



February 7, 2013

Attn: Mail Control Number 575230
Materials Licensing Branch
U.S. Nuclear Regulatory Commission, Region III
2443 Warrenville Road, Suite 210
Lisle, Illinois, 60532-4352

To Whom It May Concern,

You will find the final termination report for NRC license 13-04004-02 included in this mailing along with shipping manifests for the disposal of the Pu-Be Howitzer that was shipped to Los Alamos in 1998 and the more recent disposal (2010 & 2011) of all remaining radioactive materials by Bionomics, Inc.

Please let us know if there is more information needed or if we should modify this report.

Sincerely,

DG Hammond, PhD & Chair
Dept of Chemistry & Biochemistry
Taylor University
236 W. Reade Ave.
Upland, IN 46989
765-998-5273
dnhammond@tayloru.edu

Taylor University Decommissioning Report

Prepared by DG Hammond

January 10, 2013

I. Historical Site Assessment

Taylor University is a small liberal arts university in rural Upland, IN with a student population of about 2,000. The president of the university is Dr. Eugene Habecker, provost is Dr. Jeff Moshier, dean of the School of Natural and Applied Sciences is Dr. Bill Toll, and the Radiation Safety Officer is Dr. Dan Hammond.

Sources for this Assessment include archival information on Dr. Elmer Nussbaum at the Taylor University Zondervan Library, NRC licenses, communication with Roger Roth (Physics professor at Taylor University from 1965-1998) and other faculty, and waste manifests from Bionomics.

1. Dr. Elmer Nussbaum was the first person to use regulated quantities of radioactive materials at Taylor University. He began teaching at Taylor University in 1954 with a MA in Science from Ball State University. He then pursued a doctorate at the University of Rochester, which awarded him a PhD in Radiation Biology in 1957. His research looked at the solubility of radon in body tissues.

The first license issued by the U.S. Atomic Energy Commission was on August 27, 1958 (13-04004-01). This license listed four short lived isotopes ($t_{1/2}$ of days) along with Strontium-90 which has a $t_{1/2}$ of 28.90 y. The maximum amount of all isotopes was 10 mCi. Dr. Nussbaum was listed as the supervisor.

Elmer Nussbaum did studies of Diffusion of Radon and Tritium through semi-permeable membranes – indicated by publications from 1961 to 1964. No further work on this project is indicated after 1964. This work was done in a stainless steel hood in a back room (12' x 20') of the steam generator building. That building was torn down in 2010. All radioactive materials had been removed from the steam generating plant in 1967 when the Science Center was opened across campus. The radioactivity lab in the heat plant was tested for residual radioactivity using a wipe test with a gas flow proportional counter or multi-channel analyzer sensitive to alpha, beta, and gamma radiation (personal communication from Roger Roth).

There are no records of actual amounts used in these experiments. Most of the publications were USAEC reports that are no longer available. We tried looking at the NRC online library for these and contacted individuals at the library to see if we could get hard copies. The NRC librarians were not able to locate these references. We also sought help through our university library to no avail. Dr Dan Howell, the head librarian, has a friend with expertise in government documents. He was not able to help us.

There were a few publications in journals that we could access. We also obtained Dr. Nussbaum's dissertation from the University of Rochester. None of these resources included enough detail to be able to calculate a maximum amount of residue that could have been released into the lab.

The only basis we have of determining the amounts that could have been released into the lab are those reported in the license. Based on our experience, this does not indicate that those isotopes were actually ever on site. In more recent years, individuals have listed themselves on the license but never possessed or used any of the materials they were licensed to use. This could have been the case with Dr. Nussbaum. He may have anticipated a use for a certain isotope but never actually used it.

