

DUKE POWER COMPANY

P.O. BOX 33189
CHARLOTTE, N.C. 28242

HAL B. TUCKER
VICE PRESIDENT
NUCLEAR PRODUCTION

TELEPHONE
(704) 373-4531

June 18, 1984

Mr. Harold R. Denton, Director
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Attention: Ms. E. G. Adensam, Chief
Licensing Branch no. 4

Re: McGuire Nuclear Station
Docket Nos. 50-369, -370

Dear Mr. Denton:

Pursuant to 10 CFR 20 §20.302, please find attached an application for the disposal of very low level radioactive waste. Duke Power Company hereby requests NRC approval of the proposed disposal method described in the attached application.

This application proposes to relocate slightly contaminated water treatment residues from the initial holdup pond of the conventional wastewater treatment system to the Landfarming Permit site which is to be covered with approximately four to six inches of uncontaminated topsoil. The landspreading site is located outside the security fence but on company owned land which is accessible from the company controlled area.

In order to prevent further build-up of low level radioactive waste in the initial holdup pond, backwashing the demineralizers can be kept to a minimum for approximately two months. Duke Power requests that the NRC review and approve this proposal expeditiously to enable uninterrupted operation of McGuire.

Duke Power has determined that a license fee is required for this approval; therefore, please find attached a check in the amount of \$150.00.

Very truly yours,

H.B. Tucker /-BT
Hal B. Tucker

WHM/php

Attachment

cc: Mr. James P. O'Reilly
Regional Administrator
U. S. Nuclear Regulatory Commission
Region II
101 Marietta Street, NW, Suite 2900
Atlanta, Georgia 30323

Mr. W. T. Orders
NRC Resident Inspector
McGuire Nuclear Station

8406260142 840618
PDR ADOCK 05000369
P PDR

A001
Rec'd w/ check \$150.00

MCGUIRE NUCLEAR STATION
APPLICATION FOR THE APPROVAL TO DISPOSE
OF VERY LOW-LEVEL RADIOACTIVE WASTE

1.0 Purpose

Pursuant to 10CFR20, § 20.302 Duke Power Company requests NRC approval of the proposed method for the disposal of water treatment residues contaminated at very low-levels of radioactivity. This application addresses the specific information requested in § 20.302.

2.0 Description of Waste Source

Sanitary, potable, and demineralized water systems at McGuire Nuclear Station are supplied with water that has been filtered through diatomaceous earth (DE) pressure filters. There are two DE filters, each with a capacity of 750 gpm for 24 hours, but normal filtered water usage requires operation of one filter at 750 gpm approximately 6 hours per day. The filters are backwashed as needed. With each backwash, 0.15 cubic yards of spent DE are flushed to the conventional wastewater treatment system.

The condensate demineralization system, which removes impurities from the steam cycle water, consists of four mixed bed demineralizer filters that use powdered ion-exchange resin. Under normal operation, three condensate demineralizers are operated continuously and each cell is backwashed every 10 days. With each backwash, 0.67 cubic yards of spent resin are flushed to the conventional wastewater treatment system.

Raw water intended for condensate makeup is pretreated to remove chlorine and organic material. Two 270 ft³ beds of organic removal type activated charcoal are used for this purpose and generate approximately 540 ft³ of spent charcoal per year.

All non-radioactive station waste streams, except sanitary waste, are routed to the conventional wastewater treatment system, which uses sedimentation, chemical addition, and aeration to treat the wastewater prior to discharge to the Catawba River via the National Pollutant Discharge Elimination System (NPDES) discharge point. Primary sedimentation occurs in the initial holdup pond, a 200,000-gallon concrete basin. Spent powdered resin, charcoal, and DE accumulate in this pond and must be removed periodically to maintain proper settling and retention of wastewater.

3.0 Waste Description

The sludge collected from the initial holdup pond is a semi-solid mixture of powdered resins, diatomaceous earth, and associated residues. The resins are styrene divinylbenzene polymers and contain the ions removed from the condensate.

The radioactivity concentrations of the sludge have been determined to be very low. The radionuclides and average concentrations obtained from eight samples of these sludge were identified as follows:

<u>Radionuclide</u>	<u>Average Concentration ($\mu\text{Ci}/\text{cm}^3$)</u>	<u>% Abundance</u>
Co-58	1.22 E-07	51.5
Co-60	1.15 E-07	48.5

The sample analysis reports are provided in Appendix 1.

The volume of waste being generated per year is projected to range from 8,500 to 13,500 cubic feet. At present, McGuire has accumulated approximately 10,000 cubic feet of these materials in the initial holdup pond.

4.0 Proposed Disposal Method

Because the sludge is slow to dry, it is unsuitable for landfilling, where the waste must be covered with soil the same day it is deposited. It is preferable to landspread the sludge at a suitable site and incorporate it into the soil after it has dried. The proposed disposal procedures which already approved for use by the state under Landfarming permit are as follows:

4.1 Transportation Procedure

- To remove this sludge, the pond is drained and the sludge is dredged from the bottom and transferred by dump truck to the disposal site.
- The sludge will be transported to or from the disposal site in such way that liquid or solid spills will be kept to a minimum.
- The preparation and shipment of radioactive material will be in accordance with station Health Physics procedures and station directives.

4.2 Disposal Procedure

- During and after the disposal process access to the proposed disposal site will be controlled. Proper warnings will be maintained as described in Landfarming permit.
- The waste sludge (water treatment residues) will be spread on the surface of the proposed disposal site over an approximate area and depth of one acre and six inches, respectively.
- The sludge will be incorporated approximately six inches into the soil after drying to the extent practical. Because of water retention by the resins, there will be no inhalation hazard from diatomaceous earth particles.
- A suitable year round vegetative cover will be established and maintained after the waste has been incorporated and covered with topsoil as needed, if necessary.
- The workers handling the waste disposal will be properly dressed in accordance with station Health Physics procedures and station directives.

4.3 Administration Procedure

- The waste volume of each batch disposed will be properly estimated and documented.
- For each batch of waste generated, a composite sample from different locations will be taken for radiological analysis, and results will be documented.
- The total waste volume and radioactivity inventories will be documented, and the total accumulating dose will be periodically evaluated.
- The disposal rates will be limited to 500 cubic yards per year (6 inches/acre/year).
- Adequate provisions will be taken to prevent wind erosion and surface runoff from conveying pollutants from the waste material application disposal area onto the adjacent property.
- Upon retirement, the site will be covered with top soil, if necessary, and grassed.

5.0 Evaluation of Environmental Impact

5.1 Proposed Site Characteristics

5.1.1 Topography

The proposed landspreading site is located northwest of the McGuire conventional treatment system outside the security fence but within the company controlled area. Figure 1 indicates the proposed landspread site location. The entry to the area is controlled by fencing and is only accessible from the station site. The disposal site is at an elevation of 719.5 MSL. Figure 2 is a USGS Topographic Map showing Duke Power property in vicinity of McGuire Nuclear Station and location of proposed land application site. The proposed disposal site is approximately 600 ft. long and 450 ft. wide and is used for deposition of soil removed during construction activities at McGuire Nuclear Station. McGuire FSAR Figures 2.3.2-1 through 2.3.2-3 illustrate the topography in some detail from within 1 mile to within 50 miles of the site. There will be no impact on topography in this area by the proposed method of disposal.

5.1.2 Geology

The ground surface residual soil consists of a variable thickness of soil underlain by partially weathered rock. The residual soils primarily are silty sands or sandy silty clay. The four major rock types appearing at the site are dark green meta-gabbro, light gray fine to medium grained granite, black and white fine grained diorite, and black and

white coarse grained diorite. The fill soils are general fine sandy silts and silty sands which include clay layers of low to moderate plasticity. For more geological information, see the McGuire FSAR, Volume 1, Section 2.5.1. There will be no impact on geology in this area by the proposed method of disposal.

5.2 Area Characteristics

5.2.1 Meteorology

Synoptic features during winter effect rather frequent alternation between mild and cool periods with occasional outbreaks of cold air. Such intrusions of cold air, however, are modified in the crossing and descent of the Appalachian Mountains. Summers, noted for their greater persistence in flow pattern, experience fairly constant trajectories from the south and southwest with advection of maritime tropical air. Wintertime precipitation occurs primarily in connection with migratory low pressure systems. Recurrence and areal distribution, therefore, are reasonably uniform. Summer rains on the contrary are associated more with showers and thunder-showers of the air mass variety, occasioned by intense and uneven heating of the earth's surface.

Severe weather, although infrequent, is most likely from March-October. During this season wind, water and hail damage can result from the thunderstorm, tornado and tropical storm (or hurricane).

There will be no impact on meteorology in this area by the proposed method of disposal. For more meteorological information, see the McGuire FSAR, Volume 1, Section 2.3.

5.2.2 Hydrology

The hydrological characteristics in the site vicinity are detailed in the McGuire FSAR, Volume 1, Section 2.4. There will be no impact on hydrology in this area by the proposed method of disposal.

5.3 Water Usage

5.3.1 Ground Water Usage

The plant site lies within the groundwater region known as the Charlotte area, which is part of the Piedmont Groundwater Province. Groundwater in this area is derived entirely from local precipitation. The surface materials in many locations are relatively impermeable with the result that only 10 to 15 inches of the average 43 inches of precipitation percolates to the water table.

Groundwater is contained in the pores that occur in the weathered material (residual soil-saprolite) above the relatively unweathered rock and in the fractures in the igneous and metamorphic rock. Although generally the depth to the water table depends on climate, topography and rock type, in the Charlotte area the depth depends primarily on topography and rock weathering because there is little variation in the hydrologic properties of rock types within the area. The water table varies from ground surface elevation in valleys to more than 100 feet below the surface on sharply rising hills. The groundwater level normally declines during the late spring, summer and early fall months as a result of evaporation and transpiration by plants, and, in the fall, when rainfall is low. The groundwater level rises in the late fall and winter when the evaporation potential is reduced.

The nearest major user of groundwater for public use is in Cornelius, located approximately six miles northeast of the plant. The nearest industrial user of surface water for human consumption is located approximately 17.8 river miles downstream of the plant. The Charlotte Municipal Water Intake is located 11.2 river miles downstream of the plant. For more information on ground water usage, see the McGuire FSAR, Volume 1, Section 2.4.13. There will be no impact on ground water usage by the proposed method of disposal.

5.3.2 Surface Water Usage

Subsurface water is typical of Piedmont area. The top of the zone of saturation, or water table, follows the topography, but is deeper in the uplands and more shallow in valley bottoms. It migrates through the pores of the weathered rock, where the feldspars have disintegrated and left interstitial spaces between the quartz grains. Additional water is contained in the deeper fractures and joints below the sound rock line. The water table is not stationary, but fluctuates continually as a reflection seasonal precipitation.

Shallow dug wells are supplied from surface deposits or from the upper decomposed parts of the bedrock. Many drilled wells of moderate depth are supplied from joints in the crystalline rocks.

Figure 3 indicates the locations of existing drinking wells in the vicinity of McGuire Nuclear Station. For more information on surface water usage, see McGuire FSAR, Volume 1, Section 2.4.13. There will be no impact on surface water usage by the proposed method of disposal.

5.4 Nearby Facilities

Military and transportation facilities are nearly non-existent and only a few industrial facilities are located in the vicinity of McGuire. The few facilities that do exist have no effect on the

McGuire Nuclear Station nor will McGuire Nuclear Station have any effect on the nearby facilities. For more information, see the McGuire FSAR, Volume 1, Section 2.2. There will be no impact on nearby facilities by the proposed method of disposal.

5.5 Radiological Impact

The annual dose rate to the total body for a person continuously occupying the area is estimated to be 0.5 mrem/yr at the center and 0.25 mrem/yr at the boundary of the disposal site. After one year the total dose at the center will be 0.3 mrem/yr. For a worker spending 2000 hr/yr in the area, the estimated whole body dose would be 0.1 mrem/yr. Actual doses to any member of the public are anticipated to be much lower due to infrequent occupancy. Detail calculations of annual dose rate estimation are included in Appendix 2.

6.0 Radiation Protection

The operational procedure to minimize the risk of unexpected or hazardous exposures will follow the guidelines provided by System Health Physics Manual and station directives on radiation exposure control and radioactive material control. All radioactive-waste release and disposal operations will be performed under the technical guidance and review of the Station Health Physicist.

