume ($\times 10^6$ Gal)	Total Beta (Curies)	Pu (Grams)	^{60}Co (Curies)	^{90}Sr (Curies)	^{137}Cs (Curies)
1969	17.90	8.00	<0.026	<0.002	<0.02	3.32
1970	8.06	2.75	<0.00185	<0.00099	0.04	1.61
1971	12.31	3.54	<0.0016	<0.0018	0.236	2.06

b. Average Concentrations

CY	Total Beta Emitters $\mu\text{Ci/ml}$	^{239}Pu $\mu\text{Ci/ml}$	^{60}Co $\mu\text{Ci/ml}$	^{90}Sr $\mu\text{Ci/ml}$	^{137}Cs $\mu\text{Ci/ml}$
1969	1.2×10^{-4}	$<2.4 \times 10^{-8}$	$<3.0 \times 10^{-8}$	3.0×10^{-7}	4.9×10^{-5}
1970	9.01×10^{-5}	$<3.73 \times 10^{-9}$	$<3.22 \times 10^{-8}$	1.31×10^{-6}	5.28×10^{-5}
1971	7.60×10^{-5}	$<2.44 \times 10^{-9}$	$<2.12 \times 10^{-8}$	5.06×10^{-6}	4.42×10^{-5}
*	-	5×10^{-6}	5×10^{-5}	3×10^{-7}	2×10^{-5}

8. 242-T Cooling Water

a. Discharges	Volume ($\times 10^6$ Gal)	Total Beta (Curies)	Pu (Grams)	^{60}Co (Curies)	^{90}Sr (Curies)	^{137}Cs (Curies)
CY 1969	89.0	0.54	<0.574	<0.013	0.044	0.24
CY 1970	123.0	0.219	<0.093	-	-	-
CY 1971	119.4	<0.082	<0.0044	-	-	-

b. Average Concentrations

CY	Total Beta Emitters $\mu\text{Ci/ml}$	^{239}Pu $\mu\text{Ci/ml}$	^{60}Co $\mu\text{Ci/ml}$	^{90}Sr $\mu\text{Ci/ml}$	^{137}Cs $\mu\text{Ci/ml}$
1969	$<7.6 \times 10^{-7}$	$<4.9 \times 10^{-8}$	$<1.8 \times 10^{-8}$	6.2×10^{-8}	3.3×10^{-7}
1970	4.36×10^{-7}	$<1.13 \times 10^{-8}$	-	-	-
1971	$<1.81 \times 10^{-7}$	$<6.01 \times 10^{-10}$	-	-	-
*	-	5×10^{-6}	5×10^{-5}	3×10^{-7}	2×10^{-5}

*AECM-0524 Table 2, Column 2 limits

UNCLASSIFIED

ARH-2419

Page 20

2. 241-SX Tank Farm Cooling Water

a. Discharges	Volume ($\times 10^6$ Gal)	Total Beta (Curies)	Pu (Grams)	^{60}Co (Curies)	^{90}Sr (Curies)	^{137}Cs (Curies)
CY 1969	46.96	<0.911	<0.388	<0.011	<0.15	<0.47
CY 1970	44.56	<0.132	<0.116	-	-	-
CY 1971	51.19	<0.049	<0.0063	-	-	-

b. Average Concentrations

CY	Total Beta Emitters $\mu\text{Ci/ml}$	^{239}Pu $\mu\text{Ci/ml}$	^{60}Co $\mu\text{Ci/ml}$	^{90}Sr $\mu\text{Ci/ml}$	^{137}Cs $\mu\text{Ci/ml}$
1969	$<5.12 \times 10^{-6}$	$<1.34 \times 10^{-7}$	$<6.19 \times 10^{-8}$	$<8.44 \times 10^{-7}$	$<2.64 \times 10^{-6}$
1970	$<7.83 \times 10^{-7}$	$<4.22 \times 10^{-8}$	-	-	-
1971	$<2.52 \times 10^{-7}$	$<1.98 \times 10^{-9}$	-	-	-
*	-	5×10^{-6}	5×10^{-5}	3×10^{-7}	2×10^{-5}

10. 222-S Laboratory Waste Waters

a. Discharges	Volume ($\times 10^6$ Gal)	Total Beta (Curies)	Pu (Grams)	^{60}Co (Curies)	^{90}Sr (Curies)	^{137}Cs (Curies)
CY 1969	9.1	1.20	<0.185	<0.001	<0.012	0.941
CY 1970	9.12	0.03	<0.043	-	-	-
CY 1971	9.12	0.069	<0.0081	-	-	-

b. Average Concentrations

CY	Total Beta Emitters $\mu\text{Ci/ml}$	^{239}Pu $\mu\text{Ci/ml}$	^{60}Co $\mu\text{Ci/ml}$	^{90}Sr $\mu\text{Ci/ml}$	^{137}Cs $\mu\text{Ci/ml}$
1969	3.5×10^{-5}	3.3×10^{-7}	$<2.9 \times 10^{-8}$	$<3.5 \times 10^{-7}$	2.7×10^{-5}
1970	8.69×10^{-7}	$<7.64 \times 10^{-8}$	-	-	-
1971	1.99×10^{-6}	$<1.44 \times 10^{-8}$	-	-	-
*	-	5×10^{-6}	5×10^{-5}	3×10^{-7}	2×10^{-5}