Dr. Nussbaum was very fastidious in everything he did, including his work with radioactive materials. Being a radiation biologist (he would have considered himself a health physicist), he was familiar with the hazards of using radioactive materials. He did routine wipe tests (personal communication from Roger Roth) of the area and equipment where radionuclides were used. A gas flow proportional counter or multi-channel analyzer sensitive to alpha, beta, and gamma radiation (communication from Roger Roth, photo in Chronicle-Tribune from March 6, 1977, 1979 NRC license) was routinely used in these tests.

Short-lived materials were allowed to decay before disposal and long-lived materials were disposed via Atomic Disposal Co., Kinley Park, IL. (1979 NRC license)

2. From 1957 to 1967 student labs and projects were conducted in a room in the steam generating building that had limited and restricted access. These involved exempt levels of radioactive materials. Labs that were conducted included (as determined by student lab write-ups from the period):

- Geiger Mueller Counting
- Proportional Counting
- Decay of Ag-110 and Ag-110m
- Determination of Thermal Neutron Flux (used Pu-Be source stored in 55 gal drum with paraffin shielding).
- Alpha spectroscopy lab: ^{241}Am , ^{210}Po
- Beta spectroscopy lab: ^{204}Tl
- Gamma ray spectroscopy lab: ^{137}Cs , ^{60}Co , ^{51}Cr , ^{131}I

Some of these labs were done on campus and some were done at Oak Ridge Labs. Dr. Nussbaum frequently took students to Oak Ridge during January Interterm or in the summer. Since some of these lab projects involve isotopes that were not on the license and Taylor did not have a Pu-Be howitzer at the time, those labs must have been done at Oak Ridge.

In one ongoing project, students would collect outside air samples on millipore filters which they then counted. They reported daily air sample "fallout" numbers to a local radio station. A plated RaDEF (as it was called then) standard was used to calibrate the proportional counter. Alpha only and alpha plus beta counting rates could be determined.

Subsequent licenses during this time period in which the radioactivity lab was housed in the steam generating building listed primarily short lived isotopes (P-32, I-131, Fe-59, Po-210, Zn-65, Br-82) with maximum quantities of 10 mCi; other short lived isotopes (In-114, Ga-72) with a maximum of 5 mCi; while Au-198 had a maximum of 30 mCi. The longer lived isotopes listed were Sr-90 (28.9 y, 100 mCi), H-3 (12.32 y, 50 mCi), C-14 (5730 y, 10 mCi), Co-60 (5.27 y, 1 mCi).

3. In 1967 the work with radioactive materials moved to the new Science Center (Later renamed Nussbaum Science Center). No research using regulated radioactive materials has been conducted in the building. The same hood that had been used in the old building was used in the Science Center. This was housed in NS 014 which was isolated from the rest of the building. The hood was never connected to an exhaust system.

According to Roger Roth, previous RSO, Dr. Nussbaum did wipe tests of the hood and bench before it was moved to the newer facility. He also did wipe tests on the surfaces of the room in the steam generator plant before it was repurposed. All these were negative for radioactivity above background levels. Unfortunately, no records of these tests survive.

The radioactive isotopes were moved to the new facility in NS 014 and were housed in the stainless steel hood within a lead brick castle. There were some additions to the previous license of short lived isotopes of Ca-45 (5 mCi), S-35 (5 mCi), Ag-110m (50 mCi), Cd-109 (100 mCi) and a few longer lived isotopes Am-241 (0.3 uCi), Ba-133 (500 mCi), and Cs-137 (3 mCi). The tritium amount was increased to 2 Ci to accommodate an old (dated 1957) gaseous tritium light source (GTLS) used in demonstrations.

Students in the Nuclear and Modern Physics course (PHY 311) only used exempt quantities of materials in their labs which were set-up in NS 212. This typically involved counting cards. The counting cards were prepared in the hood in NS 014 from bulk samples. Only exempt quantities of radioactive materials left NS 014. Some further preparation may have been done in NS 207 and NS 208 on occasion. The latter two rooms are faculty offices that had bench work and hoods for research purposes. However, only exempt quantities were ever used or temporarily stored in those labs. The hoods were removed in the late 1990s.