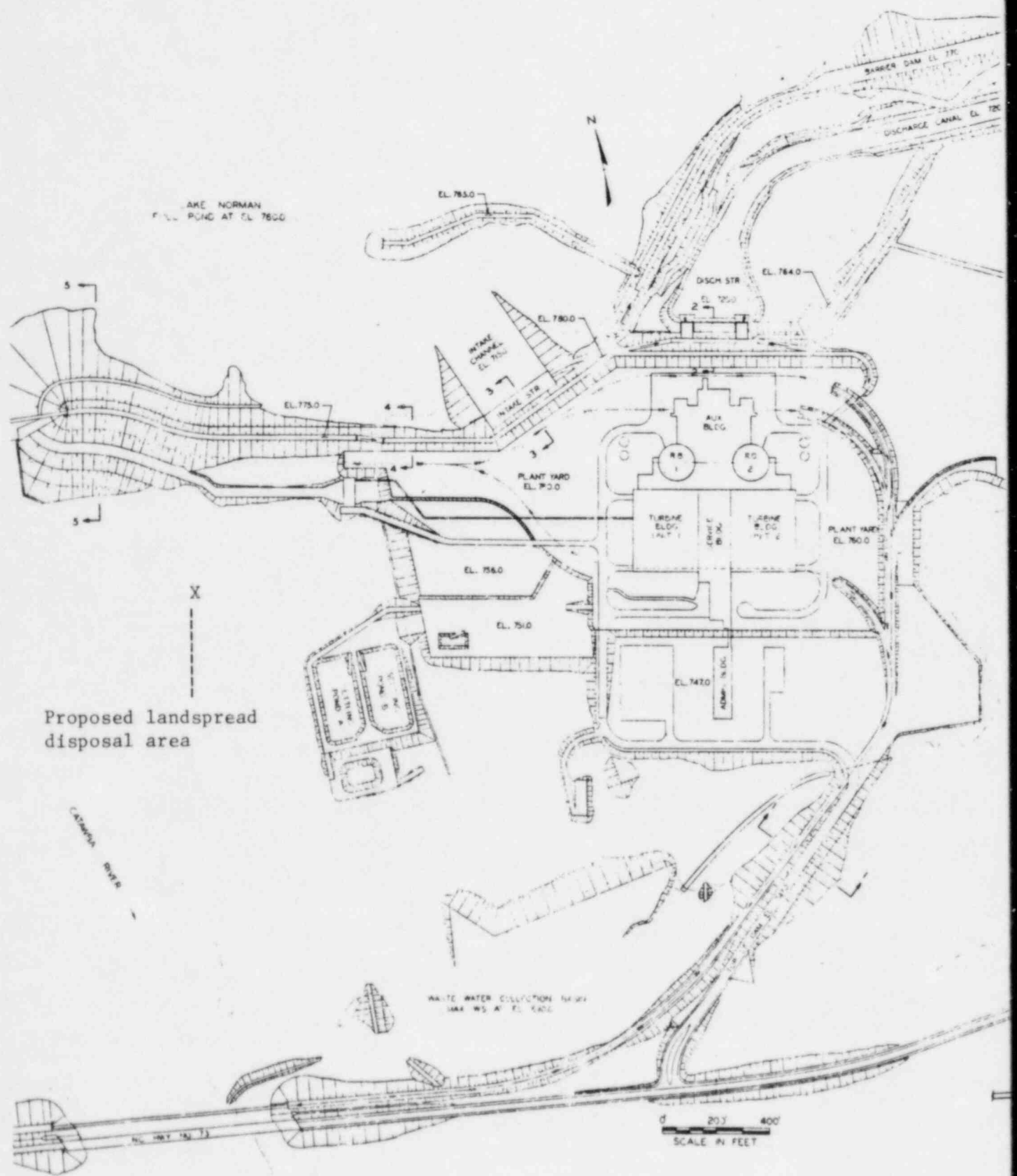
7.0 Evaluation of Overall Benefit

This sludge (10,000 ft³), if packaged and disposed of as radioactive waste, will cost approximately \$750,000 without solidification, and will cost more than 1.14 million dollars if solidification is required depending on radioactive waste packaging and waste form requirements. The actual burial space will be more than 12,000 ft³ in licensed radioactive waste burial site. Considering the generation rate of this type of waste (8,500 to 13,500 ft³ per year), the total cost saving could range from \$620,000 to 1.5 million dollars per year and save burial site space of 10,000 to 15,000 cubic feet per year. The annual dose rate for both the public and workers is much less than 1 mrem/yr assuming that they continuously occupy the proposed disposal site.

Appendix:

- (1) Water Treatment Residue Sample Analysis Results
- (2) Annual Dose Rate Estimations

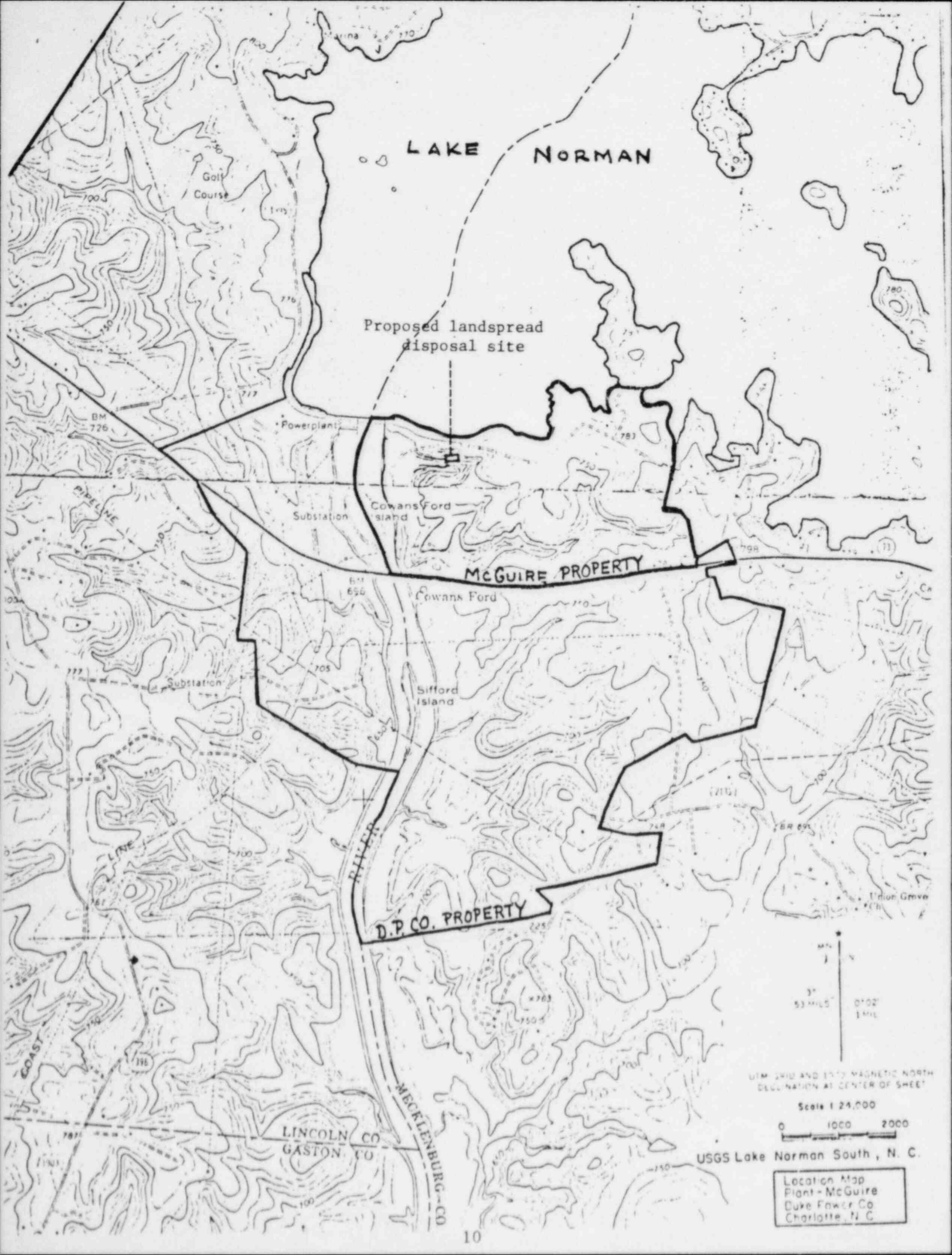
Figure 1. Layout of McGuire Nuclear Station Conventional Wastewater Treatment System, Showing Location of Proposed Land Application Site



Proposed landspread disposal area

McGUIRE NUCLEAR STATION

Figure 2. USGS Topographic Map Showing Duke Power Property in Vicinity of McGuire Nuclear Station and Location of Proposed Land Application Site.

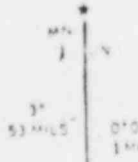


LAKE NORMAN

Proposed landspread disposal site

MCGUIRE PROPERTY

D.P. CO. PROPERTY

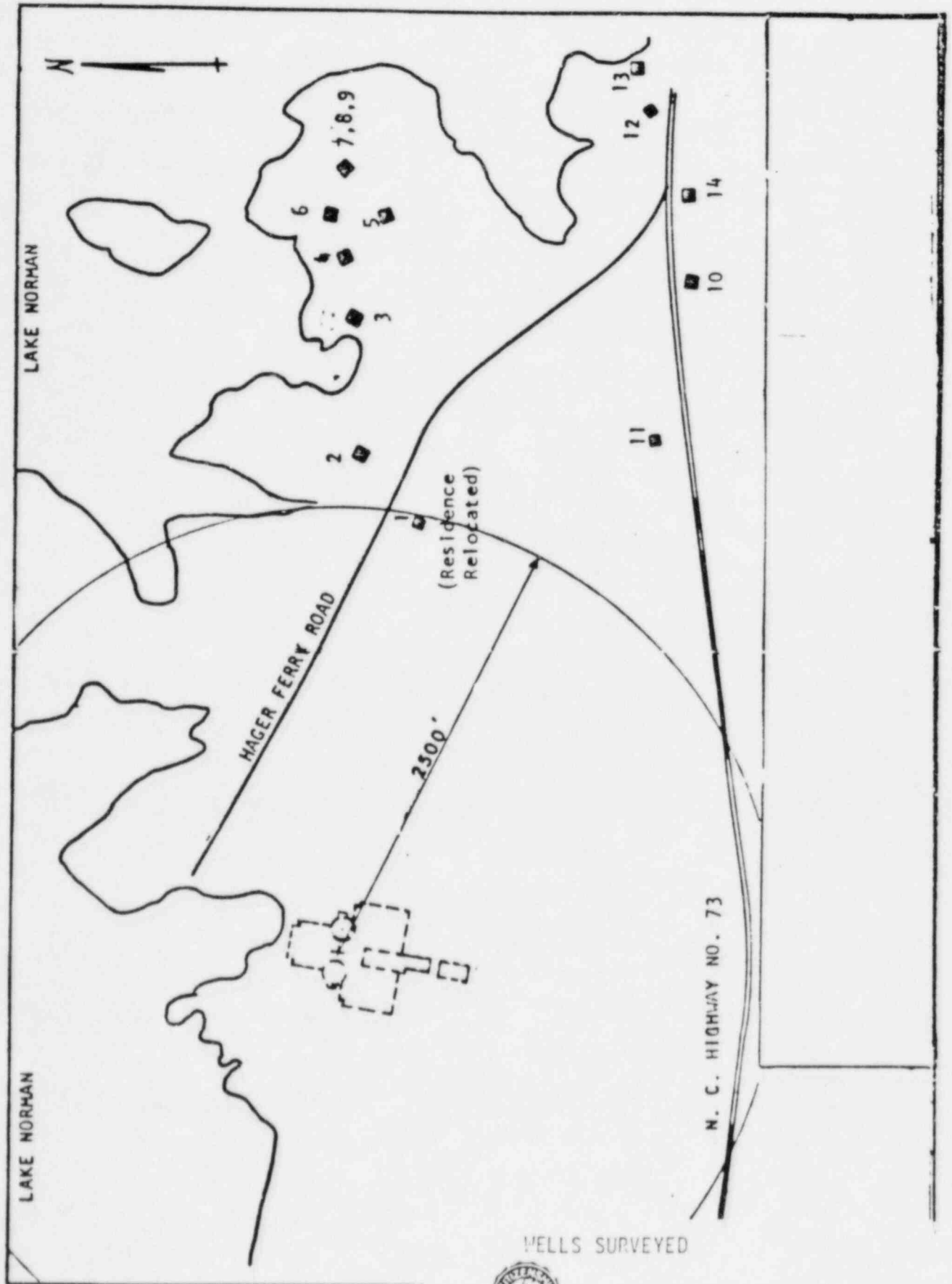


UTM GRID AND 1917 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

USGS Lake Norman South, N. C.

Location Map
Plant - McGuire
Duke Power Co
Charlotte, N. C.

Figure 3. Survey of Drinking Wells in the Vicinity of McGuire Nuclear Station.