*AECM-0524 Table 2, Column 2 limits

UNCLASSIFIED

11. Redox Process Condensate

a. Discharges	Volume ($\times 10^6$ Gal)	Total Beta (Curies)	Pu (Grams)	^{60}Co (Curies)	^{90}Sr (Curies)	^{137}Cs (Curies)
CY 1969	3.37	98.8	<0.414	<0.121	0.50	0.74
CY 1970	2.333	33.1	0.287	<0.053	0.687	0.477
CY 1971	1.894	5.89	0.035	1.24	0.336	<0.14

b. Average Concentrations

CY	Total Beta Emitters $\mu\text{Ci/ml}$	^{239}Pu $\mu\text{Ci/ml}$	^{60}Co $\mu\text{Ci/ml}$	^{90}Sr $\mu\text{Ci/ml}$	^{137}Cs $\mu\text{Ci/ml}$
1969	7.74×10^{-3}	$<1.99 \times 10^{-6}$	$<9.49 \times 10^{-6}$	3.92×10^{-5}	5.80×10^{-5}
1970	3.75×10^{-3}	2.00×10^{-6}	$<6.02 \times 10^{-6}$	7.77×10^{-5}	5.42×10^{-5}
1971	8.22×10^{-4}	3.03×10^{-7}	1.73×10^{-4}	4.69×10^{-5}	$<1.95 \times 10^{-5}$
*	-	5×10^{-6}	5×10^{-5}	3×10^{-7}	2×10^{-5}

12. Redox Plant Steam Condensates

a. Discharges	Volume ($\times 10^6$ Gal)	Total Beta (Curies)	Pu (Grams)	^{60}Co (Curies)	^{90}Sr (Curies)	^{137}Cs (Curies)
CY 1969	4.63	0.283	<0.014	<0.0014	0.073	0.042
CY 1970	32.2	1.16	<0.151	<0.00619	0.09	0.159
CY 1971	26.28	1.07	<0.048	<0.0333	<0.12	<0.219

b. Average Concentrations

CY	Total Beta Emitters $\mu\text{Ci/ml}$	^{239}Pu $\mu\text{Ci/ml}$	^{60}Co $\mu\text{Ci/ml}$	^{90}Sr $\mu\text{Ci/ml}$	^{137}Cs $\mu\text{Ci/ml}$
1969	1.6×10^{-5}	$<4.98 \times 10^{-8}$	$<5.7 \times 10^{-8}$	4.2×10^{-6}	2.4×10^{-6}
1970	9.48×10^{-6}	$<7.62 \times 10^{-8}$	$<5.07 \times 10^{-8}$	7.40×10^{-7}	1.31×10^{-6}
1971	1.07×10^{-5}	$<2.95 \times 10^{-8}$	$<3.35 \times 10^{-7}$	$<1.22 \times 10^{-6}$	2.20×10^{-6}
*	-	5×10^{-6}	5×10^{-5}	3×10^{-7}	2×10^{-5}

*AECM-0524 Table 2, Column 2 limits

UNCLASSIFIED

ARH-2419

Page 22

13. Redox Plant Cooling Water

a. <u>Discharges</u>	<u>Volume</u> ($\times 10^6$ Gal)	<u>Total</u> <u>Beta</u> (Curies)	<u>Pu</u> (Grams)	<u>^{60}Co</u> (Curies)	<u>^{90}Sr</u> (Curies)	<u>^{137}Cs</u> (Curies)
CY 1969	353.4	2.65	<4.68	<0.081	<0.287	0.433
CY 1970	222.0	0.398	<0.318	-	-	-
CY 1971	253.8	<0.076	<0.021	-	-	-

b. Average Concentrations

<u>CY</u>	<u>Total Beta</u> <u>Emitters</u> $\mu\text{Ci/ml}$	<u>^{239}Pu</u> $\mu\text{Ci/ml}$	<u>^{60}Co</u> $\mu\text{Ci/ml}$	<u>^{90}Sr</u> $\mu\text{Ci/ml}$	<u>^{137}Cs</u> $\mu\text{Ci/ml}$
1969	2.0×10^{-6}	$<2.1 \times 10^{-7}$	$<6.0 \times 10^{-8}$	$<2.1 \times 10^{-7}$	3.2×10^{-7}
1970	4.73×10^{-7}	$<2.32 \times 10^{-8}$	-	-	-
1971	$<7.89 \times 10^{-8}$	$<1.33 \times 10^{-9}$	-	-	-
*	-	5×10^{-6}	5×10^{-5}	3×10^{-7}	2×10^{-5}