In 1973, a Pu-Be howitzer was obtained from Monsanto in Dayton, Ohio (Special License SNM-700). It was kept in its paraffin filled drum in NS 014. It had a port for inserting foil samples for activation. Most commonly indium or silver foils were activated and used for a short half-live experiment in Physics courses. This would become the major source of materials used by students in Physics labs. The activated foils were carried up from the basement by the faculty member. The neutron source was leak tested before use by Dr Nussbaum or Roger Roth via wipe tests and a gas flow proportional counter. A neutron dosimeter was worn and recorded during this testing. These leak tests were always negative (personal communication from Roger Roth).

Students were frequently taken to Oak Ridge Labs for more extensive projects using materials designed by Oak Ridge Associated Universities (ORAU). Dr. Nussbaum was often an instructor at the Institute of Nuclear Studies at Oak Ridge.

We obtained some radioactive materials from the RCA lab in Marion as it was being phased out (late 1960s - 1970s). These were stored in NS 014 but never used. Dr. Nussbaum may have felt obligated to take them as a gift from Dr. James Lee who was a researcher at the Marion RCA lab and also taught Physical Chemistry at Taylor University in the 1960s.

Sometime in the early 1980s the older licenses (13-04004-01 and SNM-700) were terminated and combined into one license (13-04004-02).

Dr. Stan Burden is shown as a supervisor of radioactive materials in the late 1970s but never actually used any radioactive materials (personal communication from Dr. Burden). Similarly, Dr. Andrew Whipple's name began to appear on the license in the early 1990s, but he never used any materials listed (personal communication from Dr. Whipple). Dr. DG Hammond is also listed. He only used exempt quantities of tritium and C-14 for a brief period (2000 – 2002) and very infrequently.

Use of radioactive materials in physics teaching labs slowed down significantly after 1985 when Dr. Nussbaum retired.

4. By 1994 there were no labs using non-exempt quantities of radioactivity being taught according to a lab syllabus for the Nuclear and Modern Physics course (PHY 311) from that and subsequent years. All radioactive materials were moved to a locked closet in NS 014B which were further sequestered in a shield made of lead bricks. Dr. Hank Voss came to Taylor University in 1994 and the emphasis in the Physics Department changed to focus on space science.

In 1998 the Pu-Be source was transported to Los Alamos National Lab (DOE & NRC Nuclear Material Transaction Report, 5/27/98).

All radioactive materials (except for a few items of exempt quantities) were stored in the locked closet in NS 014 and not disturbed except for routine inventories until 2010. Official notification of cessation of the use of licensed radioactive materials was sent 7/21/2010. Most materials were removed by Bionomics, Inc. on 11/4/10 (waste manifest). The remaining materials could not be taken because there was no licensed waste depot at that time. The remaining materials were taken on 5/6/11 (waste manifest) when a facility opened to receive these materials.

II. Survey Scans

All regulated radioactive materials had been stored in a locked closet within a lead castle since the mid 1990s. These were never removed until they were disposed in 2010 and 2011 and the closet was only opened for routine inventory or inspection. The closet is in a locked room (014B) within another locked room (014A). These two rooms are within a very low traffic area open to the outside of the Nussbaum Science Center via a door that is also normally locked. Only a very few faculty and students can access this space and even fewer can access the locked closet.

Only very small, exempt, quantities of radioactive materials ever left this secluded area and entered the Nussbaum Science Center proper in the 46 year history of the building. Therefore only Nussbaum 014A, 014B, and the storage closet were scanned for radioactive materials.

We borrowed a calibrated survey meter from Ball State University in Muncie, IN. The survey meter used a Victoreen Model 491-30 probe, which is very sensitive to Beta and Gamma rays. The probe was connected to a Victoreen Model 290 survey meter which allows measuring in both CPM and mR/hr. The shield on the probe was open for all scans.

The instrument was calibrated on Oct 18, 2012 by Fluke Biomedical.