WELLS SURVEYED



McGUIRE NUCLEAR STATION

APPENDIX 1

Water Treatment Residue Sample Analysis Results

NC JHP SLUDGE #5 WILSON

ATTACHMENT 1

SAMPLE DATE: 30-MAY-84 13:00:00
 SAMPLE IDENTIFICATION: 84-10970
 TYPE OF SAMPLE: C/SLUDGE
 SAMPLE QUANTITY: 3500.000 UNITS: ML
 SAMPLE GEOMETRY: MARINELLI
 EFFICIENCY FILE NAME: CEFF.C3500M,

Sample # 1

 *
 ACQUIRE DATE: 30-MAY-84 17:03:28 * FWHM(1332) 2.639
 PRESET TIME(LIVE): 600. SEC * SENSITIVITY: 3.500
 ELAPSED REAL TIME: 601. SEC * SHAPE PARAMETER : 15.0 %
 ELAPSED LIVE TIME: 600. SEC * NBR ITERATIONS: 10.
 *

 *
 DETECTOR: C GELI 1669 * LIBRARY:NUCL. MASTER
 CALIB DATE: 21-MAY-84 18:18:42 * ENERGY TOLERANCE: 1.500KV
 KEV/CHNL: 0.5000634 * HALF LIFE RATIO: 8.00
 OFFSET: -0.0307648 KEV * ABUNDANCE LIMIT: 80.00%
 Q. COEFF. : 1.719E-08 KEV/C**2 *
 *

4 DEAD TIME= 0.17 % * REVIEWED BY: *P. L. Blanc*

ENERGY WINDOW 24.97 TO 2025.51

PK	IT	ENERGY	AREA	BKGND	FWHM	CHANNEL	LEFT	PW	CTS/SEC	%ERR	FIT
1	0	107.48	23.	119.	4.63	214.98	206	17	3.91E-02	68.9	
2	0	188.19	20.	163.	6.99	376.38	369	26	3.37E-02	92.0	
3	0	296.67	45.	88.	1.51	593.31	579	39	7.51E-02	33.0	
4	0	351.79	45.	63.	1.74	703.54	695	33	7.54E-02	29.0	
5	0	424.17	6.	41.	12.26	848.27	829	33	9.32E-03	****	
6	0	608.95	39.	15.	1.09	1217.76	1211	20	6.54E-02	21.2	
7	0	810.40	27.	40.	1.98	1620.56	1611	40	4.47E-02	38.5	
8	3	1171.54	18.	1.	1.49	2342.65	2332	20	2.92E-02	25.4	5.65E-01
9	3	1173.62	10.	1.	1.49	2346.81	2332	20	1.66E-02	33.8	
10	0	1332.04	18.	4.	2.42	2663.96	2655	16	3.00E-02	28.3	

PEAK SEARCH COMPLETED (REV 11)

Sample #1

FISSION GAS

NUCLIDE	SBHR	ENERGY	AREA	BKGND	%ABN	%EFF	UCI /UNIT	1 SIGMA ERROR
Xe-135	FG	249.79	0.	0.	89.90*	0.000E-01	0.000E 0	0.000E 0
		608.19	39.	15.	2.90	4.470E-01	4.247E -6	9.011E -7

ACTIVATION PRODUCT

NUCLIDE	SBHR	ENERGY	AREA	BKGND	%ABN	%EFF	UCI /UNIT	1 SIGMA ERROR
Co-58	AP	810.75	27.	40.	99.50*	3.352E-01	1.035E -7	3.989E -8
		863.94	0.	0.	0.70	0.000E-01	0.000E 0	0.000E 0
		1674.73	0.	0.	0.50	0.000E-01	0.000E 0	0.000E 0
Co-60	AP	1173.21	10.	1.	99.90	2.500E-01	5.129E -8	1.735E -8
		1332.46	18.	4.	100.00*	2.252E-01	1.026E -7	2.914E -8
P-239	AP	99.55	0.	0.	15.00	0.000E-01	0.000E 0	0.000E 0
		103.76	0.	0.	24.00	0.000E-01	0.000E 0	0.000E 0
		106.13	23.	119.	22.70*	9.927E-01	1.359E -7	9.365E -8
		117.00	0.	0.	11.30	0.000E-01	0.000E 0	0.000E 0
		277.60	0.	0.	14.10	0.000E-01	0.000E 0	0.000E 0

FISSION PRODUCT

NUCLIDE	SBHR	ENERGY	AREA	BKGND	%ABN	%EFF	UCI /UNIT	1 SIGMA ERROR
Ba-140	FP	423.81	6.	41.	2.50*	6.112E-01	4.721E -7	7.926E -7
		537.32	0.	0.	20.00	0.000E-01	0.000E 0	0.000E 0

NATURAL PRODUCT

NUCLIDE	SBHR	ENERGY	AREA	BKGND	%ABN	%EFF	UCI /UNIT	1 SIGMA ERROR
Pb-214	NP	295.17	45.	88.	19.20	7.875E-01	2.247E -6	7.408E -7
		351.90	45.	63.	37.10*	7.010E-01	1.312E -6	3.801E -7
Bi-214	NP	609.32	39.	15.	46.10	4.470E-01	2.646E -6	5.614E -7
		1120.28	0.	0.	15.00*	0.000E-01	0.000E 0	0.000E 0
		1764.51	0.	0.	15.90	0.000E-01	0.000E 0	0.000E 0

PK	IT	ENERGY	AREA	BKGND	FWHM	CHANNEL	LEFT	PW	CTS/SEC	%ERR	%EFF
2	0	188.19	20.	163.	6.99	376.38	369	26	3.37E-02	92.0	1.11E-00
8	3	1171.54	18.	1.	1.49	2342.65	2332	20	2.92E-02	25.4	2.50E-01

U.P.
CE13

INES NOT MEETING SUMMARY CRITERIA

PK	NUCLIDE	ENERGY	HLFE	DECAY	UCI /UNIT	ABNDIFF	FAILED
1	NP-239	106.13	2.36D	1.014E 0	1.359E -7	26.06%	ABN
5	BA-140	423.81	12.79D	1.003E 0	4.721E -7	11.11%	ABN
6	XE-135	608.19	9.08H	1.091E 0	4.247E -6	3.12%	ABN
6	BI-214	609.32	19.90M	1.081E 1	2.646E -6	59.87%	ABN

TOTAL LINES IN SPECTRUM 10
 LINES NOT LISTED IN LIBRARY 2
 IDENTIFIED IN SUMMARY REPORT 5 50.00%

ACTIVATION PRODUCT

NUCLIDE	SBHR	HLIFE	DECAY	UCI /UNIT	1-SIGMA ERROR	%ERR
CO-58	AP	70.80D	1.000	1.035E -7	3.989E -8	38.55
CO-60	AP	5.27Y	1.000	1.028E -7	2.914E -8	28.34

NATURAL PRODUCT

NUCLIDE	SBHR	HLIFE	DECAY	UCI /UNIT	1-SIGMA ERROR	%ERR
PB-214	NP	26.80M	2.155	1.312E -6	3.801E -7	28.97

MC IHP SLUDGE #6 WILSON

SAMPLE DATE: 30-MAY-84 16:00:00
 SAMPLE IDENTIFICATION: 84-10971
 TYPE OF SAMPLE: C/SLUDGE
 SAMPLE QUANTITY: 3500.000 UNITS: ML
 SAMPLE GEOMETRY: MARINELLI
 EFFICIENCY FILE NAME: DEFF.D3500M,,

Sample # 2

ACQUIRE DATE: 30-MAY-84 16:59:03 * FWHM(1332) 2.103
 PRESET TIME(LIVE): 600. SEC * SENSITIVITY: 3.900
 ELAPSED REAL TIME: 600. SEC * SHAPE PARAMETER : 15.0 %
 ELAPSED LIVE TIME: 600. SEC * NBR ITERATIONS: 10.

DETECTOR: D-GEM 23-P-67WB * LIBRARY:NUCL. MASTER
 CALIB DATE: 25-MAY-84 17:33:58 * ENERGY TOLERANCE: 1.500KV
 KEV/CHNL: 0.4997780 * HALF LIFE RATIO: 8.00
 OFFSET: 0.3698110 KEV * ABUNDANCE LIMIT: 80.00%
 Q. COEFF. : -1.322E-08 KEV/C**2 *

% DEAD TIME= 0.00 % * REVIEWED BY: *G. L. Blanc*
 ENERGY WINDOW 25.36 TO 2024.25

PK	IT	ENERGY	AREA	BKGND	FWHM	CHANNEL	LEFT	PW	CTS/SEC	%ERR	F.L.T
1	0	240.27	43.	86.	3.86	480.01	470	18	7.08E-02	34.4	
2	0	295.60	56.	56.	1.74	590.74	585	32	9.39E-02	23.0	
3	0	351.81	66.	28.	1.32	703.20	696	14	1.10E-01	16.7	
4	0	511.05	20.	14.	2.02	1021.84	1017	18	3.30E-02	34.6	
5	0	609.29	78.	7.	1.85	1218.41	1210	26	1.30E-01	12.2	
6	0	810.82	8.	39.	0.73	1621.69	1613	26	1.33E-02	****	
7	0	1173.21	16.	7.	1.45	2346.88	2340	13	2.67E-02	33.7	
8	0	1332.93	12.	0.	1.10	2666.50	2661	13	2.00E-02	28.9	
9	0	1461.11	16.	0.	1.60	2923.00	2918	16	2.67E-02	25.0	

PEAK SEARCH COMPLETED (REV 11)

sample # 2

FISSION GAS

UCLIDE	SBHR	ENERGY	AREA	BKGND	%ABN	%EFF	UCI /UNIT	1 SIGMA ERROR	
E-135	FG	249.79	0.	0.	89.90*	0.000E-01	0.000E 0	0.000E 0	0.000E 0
		608.19	78.	7.	2.90	5.680E-01	6.615E -6	8.088E -7	

ACTIVATION PRODUCT

UCLIDE	SBHR	ENERGY	AREA	BKGND	%ABN	%EFF	UCI /UNIT	1 SIGMA ERROR	
O-58	AP	810.75	8.	39.	99.50*	4.445E-01	2.329E -8	2.700E -8	
		863.94	0.	0.	0.70	0.000E-01	0.000E 0	0.000E 0	
		1674.73	0.	0.	0.50	0.000E-01	0.000E 0	0.000E 0	
O-60	AP	1173.21	16.	7.	99.90	3.402E-01	6.058E -8	2.039E -8	
		1332.46	12.	0.	100.00*	3.039E-01	5.082E -8	1.467E -8	

HALOGEN FISSION PRODUCT

UCLIDE	SBHR	ENERGY	AREA	BKGND	%ABN	%EFF	UCI /UNIT	1 SIGMA ERROR	
I-132	HFP	505.90	0.	0.	5.00	0.000E-01	0.000E 0	0.000E 0	
		522.65	0.	0.	16.10	0.000E-01	0.000E 0	0.000E 0	
		630.22	0.	0.	13.70	0.000E-01	0.000E 0	0.000E 0	
		667.69	0.	0.	98.70	0.000E-01	0.000E 0	0.000E 0	
		671.60	0.	0.	5.20	0.000E-01	0.000E 0	0.000E 0	
		772.60	0.	0.	76.20*	0.000E-01	0.000E 0	0.000E 0	
		812.20	8.	39.	5.60	4.445E-01	5.706E -7	6.614E -7	
		954.55	0.	0.	18.10	0.000E-01	0.000E 0	0.000E 0	
		1398.57	0.	0.	7.10	0.000E-01	0.000E 0	0.000E 0	

NATURAL PRODUCT

UCLIDE	SBHR	ENERGY	AREA	BKGND	%ABN	%EFF	UCI /UNIT	1 SIGMA ERROR	
I-40	NP	1460.81	16.	0.	10.70*	2.934E-01	6.791E -7	1.698E -7	
B-214	NP	295.17	56.	56.	19.20	1.001E 00	1.971E -6	4.541E -7	
		351.90	66.	28.	37.10*	8.746E-01	1.368E -6	2.290E -7	
I-214	NP	609.32	78.	7.	46.10	5.680E-01	3.853E -6	4.344E -7	
		1120.28	0.	0.	15.00*	0.000E-01	0.000E 0	0.000E 0	
		1764.51	0.	0.	15.90	0.000E-01	0.000E 0	0.000E 0	

PK	IT	ENERGY	AREA	BKGND	FWHM	CHANNEL	LEFT	PW	CTS/SEC	%ERR	%EFF	
1	0	240.27	43.	86.	3.86	480.01	470	18	7.08E-02	34.4	1.13E	007013
4	0	511.05	20.	14.	2.02	1021.84	1017	18	3.30E-02	34.6	6.53E-01	ann peak