14. Redox Plant Chemical Sewer

a. <u>Discharges</u>	<u>Volume</u> ($\times 10^6$ Gal)	<u>Total</u> <u>Beta</u> (Curies)	<u>Pu</u> (Grams)	<u>^{60}Co</u> (Curies)	<u>^{90}Sr</u> (Curies)	<u>^{137}Cs</u> (Curies)
CY 1969	0.82	<0.003	<0.002	<0.00014	<0.00022	<0.0005
CY 1970	12.22	<0.016	<0.032	-	-	-
CY 1971	30.36	<0.009	<0.0043	-	-	-

b. Average Concentrations

<u>CY</u>	<u>Total Beta</u> <u>Emitters</u> $\mu\text{Ci/ml}$	<u>^{239}Pu</u> $\mu\text{Ci/ml}$	<u>^{60}Co</u> $\mu\text{Ci/ml}$	<u>^{90}Sr</u> $\mu\text{Ci/ml}$	<u>^{137}Cs</u> $\mu\text{Ci/ml}$
1969	$<3.1 \times 10^{-8}$	$<1.3 \times 10^{-9}$	$<1.4 \times 10^{-9}$	$<2.3 \times 10^{-9}$	$<5.1 \times 10^{-9}$
1970	$<3.49 \times 10^{-7}$	$<4.28 \times 10^{-8}$	-	-	-
1971	$<7.86 \times 10^{-8}$	$<2.28 \times 10^{-9}$	-	-	-
*	-	5×10^{-6}	5×10^{-5}	3×10^{-7}	2×10^{-5}

*AECM-0524 Table 2, Column 2 limits

UNCLASSIFIED

15. UO₃ Plant Process Condensate

a. <u>Discharges</u>	<u>Volume</u> (<u>nx10⁶ Gal</u>)	<u>Total Beta</u> (<u>Curies</u>)	<u>Uranium</u> (<u>Pounds</u>)
CY 1969	1.901	0.035	13.32
CY 1970	0.811	0.011	3.1
CY 1971	1.582	0.065	4.9

b. Average Concentrations

<u>CY</u>	<u>Total Beta</u> <u>Emitters</u> <u>uCi/ml</u>	<u>²³⁸U</u> <u>uCi/ml</u>
1969	4.9×10^{-6}	2.8×10^{-7}
1970	3.59×10^{-6}	1.53×10^{-7}
1971	1.08×10^{-5}	1.24×10^{-7}
*	-	4×10^{-5}

16. UO₃ Plant Waste Waters

a. <u>Discharges</u>	<u>Volume</u> (<u>nx10⁶ Gal</u>)	<u>Total Beta</u> (<u>Curies</u>)	<u>Uranium</u> (<u>Pounds</u>)
CY 1969	197.56	2.58	51.87
CY 1970	121.15	1.54	21.14
CY 1971	171.88	3.05	27.84

b. Average Concentrations

<u>CY</u>	<u>Total Beta</u> <u>Emitters</u> <u>uCi/ml</u>	<u>²³⁸U</u> <u>uCi/ml</u>
1969	6.12×10^{-6}	1.05×10^{-8}
1970	3.36×10^{-6}	7.00×10^{-9}
1971	4.69×10^{-6}	6.48×10^{-9}
*	-	4×10^{-5}

*AECM-0524 Table 2, Column 2 limits

17. 234-5 and 231 Z Cooling Water

a. <u>Discharges</u>	<u>Volume</u> <u>($\times 10^6$ Gal)</u>	<u>Total Beta</u> <u>(Curies)</u>	<u>Pu</u> <u>(Grams)</u>
CY 1969	151.2	<2.2	<9.16
CY 1970	178	<1.233	<3.557
CY 1971	184.2	<2.12	<34.92

b. Average Concentrations

<u>CY</u>	<u>Total Beta</u> <u>Emitters</u> <u>$\mu\text{Ci/ml}$</u>	<u>^{239}Pu</u> <u>$\mu\text{Ci/ml}$</u>
1969	$<3.84 \times 10^{-6}$	$<9.83 \times 10^{-7}$
1970	$<1.83 \times 10^{-6}$	$<3.24 \times 10^{-7}$
1971	$<3.04 \times 10^{-6}$	$<3.07 \times 10^{-6}$
*	-	5×10^{-6}

18. Laundry Waste Water

a. <u>Discharges</u>	<u>Volume</u> <u>($\times 10^6$ Gal)</u>	<u>Total Beta</u> <u>(Curies)</u>	<u>Pu</u> <u>(Grams)</u>
CY 1969	15.0	<0.410	<0.137
CY 1970	16.72	<0.232	<0.115
CY 1971	14.23	<0.070	<0.014

b. Average Concentrations

<u>CY</u>	<u>Total Beta</u> <u>Emitters</u> <u>$\mu\text{Ci/ml}$</u>	<u>^{239}Pu</u> <u>$\mu\text{Ci/ml}$</u>
1969	$<7.22 \times 10^{-6}$	$<1.48 \times 10^{-7}$
1970	$<3.66 \times 10^{-6}$	$<1.12 \times 10^{-7}$
1971	$<1.31 \times 10^{-6}$	$<1.64 \times 10^{-8}$
*	-	5×10^{-6}

*AECM-0524 Table 2, Column 2 limits

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