An MDC value of 1312 dpm/100 cm² was calculated for this set-up.

Nussbaum rooms 014A, 014B, and the storage closet were surveyed in both the CPM and the mR/hr modes.

A background check was conducted in our new building (Euler Science Center) which has never had any radioactive material in it and on the third floor of the Nussbaum Science Center which also does not have radioactive materials. The background was slightly higher in Nussbaum (a cinder block building) than in Euler (primarily drywall). The background in Nussbaum was 0.02 mR/hr or 0.000175 mSv/hr based on several 5 min observations. The background observed for the CPM mode was 20 CPM based on several 5 min observations.

The closet is 3.3 ft x 3.3 ft x 8 ft and made of cinder block and lined with lead to about 6 ft above the floor. All radioactive materials were stored within the closet and most were inside another container made of lead brick. There were also two large lead pigs. All radioactive materials were removed from that closet by Bionomics, Inc on 11/4/10 and 5/6/11. The walls, floor, and shelving were slowly scanned at a few mm from the surface. Fixed point measurements were taken at several suspected hot spots within the closet which included the shelving in the storage closet, the floor of the storage closet, within the lead brick castle, and within the lead pigs. This is the most likely area to have any radioactive residue. There were no readings above background in either mode for scans conducted on 1/9/13 or on 1/10/13.

The other two rooms are also cinder block with 014A being 16 ft x 12 ft and 014B being 16 ft x 10 ft. Both have 8 ft ceilings. The walls, floors, and bench tops of each room were slowly scanned at a few mm from the surface. Fixed point measurements were taken of suspected hot spots. Surveys were done using both the mR/hr and CPM modes. There were no readings above background in either mode for scans conducted on 1/9/13 or on 1/10/13.

Given the fact that all radioactive materials were removed from the closet by a licensed waste hauler (Bionomics, Inc.) and no residual radioactivity was found in areas where these materials were used, Taylor University would like to officially be considered decommissioned.

STRAIGHT BILL OF LADING-SHORT FORM

Original-Not Negotiable

Shipper's No.
Carrier's No.

Name of Carrier ROADWAY		SCAC	Date 5-20-98
TO: US Department of Energy Consignee Los Alamos National Laboratory		FROM: Taylor University Shipper Roger Roth	
Street Receiving Building SM-30 Bikini Atoll Rd. Atten: Diana Sena		Street 500 W. Reade Ave.	
Destination Los Alamos, NM	Zip 87545	Origin Upland, IN 46989	Zip

Route:		Vehicle Number				
No. Shipping Unit	HM	Kind of Packages, Description of Articles (IF HAZARDOUS MATERIALS-PROPER SHIPPING NAME)	HAZARD CLASS	UN or NA Number	WEIGHT (subject to correction)	LABELS REQUIRED (or exemption)
1	X	RQ, Radioactive material, Fissile N.O.S.,	7	UN 2918	135 lbs	Radioactive Yellow III
		DOT 6N Type B, 239PuBe, .148TBq (4Ci)				
		Normal Form Solid, Elemental				
		Radioactive Yellow III				
		Transport Index, 6.0 64grams				