LINE NOT MEETING SUMMARY CRITERIA

PK	NUCLIDE	ENERGY	HLFE	DECAY	UCI /UNIT	ABNDIFF	FAILED
5	XE-135	608.19	9.08H	1.085E 0	6.615E -6	3.12%	ABN
5	BI-214	609.32	19.90M	9.262E 0	3.553E -6	59.87%	ABN
6	I-132	812.20	2.30H	1.379E 0	5.706E -7	2.28%	ABN

TOTAL LINES IN SPECTRUM 9
 LINES NOT LISTED IN LIBRARY 2
 IDENTIFIED IN SUMMARY REPORT 6 66.67%

sample # 2

ACTIVATION PRODUCT

NUCLIDE	SBHR	HLIFE	DECAY	UCI /UNIT	1-SIGMA ERROR	%ERR
CO-58	AP	70.80D	1.000	2.329E -8	2.700E -8	115.92 <i>N.P.</i>
CO-60	AP	5.27Y	1.000	5.082E -8	1.467E -8	28.87

NATURAL PRODUCT

NUCLIDE	SBHR	HLIFE	DECAY	UCI /UNIT	1-SIGMA ERROR	%ERR
K-40	NP *****Y		1.000	6.791E -7	1.698E -7	25.00
PB-214	NP	26.80M	2.051	1.368E -6	2.290E -7	16.74

sample # 3

30-MAY-84 17:06:12

C IHP SLUDGE #7 WILSON

SAMPLE DATE: 30-MAY-84 16:00:00
SAMPLE IDENTIFICATION: 84-10972
TYPE OF SAMPLE: C/SLUDGE
SAMPLE QUANTITY: 3500.000 UNITS: ML
SAMPLE GEOMETRY: MARINELLI
EFFICIENCY FILE NAME: AEFF.A3500M,

ACQUIRE DATE: 30-MAY-84 16:56:01 * FWHM(1332) 2.176
PRESET TIME(LIVE): 600. SEC * SENSITIVITY: 4.000
ELAPSED REAL TIME: 601. SEC * SHAPE PARAMETER : 15.0 %
ELAPSED LIVE TIME: 600. SEC * NBR ITERATIONS: 10.

DETECTOR: A GELI 1729 * LIBRARY:NUCL. MASTER
CALIB DATE: 24-MAY-84 18:03:36 * ENERGY TOLERANCE: 1.500KV
KEV/CHNL: 0.5005288 * HALF LIFE RATIO: 8.00
OFFSET: -0.1135935 KEV * ABUNDANCE LIMIT: 80.00%
Q. COEFF. : -1.962E-07 KEV/C**2

% DEAD TIME= 0.17 % * REVIEWED BY: *P. L. Blanc*

ENERGY WINDOW 49.94 TO 2038.78

PK	IT	ENERGY	AREA	BKGD	FWHM	CHANNEL	LEFT	PW	CTS/SEC	%ERR	FIT
1	0	185.53	21.	63.	1.15	370.94	365	11	3.56E-02	57.0	
2	6	238.39	28.	23.	1.36	476.59	471	28	4.53E-02	30.0	2.08E 00
3	6	241.40	29.	20.	1.24	482.62	471	29	4.03E-02	28.0	
4	0	295.16	36.	36.	1.14	590.06	584	18	5.98E-02	38.0	
5	0	352.16	69.	17.	1.65	703.99	694	33	1.14E-01	14.7	
6	0	582.61	12.	18.	3.83	1164.75	1159	18	1.04E-02	20.0	
7	0	609.63	42.	8.	1.99	1218.78	1214	15	2.37E-02	18.0	
8	0	811.41	7.	30.	0.90	1622.36	1615	20	1.10E-02	44.0	
9	0	1461.40	9.	3.	0.66	2923.29	2918	12	1.53E-02	42.0	

PEAK SEARCH COMPLETED (REV 11)

sample #3

NUCLIDE IDENTIFICATION SYSTEM (REV 5/80)
NUCLIDE LINE ACTIVITY REPORT

FISSION GAS

NUCLIDE	SBHR	ENERGY	AREA	BKGND	%ABN	%EFF	UCI /UNIT	1 SIGMA ERROR
Xe-135	FG	249.79	0.	0.	89.90*	0.000E-01	0.000E 0	0.000E 0
		608.19	42.	8.	2.90	4.533E-01	4.422E -6	7.974E -7

ACTIVATION PRODUCT

NUCLIDE	SBHR	ENERGY	AREA	BKGND	%ABN	%EFF	UCI /UNIT	1 SIGMA ERROR
CO-58	AP	810.75	7.	30.	99.50*	3.535E-01	2.416E -8	2.997E -8
		863.94	0.	0.	0.70	0.000E-01	0.000E 0	0.000E 0
		1674.73	0.	0.	0.50	0.000E-01	0.000E 0	0.000E 0

HALOGEN FISSION PRODUCT

NUCLIDE	SBHR	ENERGY	AREA	BKGND	%ABN	%EFF	UCI /UNIT	1 SIGMA ERROR
I-132	HFP	505.90	0.	0.	5.00	0.000E-01	0.000E 0	0.000E 0
		522.65	0.	0.	16.10	0.000E-01	0.000E 0	0.000E 0
		630.22	0.	0.	13.70	0.000E-01	0.000E 0	0.000E 0
		667.69	0.	0.	98.70	0.000E-01	0.000E 0	0.000E 0
		671.60	0.	0.	5.20	0.000E-01	0.000E 0	0.000E 0
		772.60	0.	0.	76.20*	0.000E-01	0.000E 0	0.000E 0
		812.20	7.	30.	5.60	3.535E-01	5.829E -7	7.208E -7
		954.55	0.	0.	18.10	0.000E-01	0.000E 0	0.000E 0
		1398.57	0.	0.	7.10	0.000E-01	0.000E 0	0.000E 0

NATURAL PRODUCT

NUCLIDE	SBHR	ENERGY	AREA	BKGND	%ABN	%EFF	UCI /UNIT	1 SIGMA ERROR
K-40	NP	1460.81	9.	3.	10.70*	2.196E-01	5.181E -7	2.188E -7
PB-214	NP	295.17	36.	36.	19.20	7.762E-01	1.498E -6	4.336E -7
		351.90	69.	17.	37.10*	6.874E-01	1.671E -6	2.457E -7
BI-214	NP	609.32	42.	8.	46.10	4.533E-01	2.146E -6	3.869E -7
		1120.28	0.	0.	15.00*	0.000E-01	0.000E 0	0.000E 0
		1764.51	0.	0.	15.90	0.000E-01	0.000E 0	0.000E 0

sample # 3

NUCLIDE IDENTIFICATION SYSTEM (REV 5/80)
UNKNOWN LINE REPORT

PAGE 2

PK	IT	ENERGY	AREA	BOUND	FWHM	CHANNEL	LEFT	PW	CTS/SEC	%ERR	%EFF
1	0	185.53	21.	22.	1.15	370.94	365	11	3.56E-02	57.0	1.01E-00
2	6	238.39	28.	23.	1.36	476.59	471	28	4.59E-02	30.9	8.63E-04
3	6	241.40	29.	20.	1.24	482.62	471	28	4.85E-02	28.5	8.57E-04
5	0	582.61	12.	16.	3.83	1164.75	1159	18	1.94E-02	59.2	4.70E-01

INES NOT MEETING SUMMARY CRITERIA

PK	NUCLIDE	ENERGY	HLFE	DECAY	UCI /UNIT	ABNDIFF	FAILED
7	XE-135	608.19	9.08H	1.081E 0	4.422E -6	3.12%	ABN
7	BI-214	609.32	19.90M	8.326E 0	2.146E -6	59.87%	ABN
8	I-132	812.20	2.30H	1.359E 0	5.829E -7	2.28%	ABN

sample #3

NUCLIDE IDENTIFICATION SYSTEM (REV 5/80)
SUMMARY OF NUCLIDE ACTIVITY

TOTAL LINES IN SPECTRUM 3
LINES NOT LISTED IN LIBRARY 4
IDENTIFIED IN SUMMARY REPORT 4 44.44%

ACTIVATION PRODUCT

NUCLIDE	SBHR	HLIFE	DECAY	UCI /UNIT	1-SIGMA ERROR	%ERR
C-58	AP	70.80D	1.000	2.416E -8	2.987E -8	123.65

NATURAL PRODUCT

NUCLIDE	SBHR	HLIFE	DECAY	UCI /UNIT	1-SIGMA ERROR	%ERR
-40	NP *****Y		1.000	5.181E -7	2.188E -7	42.23
B-214	NP	26.80M	1.982	1.671E -6	2.457E -7	14.71

30-MAY-84 16:58:42

Sample # 4

4C IHP SLUDGE #8

SAMPLE DATE: 30-MAY-84 16:00:00
SAMPLE IDENTIFICATION: 84-10973
TYPE OF SAMPLE: C/SLUDGE
SAMPLE QUANTITY: 3500.000 UNITS: ML
SAMPLE GEOMETRY: MARINELLI
EFFICIENCY FILE NAME: CEFF.C3500M,

ACQUIRE DATE: 30-MAY-84 16:45:08 * FWHM(1332) 2.639
PRESET TIME(LIVE): 600. SEC * SENSITIVITY: 3.500
ELAPSED REAL TIME: 600. SEC * SHAPE PARAMETER : 15.0 %
ELAPSED LIVE TIME: 600. SEC * NBR ITERATIONS: 10.

DETECTOR: C GELI 1669 * LIBRARY:NUCL. MASTER
CALIB DATE: 21-MAY-84 18:18:42 * ENERGY TOLERANCE: 1.500KV
KEV/CHNL: 0.5000634 * HALF LIFE RATIO: 8.00
OFFSET: -0.0307648 KEV * ABUNDANCE LIMIT: 80.00%
Q. COEFF. : 1.719E-08 KEV/C**2

% DEAD TIME= 0.00 % * REVIEWED BY: P. LeBlanc

ENERGY WINDOW 24.97 TO 2025.51

Table with 11 columns: PK, IT, ENERGY, AREA, BKGND, FWHM, CHANNEL, LEFT, PW, CTS/SEC, %ERR, FIT. Contains 8 rows of peak data.

PEAK SEARCH COMPLETED (REV 11)

FISSION GAS

NUCLIDE	SBHR	ENERGY	AREA	BKGND	%ABN	%EFF	UCI /UNIT	1 SIGMA ERROR
XE-135	FG	249.79	0.	0.	89.90*	0.000E-01	0.000E 0	0.000E 0
		608.19	41.	10.	2.90	4.467E-01	4.297E -6	8.237E -7

ACTIVATION PRODUCT

NUCLIDE	SBHR	ENERGY	AREA	BKGND	%ABN	%EFF	UCI /UNIT	1 SIGMA ERROR
CO-60	AP	1173.21	28.	20.	99.90	2.500E-01	1.422E -7	4.252E -8
		1332.46	34.	4.	100.00*	2.252E-01	1.948E -7	3.708E -8

FISSION PRODUCT

NUCLIDE	SBHR	ENERGY	AREA	BKGND	%ABN	%EFF	UCI /UNIT	1 SIGMA ERROR
CS-134	FP	563.23	0.	0.	8.40	0.000E-01	0.000E 0	0.000E 0
		569.32	0.	0.	15.40	0.000E-01	0.000E 0	0.000E 0
		604.70	21.	12.	97.60	4.494E-01	6.025E -8	1.955E -8
		795.85	0.	0.	85.40*	0.000E-01	0.000E 0	0.000E 0
		801.93	0.	0.	8.70	0.000E-01	0.000E 0	0.000E 0

NATURAL PRODUCT

NUCLIDE	SBHR	ENERGY	AREA	BKGND	%ABN	%EFF	UCI /UNIT	1 SIGMA ERROR
PB-214	NP	295.17	13.	173.	19.20	7.896E-01	4.149E -7	5.861E -7
		351.90	64.	44.	37.10*	7.005E-01	1.156E -6	2.226E -7
BI-214	NP	609.32	41.	10.	46.10	4.467E-01	1.446E -6	2.773E -7
		1120.28	0.	0.	15.00*	0.000E-01	0.000E 0	0.000E 0
		1764.51	0.	0.	15.90	0.000E-01	0.000E 0	0.000E 0

PK	IT	ENERGY	AREA	BKGND	FWHM	CHANNEL	LEFT	PW	CTS/SEC	%ERR	%EFF	
3	0	443.90	17.	9.	14.94	887.72	874	35	2.87E-02	34.2	5.87E-01	<i>N.P</i>
4	0	511.05	12.	38.	3.26	1022.00	1016	15	2.06E-02	75.8	5.19E-01	<i>N.P</i>

INES NOT MEETING SUMMARY CRITERIA

PK	NUCLIDE	ENERGY	HLFE	DECAY	UCI /UNIT	ABNDIFF	FAILED
5	CS-134	604.70	2.06Y	1.000E 0	6.025E -8	45.29%	ABN
6	XE-135	608.19	9.08H	1.066E 0	4.297E -6	3.12%	ABN
6	BI-214	609.32	19.90M	5.704E 0	1.446E -6	59.87%	ABN

TOTAL LINES IN SPECTRUM 8
LINES NOT LISTED IN LIBRARY 2
IDENTIFIED IN SUMMARY REPORT 4 50.00%

ACTIVATION PRODUCT

NUCLIDE	SBHR	HLIFE	DECAY	UCI /UNIT	1-SIGMA ERROR	%ERR
Co-60	AP	5.27Y	1.000	1.948E -7	3.708E -8	19.03

NATURAL PRODUCT

NUCLIDE	SBHR	HLIFE	DECAY	UCI /UNIT	1-SIGMA ERROR	%ERR
Pb-214	NP	26.80M	1.754	1.156E -6	2.226E -7	19.26

Chem # 2949

sample #5

30-MAY-84 10:32:55

NO I HD SLUDGE I

SAMPLE DATE: 30-MAY-84 10:00:00
SAMPLE IDENTIFICATION: 84-10052
TYPE OF SAMPLE: C/SLUDGE
SAMPLE QUANTITY: 3500.000 UNITS: ML
SAMPLE GEOMETRY: MARI
EFFICIENCY FILE NAME: CEFF.C3500M,

ACQUIRE DATE: 30-MAY-84 10:22:43 * FWHM(1332) 2.639
PRESET TIME(LIVE): 600. SEC * SENSITIVITY: 3.500
ELAPSED REAL TIME: 601. SEC * SHAPE PARAMETER : 15.0 %
ELAPSED LIVE TIME: 600. SEC * NBR ITERATIONS: 10.

DETECTOR: C GELI 1669 * LIBRARY:NUCL.MASTER
CALIB DATE: 21-MAY-84 18:18:42 * ENERGY TOLERANCE: 1.500KV
KEV/CHNL: 0.5000634 * HALF LIFE RATIO: 8.00
OFFSET: -0.0307648 KEV * ABUNDANCE LIMIT: 80.00%
Q. COEFF. : 1.719E-08 KEV/C**2

% DEAD TIME= 0.17 % * REVIEWED BY: A. Smith

ENERGY WINDOW 24.97 TO 2025.51

Table with 11 columns: PK, IT, ENERGY, AREA, BKGND, FWHM, CHANNEL, LEFT, PW, CTS/SEC, %ERR, FIT. It contains 14 rows of peak data.

PEAK SEARCH COMPLETED (REV 11)

sample #5

NUCLIDE IDENTIFICATION SYSTEM (REV 5/80)
NUCLIDE LINE ACTIVITY REPORT

FISSION GAS

NUCLIDE	SBHR	ENERGY	AREA	BKGND	%ABN	%EFF	UCI /UNIT	1 SIGMA ERROR
KR-85	FG	513.99	3.	23.	0.40*	5.168E-01	1.697E -6	4.301E -6
XE-135	FG	249.79	0.	0.	89.90*	0.000E-01	0.000E 0	0.000E 0
		608.19	65.	48.	2.90	4.468E-01	6.647E -6	1.300E -6

ACTIVATION PRODUCT

NUCLIDE	SBHR	ENERGY	AREA	BKGND	%ABN	%EFF	UCI /UNIT	1 SIGMA ERROR
W-187	AP	479.53	3.	13.	23.40*	5.467E-01	2.662E -8	5.548E -8
		685.81	0.	0.	29.20	0.000E-01	0.000E 0	0.000E 0
NP-239	AP	99.55	0.	0.	15.00	0.000E-01	0.000E 0	0.000E 0
		103.76	17.	264.	24.00	9.665E-01	9.486E -8	1.303E -7
		106.13	0.	0.	22.70*	0.000E-01	0.000E 0	0.000E 0
		117.00	0.	0.	11.30	0.000E-01	0.000E 0	0.000E 0
		277.60	0.	0.	14.10	0.000E-01	0.000E 0	0.000E 0

FISSION PRODUCT

NUCLIDE	SBHR	ENERGY	AREA	BKGND	%ABN	%EFF	UCI /UNIT	1 SIGMA ERROR
CS-138	FP	408.98	0.	0.	4.70	0.000E-01	0.000E 0	0.000E 0
		462.79	5.	17.	30.70	5.659E-01	6.715E -8	8.387E -8
		871.80	0.	0.	5.10	0.000E-01	0.000E 0	0.000E 0
		1009.78	0.	0.	29.80	0.000E-01	0.000E 0	0.000E 0
		1435.86	0.	0.	76.30*	0.000E-01	0.000E 0	0.000E 0
BA-140	FP	423.81	0.	0.	2.50*	0.000E-01	0.000E 0	0.000E 0
		537.32	3.	24.	20.00	4.980E-01	4.406E -8	9.275E -8

NATURAL PRODUCT

NUCLIDE	SBHR	ENERGY	AREA	BKGND	%ABN	%EFF	UCI /UNIT	1 SIGMA ERROR
K-40	NP	1460.81	15.	0.	10.70*	2.085E-01	8.653E -7	2.234E -7
OB-214	NP	295.17	46.	67.	19.20	7.898E-01	7.975E -7	2.319E -7
		351.90	83.	38.	37.10*	7.007E-01	8.393E -7	1.275E -7
BI-214	NP	609.32	65.	48.	46.10	4.468E-01	1.055E -6	2.063E -7
		1120.28	0.	0.	15.00*	0.000E-01	0.000E 0	0.000E 0
		1764.51	0.	0.	15.90	0.000E-01	0.000E 0	0.000E 0

sample #5

NUCLIDE IDENTIFICATION SYSTEM (REV 5/80)
UNKNOWN LINE REPORT

PK	IT	ENERGY	AREA	BKGND	FWHM	CHANNEL	LEFT	PW	CTS/SEC	%ERR	%EFF
2	0	136.33	18.	52.	1.35	272.68	268	8	2.98E-02	61.8	1.15E-00
3	0	186.62	27.	84.	1.57	373.26	365	16	4.46E-02	52.1	1.12E-00
4	0	226.00	6.	142.	0.75	452.00	446	21	9.23E-03	****	9.46E-01
8	0	477.05	3.	62.	0.29	954.00	943	19	4.32E-03	****	5.50E-01
13	0	911.64	7.	6.	0.54	1823.00	1818	11	1.08E-02	64.4	2.96E-01

LINE NOT MEETING SUMMARY CRITERIA

PK	NUCLIDE	ENERGY	HLFE	DECAY	UCI /UNIT	ABNDIFF	FAILED
1	NP-239	103.76	2.36D	1.006E 0	9.486E -8	27.55%	ABN
7	CS-138	462.79	32.20M	1.813E 0	6.715E -8	20.94%	ABN
9	W-187	479.53	23.90H	1.013E 0	2.662E -8	44.49%	ABN
12	XE-135	608.19	9.08H	1.036E 0	6.647E -6	3.12%	ABN
12	BI-214	609.32	19.90M	2.613E 0	1.055E -6	59.87%	ABN

sample # 5

NUCLIDE IDENTIFICATION SYSTEM (REV 5/80)
SUMMARY OF NUCLIDE ACTIVITY

PAGE 3

TOTAL LINES IN SPECTRUM 14
LINES NOT LISTED IN LIBRARY 5
IDENTIFIED IN SUMMARY REPORT 5 35.71%

FISSION GAS

NUCLIDE	SBHR	HLIFE	DECAY	UCI /UNIT	1-SIGMA ERROR	%ERR
KR-85	FG	10.72Y	1.000	1.697E -6	4.301E -6	253.52 NP

FISSION PRODUCT

NUCLIDE	SBHR	HLIFE	DECAY	UCI /UNIT	1-SIGMA ERROR	%ERR
BA-140	FP	12.79D	1.000	**KEY LINE NOT PRESENT**		

NATURAL PRODUCT

NUCLIDE	SBHR	HLIFE	DECAY	UCI /UNIT	1-SIGMA ERROR	%ERR
K-40	NP	*****Y	1.000	8.653E -7	2.234E -7	25.82
PB-214	NP	26.80M	1.364	8.393E -7	1.275E -7	15.19

sample # 6
Chem # 2950

 ***** 30-MAY-84 10:49:03 *****

WC I HP SLUDGE II

SAMPLE DATE: 30-MAY-84 10:00:00
 SAMPLE IDENTIFICATION: 84-10953
 TYPE OF SAMPLE: C/SLUDGE
 SAMPLE QUANTITY: 3500.000 UNITS: ML
 SAMPLE GEOMETRY: MARI
 EFFICIENCY FILE NAME: DEFF.D3500M, ,

 *
 ACQUIRE DATE: 30-MAY-84 10:38:53 * FWHM(1332) 2.103
 PRESET TIME(LIVE): 600. SEC * SENSITIVITY: 3.900
 ELAPSED REAL TIME: 600. SEC * SHAPE PARAMETER : 15.0 %
 ELAPSED LIVE TIME: 600. SEC * NBR ITERATIONS: 10.
 *

 *
 DETECTOR: D-GEM 23-P-67WB * LIBRARY:NUCL.MASTER
 CALIB DATE: 25-MAY-84 17:33:58 * ENERGY TOLERANCE: 1.500KV
 KEV/CHNL: 0.4997780 * HALF LIFE RATIO: 8.00
 OFFSET: 0.3698110 KEV * ABUNDANCE LIMIT: 80.00%
 Q. COEFF. : -1.322E-08 KEV/C**2 *
 *

* DEAD TIME= 0.00 % * REVIEWED BY: *A. Smith*

ENERGY WINDOW 25.36 TO 2024.25

PK	IT	ENERGY	AREA	BKGND	FWHM	CHANNEL	LEFT	PW	CTS/SEC	%ERR	FIT
1	0	77.06	31.	304.	0.82	153.46	149	19	5.20E-02	81.0	
2	0	185.97	22.	378.	1.00	371.37	368	36	3.70E-02	****	
3	7	238.46	32.	28.	1.24	476.41	468	20	5.34E-02	29.4	1.21E 00
4	7	241.97	25.	20.	1.16	483.42	468	20	4.25E-02	31.7	
5	0	295.20	43.	35.	1.27	589.92	586	10	7.11E-02	24.9	
6	0	352.09	79.	29.	1.37	703.77	700	13	1.31E-01	14.9	
7	5	477.81	36.	0.	2.08	955.33	947	37	5.93E-02	16.8	2.08E 00
8	5	486.95	18.	0.	2.39	973.62	947	37	3.02E-02	23.5	
9	0	511.62	40.	18.	2.44	1022.97	1018	14	6.65E-02	21.7	
10	0	582.22	15.	16.	0.53	1164.26	1158	16	2.49E-02	45.9	
11	0	609.00	36.	44.	2.04	1217.85	1209	22	6.06E-02	30.7	
12	0	657.91	7.	30.	1.31	1315.72	1311	20	1.24E-02	****	
13	0	810.80	54.	10.	1.78	1621.64	1613	20	8.92E-02	16.0	
14	0	1120.06	14.	0.	1.83	2240.50	2233	17	2.33E-02	26.7	
15	0	1173.30	24.	4.	1.08	2347.04	2339	15	4.06E-02	23.2	
16	0	1332.74	29.	0.	2.14	2666.10	2659	14	4.83E-02	18.6	
17	0	1461.08	16.	15.	1.12	2922.95	2916	20	2.72E-02	41.7	
18	0	1764.77	17.	3.	1.94	3530.69	3526	14	2.79E-02	28.1	

PEAK SEARCH COMPLETED (REV 11)

sample # 6

NUCLIDE IDENTIFICATION SYSTEM (REV 5/80)
NUCLIDE LINE ACTIVITY REPORT

PAGE 1

FISSION GAS

NUCLIDE	SBHR	ENERGY	AREA	BKGND	%ABN	%EFF	UCI /UNIT	1 SIGMA ERROR
E-135	FG	249.79	0.	0.	89.90*	0.000E-01	0.000E 0	0.000E 0
		608.19	36.	44.	2.90	5.682E-01	3.002E -6	9.210E -7