FOR SHIPMENT STATUS
CALL 1-800-ROADWAY
328-574742-X

EMERGENCY CONTACT **765-998-5555** (EMERGENCY RESPONSE INFORMATION ATTACHED) Guide 165

LAN# **2377** 741# **ZVG-AUA-1** TID(s) **000071** Drum #'s **1224**

Where the rate is dependent on value, shippers are required to state specifically, in writing, the agreed or declared value of the property. The agreed or declared value of the property is hereby specifically stated by the shipper to be not exceeding \$ _____ Per _____	Subject to Section 7 of the conditions, if this shipment is to be delivered to the consignee without recourse on the consignor, the consignor shall sign the following statement. The carrier shall not make delivery of the shipment without payment of freight and all other lawful charges. _____ (Signature of Consignor)	FREIGHT CHARGES Prepaid <input checked="" type="checkbox"/> Collect <input type="checkbox"/>
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RECEIVED, subject to the classifications and tariffs in effect on the date of the issue of this Bill of Lading, the property described above is in apparent good order, except as noted (contents and condition of contents of packages unknown), marked, consigned, and destined as indicated above, which said carrier (the word carrier being understood throughout this contract as meaning any person or corporation in possession of the property under the contract) agrees to carry to its usual place of delivery at said destination, if on its route, otherwise to deliver to another carrier on the route to said destination. It is mutually agreed as to each carrier of all or any of, said property over all or any portion of said route to destination and as to each party at any time interested in all or any said property, that every service to be performed hereunder shall be subject to all the bill of lading terms and conditions in the governing classification on the date of shipment.

SHIPPER hereby certifies that he is familiar with all the bill of lading terms and conditions in the governing classification and the said terms and conditions are hereby agreed to by the shipper and accepted for himself and his assigns.

This is to certify that the above-named materials are properly classified, described, packaged, marked and labeled and are in proper condition for transportation according to the applicable regulations of the Department of Transportation. PER: <u><i>Roger Roth</i></u>	PLACARDS REQUIRED RADIOACTIVE PLACARDS SUPPLIED <input type="checkbox"/> YES <input checked="" type="checkbox"/> NO, FURNISHED BY CARRIER DRIVER'S SIGNATURE (x) <u><i>[Signature]</i></u> CARRIER <u><i>ROADWAY</i></u> PER: <u><i>[Signature]</i></u> DATE: 5-20-98
Special Instructions LANL Contact: Sherry Jones (505) 665-2712 SHIPPER: <u><i>Taylor University, Physics</i></u> PER: <u><i>Roger Roth</i></u> DATE: 5-20-98	PER: <u><i>[Signature]</i></u> DATE: 5-20-98

**LOS ALAMOS
NATIONAL LABORATORY**

SHIPPING MANIFEST #



**IMPORTANT: SEE INSTRUCTIONS FOR COMPLETING THE SHIPPING MANIFEST.
THIS FORM MUST BE TYPED. REPRODUCE A COPY FOR YOUR FILES.**

From Daniel Martinez		Telephone Number (505) 667-3470		Date 4/28/98	
Group NMT-4	Mail Stop E513	Return Material Authorization Number		Laboratory's Reference # (e.g., Purchase Order #)	
Consignee's Name, Complete Street Address, Zip Code <i>(include all destinations on international shipments)</i> Taylor University Physics Dept. 500 W. Reade Avenue Upland, IN 46989				Consignee's Reference Number	
ATTN: Roger Roth				Delivery Date Requested	
Telephone Number (765) 998-5226 Fax Number (765) 998-4844 <small>Required for RAM CLASSIFIED shipments</small>				Cost Code / Program Code / Cost Acct / Wk Pkg 8J04/KG12/1000/0000	
				Carrier ROADWAY <input checked="" type="checkbox"/> PPD <input type="checkbox"/> Collect	
				Carrier Waybill Number 859-982312-9	
ALL PACKAGES AND CORRESPONDENCE MUST BE IDENTIFIED WITH LABORATORY REFERENCE NUMBER		Pieces 1	Weight 120	Kind of Package yellow drum	
Item No	Quantity	Complete Description (Manufacturer, model number, serial number)			Property Number Line Value
	1	Radioactive material, excepted package- empty packaging, 7, UN2910, TYPE B DOT 6m PuBe, 30 gal. 20" X 30", 135 Lbs.			
		Drum# 1224 TID# B27599			
Reason for Shipment Justification for Premium Transportation Shipper to return with material					Total Value
HAZARDOUS MATERIAL EMERGENCY RESPONSE CONTACTS					
Name		Group	Office Telephone	After Hour Telephone	
1 EMO			(505) 667-6211		
2 Daniel Martinez		NMT-4	(505) 667-3470	(505) 753-5198	
3 Tim Stone		NMT-4	(505) 665-3585	(505) 661-6553	
IT IS A FEDERAL OFFENSE TO VIOLATE SHIPPING REGULATIONS FOR HAZARDOUS MATERIALS, WASTE, OR SUBSTANCES					
Check all that apply: <input type="checkbox"/> Return of Loan # _____ <input type="checkbox"/> Permanent Transfer # _____ <input type="checkbox"/> Repair <input type="checkbox"/> Loan, # _____ How Long? _____ (1 year MAXIMUM) <input type="checkbox"/> Return No Replacement <input type="checkbox"/> Government Furnished Property <input type="checkbox"/> FRAGILE <input checked="" type="checkbox"/> Security Classification of this SM Document UNCLASSIFIED <input checked="" type="checkbox"/> Security Classification of this Material UNCLASSIFIED <input type="checkbox"/> Export (Country of Origin) _____ <input type="checkbox"/> RUSH <input type="checkbox"/> Other _____					
Pick up Date ASAP	From Daniel Martinez	Group NMT-4	Site TA-55	Building Drop Point PF-4	Telephone Number &-3470
Authorized Signature 		Property Administrator Signature		Buyer Signature	
Type Name, Title, and Z Number Tim Stone 093414 Supervisor		Type Name, Title, and Z Number		Type Name, Title, and Z Number	
Export License	TDG Checked By	Units Accepted by		for BUS 6	Printed On
				grp/P. Apodaca	5/1/98 mim