ACTIVATION PRODUCT

NUCLIDE	SBHR	ENERGY	AREA	BKGND	%ABN	%EFF	UCI /UNIT	1 SIGMA ERROR
CO-58	AP	810.75	54.	10.	99.50*	4.445E-01	1.557E -7	2.496E -8
		863.94	0.	0.	0.70	0.000E-01	0.000E 0	0.000E 0
		1674.73	0.	0.	0.50	0.000E-01	0.000E 0	0.000E 0
CO-60	AP	1173.21	24.	4.	99.90	3.402E-01	9.220E -8	2.137E -8
		1332.46	29.	0.	100.00*	3.039E-01	1.228E -7	2.281E -8
AG-110M	AP	446.79	0.	0.	3.70	0.000E-01	0.000E 0	0.000E 0
		657.75	7.	30.	94.70	5.341E-01	1.896E -8	2.090E -8
		706.67	0.	0.	16.40	0.000E-01	0.000E 0	0.000E 0
		744.26	0.	0.	4.70	0.000E-01	0.000E 0	0.000E 0
		763.93	0.	0.	22.40	0.000E-01	0.000E 0	0.000E 0
		937.48	0.	0.	34.40*	0.000E-01	0.000E 0	0.000E 0
		1384.27	0.	0.	24.70	0.000E-01	0.000E 0	0.000E 0
		1475.76	0.	0.	4.00	0.000E-01	0.000E 0	0.000E 0
		1505.00	0.	0.	13.30	0.000E-01	0.000E 0	0.000E 0
		1562.27	0.	0.	1.20	0.000E-01	0.000E 0	0.000E 0

HALOGEN FISSION PRODUCT

NUCLIDE	SBHR	ENERGY	AREA	BKGND	%ABN	%EFF	UCI /UNIT	1 SIGMA ERROR
I-132	HFP	505.90	0.	0.	5.00	0.000E-01	0.000E 0	0.000E 0
		522.65	0.	0.	16.10	0.000E-01	0.000E 0	0.000E 0
		630.22	0.	0.	13.70	0.000E-01	0.000E 0	0.000E 0
		667.69	0.	0.	98.70	0.000E-01	0.000E 0	0.000E 0
		671.60	0.	0.	5.20	0.000E-01	0.000E 0	0.000E 0
		772.60	0.	0.	76.20*	0.000E-01	0.000E 0	0.000E 0
		812.20	54.	10.	5.80	4.445E-01	3.448E -6	5.526E -7
		954.55	0.	0.	18.10	0.000E-01	0.000E 0	0.000E 0
		1398.57	0.	0.	7.10	0.000E-01	0.000E 0	0.000E 0

FISSION PRODUCT

NUCLIDE	SBHR	ENERGY	AREA	BKGND	%ABN	%EFF	UCI /UNIT	1 SIGMA ERROR
IB-97	FP	657.92	7.	30.	96.34*	5.341E-01	2.782E -8	3.067E -8

NATURAL PRODUCT

NUCLIDE	SBHR	ENERGY	AREA	BKGND	%ABN	%EFF	UCI /UNIT	1 SIGMA ERROR
K-40	NP	1460.81	16.	15.	10.70*	2.834E-01	6.919E -7	2.888E -7
PB-214	NP	295.17	43.	35.	19.20	1.002E 00	8.851E -7	2.203E -7
		351.90	79.	29.	37.10*	8.741E-01	9.706E -7	1.443E -7

Sample # 6

NUCLIDE IDENTIFICATION SYSTEM (REV 5/80)
NUCLIDE LINE ACTIVITY REPORT

PAGE 2

NATURAL PRODUCT

NUCLIDE	SBHR	ENERGY	AREA	BKGND	%ABN	%EFF	UCI /UNIT	1 SIGMA ERROR
BI-214	NP	609.32	36.	44.	46.10	5.682E-01	8.193E -7	2.514E -7
		1120.28	14.	0.	15.00*	3.510E-01	1.570E -6	4.196E -7
		1764.51	17.	3.	15.90	2.454E-01	2.529E -6	7.368E -7

sample #6

NUCLIDE IDENTIFICATION SYSTEM (REV 5/80)
UNKNOWN LINE REPORT

PAGE 3

PK	IT	ENERGY	AREA	BKGND	FWHM	CHANNEL	LEFT	PW	CTS/SEC	%ERR	%EFF	
1	0	77.06	31.	304.	0.82	153.46	149	19	5.20E-02	81.0	0.00E-01	NP
2	0	185.97	22.	378.	1.00	371.37	368	36	3.70E-02	****	1.31E 00	NP
3	7	238.46	32.	28.	1.24	476.41	468	20	5.34E-02	29.4	1.13E 00	NP
4	7	241.97	25.	20.	1.16	483.42	468	20	4.25E-02	31.7	1.12E 00	PBZ
7	5	477.81	36.	0.	2.08	955.33	947	37	5.93E-02	16.8	6.89E-01	NP
8	5	486.95	18.	0.	2.39	973.62	947	37	3.02E-02	23.5	6.79E-01	PBZ
9	0	511.62	40.	18.	2.44	1022.97	1018	14	6.65E-02	21.7	6.53E-01	ANN
10	0	582.22	15.	16.	0.53	1164.26	1158	16	2.49E-02	45.9	5.89E-01	NP

LINE NOT MEETING SUMMARY CRITERIA

PK	NUCLIDE	ENERGY	HLFE	DECAY	UCI /UNIT	ABNDIFF	FAILED
11	XE-135	608.19	9.08H	1.057E 0	3.002E -6	3.12%	ABN
12	AG-110M	657.75	250.80D	1.000E 0	1.896E -8	43.14%	ABN
13	I-132	812.20	2.30H	1.246E 0	3.448E -6	2.28%	ABN

sample # 6

NUCLIDE IDENTIFICATION SYSTEM (REV 5/80)
SUMMARY OF NUCLIDE ACTIVITY

PAGE 4

TOTAL LINES IN SPECTRUM 18
LINES NOT LISTED IN LIBRARY 8
IDENTIFIED IN SUMMARY REPORT 10 55.56%

ACTIVATION PRODUCT

NUCLIDE	SBHR	HLIFE	DECAY	UCI /UNIT	1-SIGMA ERROR	%ERR
CO-58	AP	70.80D	1.000	1.557E -7	2.496E -8	16.02
CO-60	AP	5.27Y	1.000	1.228E -7	2.281E -8	18.57

FISSION PRODUCT

NUCLIDE	SBHR	HLIFE	DECAY	UCI /UNIT	1-SIGMA ERROR	%ERR
FB-97	FP	72.10M	1.201	2.782E -8	3.067E -8	110.24 NP

NATURAL PRODUCT

NUCLIDE	SBHR	HLIFE	DECAY	UCI /UNIT	1-SIGMA ERROR	%ERR
K-40	NP	*****Y	1.000	6.919E -7	2.888E -7	41.74
PB-214	NP	26.80M	1.635	9.706E -7	1.443E -7	14.87
BI-214	NP	19.90M	1.938	1.570E -6	4.196E -7	26.73

WC IHP SLUDGE #3 WILSON

sample # 7

SAMPLE DATE: 30-MAY-84 16:00:00
SAMPLE IDENTIFICATION: 84-10962
TYPE OF SAMPLE: C/SLUDGE
SAMPLE QUANTITY: 3500.000 UNITS: ML
SAMPLE GEOMETRY: MARINELLI
EFFICIENCY FILE NAME: DEFF.D3500M.

ACQUIRE DATE: 30-MAY-84 17:12:32 * FWHM(1332) 2.103
PRESET TIME(LIVE): 600. SEC * SENSITIVITY: 3.900
ELAPSED REAL TIME: 600. SEC * SHAPE PARAMETER : 15.0 %
ELAPSED LIVE TIME: 600. SEC * NBR ITERATIONS: 10.

DETECTOR: D-GEM 23-P-67WB * LIBRARY:NUCL. MASTER
CALIB DATE: 25-MAY-84 17:33:58 * ENERGY TOLERANCE: 1.500KV
KEV/CHNL: 0.4997750 * HALF LIFE RATIO: 8.00
OFFSET: 0.3698110 KEV * ABUNDANCE LIMIT: 80.00%
G. COEFF. : -1.322E-08 KEV/C**2 *

% DEAD TIME= 0.00 % * REVIEWED BY: *J. LeBlanc*

ENERGY WINDOW 25.36 TO 2024.25

PK	IT	ENERGY	AREA	BKGND	FWHM	CHANNEL	LEFT	PW	CTS/SEC	%ERR	FIT
1	0	92.06	17.	92.	1.51	183.47	180	9	2.76E-02	85.6	
2	0	186.25	34.	156.	0.92	371.92	365	24	5.59E-02	55.4	
3	0	234.26	7.	58.	0.59	468.00	463	10	1.20E-02	****	
4	4	238.82	25.	24.	1.18	477.12	473	21	4.12E-02	34.3	3.30E 00
5	4	242.06	35.	29.	1.38	483.60	473	21	5.83E-02	27.5	
6	0	294.98	98.	14.	1.74	589.50	582	14	1.63E-01	11.5	
7	0	352.35	100.	30.	1.61	704.29	699	24	1.67E-01	12.6	
8	0	386.47	30.	13.	8.06	772.57	761	26	5.00E-02	24.9	
9	0	582.84	19.	5.	1.46	1165.50	1159	18	3.21E-02	27.6	
10	0	609.54	94.	0.	1.88	1218.91	1212	20	1.57E-01	10.3	
11	0	810.66	36.	14.	2.21	1621.38	1611	28	6.00E-02	22.2	
12	0	835.11	7.	7.	0.76	1570.29	1666	9	1.24E-02	61.5	
13	0	1120.81	5.	11.	0.57	2242.00	2236	11	8.48E-03	****	
14	0	1173.75	11.	24.	3.22	2347.96	2340	19	1.90E-02	67.3	
15	0	1461.33	26.	3.	1.76	2923.45	2918	14	4.31E-02	22.2	
16	0	1764.75	9.	0.	0.62	3530.67	3527	10	1.50E-02	33.3	

PEAK SEARCH COMPLETED (REV 11)

FISSION GAS

NUCLIDE	SBHR	ENERGY	AREA	BKGND	%ABN	%EFF	UCI /UNIT	1 SIGMA ERROR
KR-88	FG	165.98	0.	0.	3.10	0.000E-01	0.000E 0	0.000E 0
		196.32	0.	0.	26.30*	0.000E-01	0.000E 0	0.000E 0
		362.23	0.	0.	2.30	0.000E-01	0.000E 0	0.000E 0
		834.83	7.	7.	13.10	4.329E-01	2.316E -7	1.423E -7
		1518.39	0.	0.	2.20	0.000E-01	0.000E 0	0.000E 0
		1529.77	0.	0.	11.10	0.000E-01	0.000E 0	0.000E 0
		2029.84	0.	0.	4.60	0.000E-01	0.000E 0	0.000E 0
2035.41	0.	0.	3.80	0.000E-01	0.000E 0	0.000E 0		
XE-133M	FG	233.18	7.	58.	10.30*	1.143E 00	8.037E -8	1.230E -7
XE-135	FG	249.79	0.	0.	89.90*	0.000E-01	0.000E 0	0.000E 0
		608.19	94.	0.	2.90	5.678E-01	8.109E -6	8.364E -7

ACTIVATION PRODUCT

NUCLIDE	SBHR	ENERGY	AREA	BKGND	%ABN	%EFF	UCI /UNIT	1 SIGMA ERROR
AN-54	AP	834.83	7.	7.	100.00*	4.329E-01	2.213E -8	1.361E -8
CO-58	AP	810.75	36.	14.	99.50*	4.445E-01	1.048E -7	2.329E -8
		863.94	0.	0.	0.70	0.000E-01	0.000E 0	0.000E 0
CO-60	AP	1674.73	0.	0.	0.50	0.000E-01	0.000E 0	0.000E 0
		1173.21	11.	24.	99.90	3.401E-01	4.316E -8	2.907E -8
		1332.46	0.	0.	100.00*	0.000E-01	0.000E 0	0.000E 0

NATURAL PRODUCT

NUCLIDE	SBHR	ENERGY	AREA	BKGND	%ABN	%EFF	UCI /UNIT	1 SIGMA ERROR
K-40	NP	1460.81	26.	3.	10.70*	2.833E-01	1.098E -6	2.433E -7
PB-214	NP	295.17	98.	14.	19.20	1.003E 00	4.838E -6	5.552E -7
		351.90	100.	30.	37.10*	8.736E-01	2.945E -6	3.722E -7
BI-214	NP	609.32	94.	0.	46.10	5.678E-01	6.847E -6	7.062E -7
		1120.28	5.	11.	15.00*	3.509E-01	1.844E -6	1.886E -6
		1764.51	9.	0.	15.90	2.454E-01	4.397E -6	1.466E -6

PK	IT	ENERGY	AREA	BKGND	FWHM	CHANNEL	LEFT	PW	CTS/SEC	%ERR	%EFF
1	0	92.06	17.	92.	1.51	183.47	180	9	2.76E-02	85.6	1.06E-00
2	0	186.25	34.	156.	0.92	371.92	365	24	5.59E-02	55.4	1.31E-00
4	4	238.82	25.	24.	1.18	477.12	473	21	4.13E-02	34.3	1.13E-00
5	4	242.06	35.	29.	1.38	483.60	473	21	5.83E-02	27.5	1.12E-00
8	0	386.47	30.	13.	8.08	772.57	761	26	5.00E-02	24.9	8.17E-01
9	0	582.84	19.	5.	1.46	1165.50	1159	18	3.21E-02	27.6	5.88E-01

INES NOT MEETING SUMMARY CRITERIA

PK	NUCLIDE	ENERGY	HLFE	DECAY	UCI /UNIT	ABNDIFF	FAILED
10	XE-135	608.19	9.08H	1.104E 0	8.109E -6	3.12%	ABN
12	KR-88	834.83	2.84H	1.371E 0	2.316E -7	19.70%	ABN
14	CO-60	1173.21	5.27Y	1.000E 0	4.316E -8	49.97%	ABN

sample #7

TOTAL LINES IN SPECTRUM	16	
LINES NOT LISTED IN LIBRARY	6	
IDENTIFIED IN SUMMARY REPORT	9	56.25%

FISSION GAS

NUCLIDE	SBHR	HLIFE	DECAY	UCI /UNIT	1-SIGMA ERROR	%ERR
CE-133M	FG	2.19D	1.007	8.037E -8	1.230E -7	153.02 N.P.