NRC FORM 540 US Nuclear Regulatory Commission		5. SHIPPER - NAME AND FACILITY TAYLOR UNIVERSITY 238 W. READE AVE. UPLAND, IN 46989		SHIPPER I.D. NUMBER X COLLECTOR PROCESSOR		7. NRC FORM 540 AND 540A PAGE 1 OF 1 NRC 541 AND 541A NRC 542 AND 542A ADDITIONAL INFORMATION		8. MANIFEST NUMBER (Use the number on all continuation pages) TU-1	
UNIFORM LOW-LEVEL RADIOACTIVE WASTE MANIFEST SHIPPING PAPER		USER PERMIT NUMBER SHIPMENT NUMBER		GENERATOR TYPE (Specify)		9. CONSIGNEE - Name and Facility Address Energy Solutions 1560 Bear Creek Road Oak Ridge, TN 37831		CONTACT: Donnie Brackett (865) 220-1526	
1. EMERGENCY TELEPHONE NUMBER (Include Area Code) 865-220-8520		CONTACT DAN HAMMOND		TELEPHONE NUMBER 765-998-5273		SIGNATURE - Authorized consignee acknowledging waste receipt DATE		10. CERTIFICATION This is to certify that the herein-named materials are properly classified, described, packaged, marked, and labeled and are in proper condition for transportation according to the applicable regulations of the Department of Transportation. This also certifies that the materials are classified, packaged, marked, and labeled and are in proper condition for transportation and disposal as described in accordance with the requirements of 10 CFR Parts 20 and 61, or equivalent state regulations.	
ORGANIZATION Bionomics, Inc.		6. CARRIER - Name and Address BIONOMICS, INC. 1550 BEAR CREEK RD. OAK RIDGE, TN 37830		EPA I.D. NUMBER TND982116493		SHIPPING DATE 11-4-2010		11. U.S. DEPARTMENT OF TRANSPORTATION DESCRIPTION (including proper shipping name, hazard class, UN ID number, and any additional information)	
2. IS THIS AN "EXCLUSIVE USE" SHIPMENT? <input checked="" type="checkbox"/> YES <input type="checkbox"/> NO		3. TOTAL NUMBER OF PACKAGES IDENTIFIED ON THIS MANIFEST 3		CONTACT JOHN McCORMICK		TELEPHONE NUMBER (Including Area Code) (865) 220-8501		AUTHORIZED SIGNATURE TITLE RSO DATE 11/4/2010	
4. DOES EPA REGULATED WASTE REQUIRING A MANIFEST ACCOMPANY THIS SHIPMENT? <input checked="" type="checkbox"/> YES <input type="checkbox"/> NO		EPA MANIFEST NUMBER		SIGNATURE - Authorized carrier acknowledging waste receipt DATE 11/4/2010		12. DOT LABEL "RADIOACTIVE" 13. TRANSPORT INDEX 14. PHYSICAL AND CHEMICAL FORM 15. INDIVIDUAL RADIONUCLIDES 16. TOTAL PACKAGE ACTIVITY IN SI UNITS 17. LSA/SCO CLASS 18. TOTAL WEIGHT OR VOLUME (Use appropriate units) 19. IDENTIFICATION NUMBER OF PACKAGE		20. FOR CONSIGNEE USE ONLY	
UN3321, Radioactive material, low specific activity (LSA-II), 7		N/A		N/A		Solid / Oxides		C-14;Co-60; Cs-137; U-238	
UN3321, Radioactive material, low specific activity (LSA-II), 7		N/A		N/A		Solid / Oxides		C-14;Co-60; Cs-137; U-238	
UN3321, Radioactive material, low specific activity (LSA-II), 7		N/A		N/A		Solid / Oxides		Th-232; U-238	