ACTIVATION PRODUCT

NUCLIDE	SBHR	HLIFE	DECAY	UCI /UNIT	1-SIGMA ERROR	%ERR
IN-54	AP	312.50D	1.000	2.213E -8	1.361E -8	61.48 N.P.
CO-58	AP	70.80D	1.000	1.048E -7	2.329E -8	22.22

NATURAL PRODUCT

NUCLIDE	SBHR	HLIFE	DECAY	UCI /UNIT	1-SIGMA ERROR	%ERR
K-40	NP	*****Y	1.000	1.098E -6	2.433E -7	22.17
PB-214	NP	26.80M	2.386	2.945E -6	3.722E -7	12.64
BI-214	NP	19.90M	3.224	1.844E -6	1.886E -6	102.24 N.P.

sample # 8

MC IHP SLUDGE #4 WILSON

SAMPLE DATE: 30-MAY-84 16:00:00
 SAMPLE IDENTIFICATION: 84-10969
 TYPE OF SAMPLE: C/SLUDGE
 SAMPLE QUANTITY: 3500.000 UNITS: ML
 SAMPLE GEOMETRY: MARINELLI
 EFFICIENCY FILE NAME: CEFF.C3500M,,

ACQUIRE DATE: 30-MAY-84 17:19:58 * FWHM(1332) 2.639
 PRESET TIME(LIVE): 600. SEC * SENSITIVITY: 3.500
 ELAPSED REAL TIME: 600. SEC * SHAPE PARAMETER : 15.0 %
 ELAPSED LIVE TIME: 600. SEC * NBR ITERATIONS: 10.

DETECTOR: C GELI 1669 * LIBRARY:NUCL. MASTER
 CALIB DATE: 21-MAY-84 18:18:42 * ENERGY TOLERANCE: 1.500KV
 KEV/CHNL: 0.5000634 * HALF LIFE RATIO: 8.00
 OFFSET: -0.0307648 KEV * ABUNDANCE LIMIT: 80.00%
 Q. COEFF. : 1.719E-08 KEV/C**2 *

% DEAD TIME= 0.00 % * REVIEWED BY: *O. LeBlanc*
 ENERGY WINDOW 24.97 TO 2025.51

PK	IT	ENERGY	AREA	BKGND	FWHM	CHANNEL	LEFT	PW	CTS/SEC	%ERR	FIT
1	0	117.49	7.	135.	0.49	235.00	229	15	1.20E-02	****	
2	3	230.48	26.	37.	2.21	460.95	456	32	4.38E-02	38.1	2.49E 00
3	3	240.35	50.	30.	2.73	480.69	456	32	8.35E-02	21.0	
4	0	295.74	61.	48.	1.89	591.45	579	24	1.01E-01	20.6	
5	0	351.98	74.	22.	2.09	703.91	698	18	1.23E-01	14.8	
6	0	392.03	4.	36.	0.40	784.00	776	16	6.38E-03	****	
7	0	609.33	52.	35.	1.53	1218.51	1207	28	8.72E-02	21.1	
8	0	810.93	33.	15.	3.03	1621.63	1612	20	5.42E-02	24.3	

PEAK SEARCH COMPLETED (REV 11)

FISSION GAS

NUCLIDE	SBHR	ENERGY	AREA	BKGND	%ABN	%EFF	UCI /UNIT	1 SIGMA ERROR
Xe-135	FG	249.79	0.	0.	89.90*	0.000E-01	0.000E 0	0.000E 0
		608.19	52.	35.	2.90	4.468E-01	5.788E -6	1.224E -6

ACTIVATION PRODUCT

NUCLIDE	SBHR	ENERGY	AREA	BKGND	%ABN	%EFF	UCI /UNIT	1 SIGMA ERROR
Co-58	AP	810.75	33.	15.	99.50*	3.350E-01	1.257E -7	3.055E -8
		863.94	0.	0.	0.70	0.000E-01	0.000E 0	0.000E 0
		1674.73	0.	0.	0.50	0.000E-01	0.000E 0	0.000E 0
I-131	AP	99.55	0.	0.	15.00	0.000E-01	0.000E 0	0.000E 0
		103.76	0.	0.	24.00	0.000E-01	0.000E 0	0.000E 0
		106.13	0.	0.	22.70*	0.000E-01	0.000E 0	0.000E 0
		117.00	7.	135.	11.30	1.060E 00	7.869E -8	1.820E -7
		277.60	0.	0.	14.10	0.000E-01	0.000E 0	0.000E 0

HALOGEN FISSION PRODUCT

NUCLIDE	SBHR	ENERGY	AREA	BKGND	%ABN	%EFF	UCI /UNIT	1 SIGMA ERROR
I-132	HFP	505.90	0.	0.	5.00	0.000E-01	0.000E 0	0.000E 0
		522.65	0.	0.	16.10	0.000E-01	0.000E 0	0.000E 0
		630.22	0.	0.	13.70	0.000E-01	0.000E 0	0.000E 0
		667.69	0.	0.	98.70	0.000E-01	0.000E 0	0.000E 0
		671.60	0.	0.	5.20	0.000E-01	0.000E 0	0.000E 0
		772.60	0.	0.	76.20*	0.000E-01	0.000E 0	0.000E 0
		812.20	33.	15.	5.60	3.350E-01	3.419E -6	8.311E -7
		954.55	0.	0.	18.10	0.000E-01	0.000E 0	0.000E 0
		1398.57	0.	0.	7.10	0.000E-01	0.000E 0	0.000E 0

NATURAL PRODUCT

NUCLIDE	SBHR	ENERGY	AREA	BKGND	%ABN	%EFF	UCI /UNIT	1 SIGMA ERROR
Po-214	NP	295.17	61.	48.	19.20	7.891E-01	4.636E -6	9.549E -7
		351.90	74.	22.	37.10*	7.007E-01	3.280E -6	4.844E -7
Bi-214	NP	609.32	52.	35.	46.10	4.468E-01	6.272E -6	1.326E -6
		1120.28	0.	0.	15.00*	0.000E-01	0.000E 0	0.000E 0
		1764.51	0.	0.	15.90	0.000E-01	0.000E 0	0.000E 0

PK	IT	ENERGY	AREA	BKGND	FWHM	CHANNEL	LEFT	PW	CTS/SEC	%ERR	%EFF
2	3	230.48	26.	37.	2.21	460.95	456	32	4.38E-02	38.1	9.30E-01
3	3	240.35	50.	30.	2.73	480.69	456	32	8.35E-02	21.0	9.00E-01
6	0	392.03	4.	36.	0.40	784.00	776	16	6.38E-03	****	6.52E-01

INES NOT MEETING SUMMARY CRITERIA

PK	NUCLIDE	ENERGY	HLFE	DECAY	UCI /UNIT	ABNDIFF	FAILED
1	NP-239	117.00	2.36D	1.017E 0	7.869E -8	12.97%	ABN
7	XE-135	608.19	9.08H	1.114E 0	5.788E -6	3.12%	ABN
7	BI-214	609.32	19.90M	1.919E 1	6.272E -6	59.87%	ABN
8	I-132	812.20	2.30H	1.532E 0	3.419E -6	2.28%	ABN

TOTAL LINES IN SPECTRUM 8
LINES NOT LISTED IN LIBRARY 3
IDENTIFIED IN SUMMARY REPORT 3 37.50%

ACTIVATION PRODUCT

NUCLIDE	SBHR	HLIFE	DECAY	UCI /UNIT	1-SIGMA ERROR	%ERR
CO-58	AP	70.80D	1.000	1.257E -7	3.055E -8	24.31

NATURAL PRODUCT

NUCLIDE	SBHR	HLIFE	DECAY	UCI /UNIT	1-SIGMA ERROR	%ERR
PB-214	NP	26.80M	2.594	3.280E -6	4.844E -7	14.77

Minimum Detectable Act.

Rep.

page 1.

MINIMUM DETECTABLE ACTIVITY REPORT (REV 10/80)

PEAK WIDTH = 2.18 FWHM. CONFIDENCE LEVEL = 4.66.

NUCLIDE	BKG	ENERGY	MINIMUM UCI /UNIT
AR-41	3.	1293.64	6.3413E-08
KR-85	8.	513.99	8.1855E-06
KR-85M	25.	151.18	4.4932E-08
KR-87	12.	402.58	1.1609E-07
KR-88	30.	196.32	1.6315E-07
XE-131M	28.	163.93	1.5226E-06
XE-133	36.	81.00	2.2771E-07
XE-133M	26.	233.18	3.4457E-07
XE-135	15.	249.79	3.3131E-08
XE-135M	7.	526.56	4.2859E-08
XE-138	22.	258.31	2.1275E-06
I-131	6.	364.48	2.7005E-08
I-132	3.	772.60	5.0139E-08
I-133	6.	529.89	3.4402E-08
I-134	9.	595.36	7.6382E-07
I-135	1.	1260.41	9.4345E-08
SR-91	4.	749.80	1.4739E-07
SR-92	3.	1383.94	6.5105E-08
NA-24	2.	1368.53	3.8291E-08
CR-51	16.	320.08	3.3365E-07
MN-54	7.	834.83	4.6067E-08
MN-56	0.	1810.72	0.0000E-01
CO-57	41.	122.06	4.9839E-08
CO-60	10.	1332.46	7.9905E-08
NI-65	0.	1481.84	0.0000E-01
FE-59	5.	1099.22	8.6529E-08
ZN-65	5.	1115.52	9.7329E-08
ZN-69M	12.	438.63	3.9175E-08
RB-86	2.	1076.63	3.4591E-07
RB-88	5.	898.03	3.6758E-07
RB-89	0.	1031.88	0.0000E-01
ZR-95	5.	756.74	6.4824E-08
ZR-97	14.	355.39	1.4886E-06
Y-91M	4.	557.57	6.0745E-08
Y-92	5.	934.50	3.7712E-07
Y-93	23.	266.87	5.5427E-07
NB-95	6.	765.83	3.9491E-08
NB-97	8.	657.92	7.2635E-08
MO-99	4.	777.88	7.1785E-07
TC-99M	25.	140.51	3.7738E-08
RU-103	8.	497.08	3.6955E-08
RU-106	3.	1050.10	2.4329E-06
AG-108M	8.	614.37	4.1640E-08
AG-110M	5.	937.48	1.2520E-07
CD-115	9.	492.14	3.3358E-07
SB-122	6.	563.93	4.3660E-08
SB-124	1.	1691.02	6.3281E-08
SB-125	12.	427.90	1.1733E-07
CS-134	8.	795.85	5.5222E-08
CS-136	4.	1048.07	5.2840E-08

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PEAK WIDTH = 2.18 FWHM. CONFIDENCE LEVEL = PAGE 2
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ISOTOPE	BKG	ENERGY	MINIMUM UCI /UNIT
CS-137	7.	661.65	4.3880E-08
CS-138	1.	1435.86	1.3114E-07
SA-139	2.	1420.50	2.0962E-05
SA-140	4.	423.81	7.9498E-07
SE-141	35.	145.44	7.2453E-08
SE-143	26.	293.26	9.2375E-08
SE-144	28.	133.53	3.0182E-07
LA-140	1.	1596.49	3.1308E-08
U-187	8.	479.53	1.3653E-07
BR-84	1.	881.60	1.6471E-07
MP-239	28.	106.13	1.8851E-07
IN-115M	20.	336.24	9.5423E-08
TE-131M	1.	852.21	8.6910E-08
BI-214	12.	1120.28	4.2904E-06
BR-82	2.	554.32	2.5094E-08

APPENDIX 2

Annual Dose Rate Estimations

APPENDIX 2

ANNUAL DOSE RATE ESTIMATIONS

Waste Description: McGuire Water Treatment Residues

$$\text{Average Co-58 Concentration} = 1.2E-7 \frac{\mu\text{Ci}}{\text{cm}^3}$$

$$\text{Average Co-60 Concentration} = 1.2E-7 \frac{\mu\text{Ci}}{\text{cm}^3}$$

$$\text{Total Volume of Waste} \sim 400 \text{ yard}^3 \sim 1.08E4 \text{ ft}^3 \sim 3.06E3 \text{ cm}^3$$

thickness of the source $\sim 6 \text{ in.} = 15.24 \text{ cm}$ (assume homogeneous with soil)
 covering of soil $\sim 4 \text{ in.} = 10.16 \text{ cm}$
 surface area of source $\sim 2E7 \text{ cm}^2$
 circle of radius = 2528 cm $\sim 83 \text{ ft.}$
 or square of side = 4481 cm $\sim 147 \text{ ft.}$

Source may be approximated by an infinite slab
 Assume that soil may be approximated by ordinary concrete ($\rho = 2.35 \frac{\text{g}}{\text{cm}^3}$)

$$\dot{D} = \frac{K(E) E S_v}{2} \sum_{i=1}^2 \frac{A_i}{\mu_{si}} [E_2(b_{1i}) - E_2(b_{3i})]$$

\dot{D} = dose rate (mrem/yr)

$K(E)$ = energy flux to dose rate conversion factor ($\frac{\text{rem} \cdot \text{cm}^2 \cdot \text{sec}}{\text{hr} \cdot \text{Mev}}$)

E = energy of source photon (Mev/ γ)

S_v = source strength of volume source of photon with energy E ($\frac{\gamma}{\text{cm}^3 \cdot \text{sec}}$)

A_i, α_i = Taylor-form buildup factor coefficients

μ_s = linear attenuation coefficient of source material (cm^{-1})

$$\mu_{si} = (1 + \alpha_i) \mu_s$$

$$b_1 = \sum_j \mu_j x_j = \text{total optical thickness of the shield}$$

$$b_3 = b_1 + \mu_s t = \text{total optical thickness of the source + shield}$$

μ_j = linear attenuation coefficient of the j^{th} shield (cm^{-1})

X_j = thickness of j^{th} shield (cm)

$$b_{ni} = (1 + \alpha_i)b_n$$

Co-58 $E = 0.511$ Mev

$$S_V = 1.2E-7 \frac{\mu\text{Ci}}{\text{cm}^3} * 3.7E4 \frac{\text{dis}}{\text{sec}-\mu\text{Ci}} * 0.3 \frac{\text{Y}}{\text{dis}} = 1.332E-3 \frac{\text{Y}}{\text{cm}^3 - \text{sec}}$$

$$K(0.511) = 2.33E-6 \frac{\text{rem} - \text{cm}^2 - \text{sec}}{\text{hr} - \text{Mev}}$$

$$A_1 = 38.225$$

$$A_2 = 1 - A_1 = -37.225$$

$$\alpha_1 = -0.14824$$

$$\alpha_2 = -0.10579$$

$$\mu_s = 0.204 \text{ cm}^{-1}$$

$$\mu_{s1} = 0.174 \text{ cm}^{-1}$$

$$\mu_{s2} = 0.184 \text{ cm}^{-1}$$

$$b_1 = \mu x = 0.204 \text{ cm}^{-1} * 10.16 \text{ cm} = 2.07$$

$$b_{11} = 1.76$$

$$b_{12} = 1.85$$

$$b_3 = b_1 + \mu_s t = 2.07 + 0.204 * 15.24 = 5.18$$

$$b_{31} = 4.41$$

$$b_{32} = 4.63$$

$$E_2(b_{11}) = E_2(1.76) = 5.23E-2$$

$$E_2(b_{31}) = E_2(4.41) = 2.00E-3$$

$$E_2(b_{11}) - E_2(b_{31}) = 5.03E-2$$

$$E_2(b_{12}) = E_2(1.85) = 4.58E-2$$

$$E_2(b_{32}) = E_2(4.63) = 1.53E-3$$

$$E_2(b_{12}) - E_2(b_{32}) = 4.43E-2$$

$$\dot{D} = \frac{2.33E-6 * 0.51 * 1.332E-3}{2} \left[\frac{38.225}{0.174} * 5.03E-2 - \frac{37.225}{0.184} * 4.43E-2 \right]$$

$$\dot{D} = 1.65E-9 \frac{\text{rem}}{\text{hr}} = 1.45E-2 \frac{\text{mrem}}{\text{yr}}$$

Co-58

$$E = 0.810 \text{ Mev}$$

$$K(0.810) = 2.10E-6 \frac{\text{rem} \cdot \text{cm}^2 \cdot \text{sec}}{\text{hr} \cdot \text{Mev}}$$

$$S_V = 1.2E-7 \frac{\mu\text{Ci}}{\text{cm}^3} * 3.7E4 \frac{\text{dis}}{\text{sec} \cdot \mu\text{Ci}} * 0.99 \frac{\text{Y}}{\text{dis}} = 4.40E-3 \frac{\text{Y}}{\text{cm}^3 \cdot \text{sec}}$$

$$A_1 = 30.34$$

$$A_2 = 1 - A_1 = -29.34$$

$$\alpha_1 = -0.10116$$

$$\alpha_2 = -0.05163$$

$$\mu_s = 0.165 \text{ cm}^{-1}$$

$$\mu_{s1} = 0.148 \text{ cm}^{-1}$$

$$\mu_{s2} = 0.156 \text{ cm}^{-1}$$

$$b_1 = \mu x = 0.165 \text{ cm}^{-1} * 10.16 \text{ cm} = 1.68$$

$$b_{11} = 1.51$$

$$b_{12} = 1.59$$

$$b_3 = b_1 + \mu_s t = 1.68 + 0.165 * 15.24 = 4.19$$

$$b_{31} = 3.77$$

$$b_{32} = 3.97$$

$$E_2(b_{11}) = 7.31E-2$$

$$E_2(b_{31}) = 4.05E-3$$

$$E_2(b_{11}) - E_2(b_{31}) = 6.91E-2$$

$$E_2(b_{12}) = 6.38E-2$$

$$E_2(b_{32}) = 3.20E-3$$

$$E_2(b_{12}) - E_2(b_{32}) = 6.06E-2$$

$$\dot{D} = \frac{2.106E-6 * 0.81 * 4.40E-3}{2} \left[\frac{30.34}{0.148} * 6.91E-2 - \frac{29.34}{0.156} * 6.06E-2 \right]$$

$$\dot{D} = 1.04E-8 \frac{\text{rem}}{\text{hr}} = 9.11E-2 \frac{\text{mrem}}{\text{yr}}$$

$$\text{Total Co-58 } \dot{D} = 1.06E-1 \frac{\text{mrem}}{\text{yr}}$$

$$1 \text{ yr. decay total Co-58 } \dot{D} = 0.160 * e^{\frac{-\ln 2 * 365.25}{70.78}} = 2.97 E-3 \frac{\text{mrem}}{\text{yr}}$$

$$\text{Co-60} \quad E = 1.173 \text{ Mev}$$

$$K(E) = 1.90E-6 \frac{\text{rem} - \text{cm}^2 - \text{sec}}{\text{hr} - \text{Mev}}$$

$$S_V = 1.2E-7 \frac{\mu\text{Ci}}{\text{cm}^3} * 3.7E4 \frac{\text{dis}}{\text{sec} - \mu\text{Ci}} * 1 \frac{\text{Y}}{\text{dis}} = 4.44E-3 \frac{\text{Y}}{\text{cm}^3 - \text{sec}}$$

$$A_1 = 24.246$$

$$A_2 = 1 - A_1 = -23.246$$

$$\alpha_1 = -0.0672$$

$$\alpha_2 = -0.0139$$

$$\mu_S = 0.138 \text{ cm}^{-1}$$

$$\mu_{S1} = 0.129 \text{ cm}^{-1}$$

$$\mu_{S2} = 0.136 \text{ cm}^{-1}$$

$$b_1 = \mu x = 0.138 \text{ cm}^{-1} * 10.16 \text{ cm} = 1.40$$

$$b_{11} = 1.31$$

$$b_{12} = 1.38$$

$$b_3 = b_1 + \mu_S t = 1.40 + 0.138 \text{ cm}^{-1} * 15.24 \text{ cm} = 3.50$$

$$b_{31} = 3.26$$

$$b_{32} = 3.45$$

$$E_2(b_{11}) = 9.64E-2$$

$$E_2(b_{31}) = 7.38E-3$$

$$E_2(b_{11}) - E_2(b_{31}) = 8.90E-2$$

$$E_2(b_{12}) = 8.39E-2$$

$$E_2(b_{32}) = 5.80E-3$$

$$E_2(b_{12}) - E_2(b_{32}) = 7.81E-2$$

$$\dot{D} = \frac{1.90E-6 * 1.173 * 4.44E-3}{2} \left[\frac{24.246}{0.129} * 8.90E-2 - \frac{23.246}{0.136} * 7.81E-2 \right]$$

$$\dot{D} = 1.67E-8 \frac{\text{rem}}{\text{hr}} = 1.47E-1 \frac{\text{mrem}}{\text{yr}}$$

Co-60

$$E = 1.332 \text{ Mev}$$

$$K(E) = 1.83E-6 \frac{\text{rem} \cdot \text{cm}^2 \cdot \text{sec}}{\text{hr} \cdot \text{Mev}}$$

$$S_V = 1.2E-7 \frac{\mu\text{Ci}}{\text{cm}^3} * 3.7E4 \frac{\text{dis}}{\text{sec} \cdot \mu\text{Ci}} * 1 \frac{\text{Y}}{\text{dis}} = 4.44E-3 \frac{\text{Y}}{\text{cm}^3 \cdot \text{sec}}$$

$$A_1 = 23.059$$

$$A_2 = 1 - A_1 = -22.059$$

$$\alpha_1 = -0.0625$$

$$\alpha_2 = -0.0095$$

$$\mu_s = 0.130 \text{ cm}^{-1}$$

$$\mu_{s1} = 0.122 \text{ cm}^{-1}$$

$$\mu_{s2} = 0.129 \text{ cm}^{-1}$$

$$b_1 = \mu x = 0.130 \text{ cm}^{-1} * 10.16 \text{ cm} = 1.32$$

$$b_{11} = 1.24$$

$$b_{12} = 1.31$$

$$b_3 = b_1 + \mu_s t = 1.32 + 0.130 \text{ cm}^{-1} * 15.24 \text{ cm} = 3.30$$

$$b_{31} = 3.09$$

$$b_{32} = 3.27$$

$$E_2(b_{11}) = 1.11E-1$$

$$E_2(b_{31}) = 9.42E-3$$

$$E_2(b_{11}) - E_2(b_{31}) = 1.02E-1$$

$$E_2(b_{12}) = 9.64E-2$$

$$E_2(b_{32}) = 7.38E-3$$

$$E_2(b_{12}) - E_2(b_{32}) = 8.90E-2$$

$$\dot{D} = \frac{1.83E-6 * 1.332 * 4.44E-3}{2} \left[\frac{23.059}{0.122} * 0.102 - \frac{22.059}{0.129} * 0.089 \right]$$

$$\dot{D} = 2.20E-8 \frac{\text{rem}}{\text{hr}} = 1.93E-1 \frac{\text{mrem}}{\text{yr}}$$

$$\text{Total Co-60 } \dot{D} = 3.4\text{E-1 } \frac{\text{mrem}}{\text{yr}}$$

$$1 \text{ yr. decay total Co-60 } \dot{D} = 0.34 * e^{\frac{-\ln 2 * 1}{5.26}} = 2.98\text{E-1 } \frac{\text{mrem}}{\text{yr}}$$

$$\text{Total } \dot{D} = 4.46\text{E-1 } \frac{\text{mrem}}{\text{yr}}$$

Conclusions:

For dose rate at the ground level center, the source may be approximated by an infinite slab. The waste is spread 6" (15.24 cm) thick with a 4" (10.16 cm) soil covering. Neglecting decay during the year:

- 1) For continuous exposure:

Total Dose Rate (center) \sim 0.5 mrem/yr

Total Dose Rate (boundary) \sim 0.25 mrem/yr

- 2) After one year the total dose rate at the center will be 0.3 mrem/yr.

- 3) For 2000 hr/yr continuous exposure:

Total Dose Rate \sim 0.1 mrem/yr