UNIFORM LOW-LEVEL RADIOACTIVE MANIFEST WASTE MANIFEST

CONTAINER AND WASTE DESCRIPTION

Additional Nuclear Regulatory Commission (NRC) Requirements for Control, Transfer and Disposal of Radioactive Waste

NUMBER OF PACKAGES/ DISPOSAL CONTAINERS	NET VOLUME (m ³)	NET WEIGHT (kg)	SPECIAL NUCLEAR MATERIAL (grams)				TOTAL	TU-1 PAGE 1 OF 1 PAGE(S)
			U-233	U-235	Pu			
3	0.057	24.20	NP	NP	NP	NP		
			ACTIVITY (MBq)			SOURCE (kg)	SHIPMENT ID NUMBER	
			ALL NUCLIDES	TRITIUM	C-14			Tc-99
42.240			NP	0.74	NP	NP	3.030000	TAYLOR UNIVERSITY

DISPOSAL CONTAINER DESCRIPTION						WASTE DESCRIPTION FOR EACH WASTE TYPE IN CONTAINER								WASTE CLASSIFICATION AS-Class A AU- Class A Unstable B- Class B C- Class C
5. CONTAINER IDENTIFICATION NUMBER / GENERATOR ID NUMBER	6. CONTAINER DESCRIPTION (See Note 1)	7. VOLUME (m ³)	8. WASTE AND CONTAINER WEIGHT (kg)	9. SURFACE RADIATION LEVEL (mSv/hr)	10. SURFACE CONTAMINATION MBq/100 cm ²			11. WASTE DESCRIPTION (See Note 2)	12. APPROXIMATE WASTE VOLUME(S) IN CONTAINER (m ³)	13. SORBENT, SOLIDIFICATION, STABILIZATION MEDIA (See Note 3)	14. CHEMICAL FORM / CHELATING AGENT	15. WEIGHT % CHELATING AGENT IF > 0.1%	16. RADIOLOGICAL DESCRIPTION INDIVIDUAL RADIONUCLIDES AND ACTIVITY (MBq) AND CONTAINER TOTAL: OR CONTAINER TOTAL ACTIVITY AND RADIONUCLIDE PERCENT	
T-1	3Plastic Drum or Pail	0.019	4.6	0.005	<3.34E-7	<1.67E-5	59. INCINERABLES	0.019	100	Oxides	N/P	N/P	C-14 0.370 Co-60 0.370 Cs-137 0.370 Ba-133 0.037 U-238 3.700 [0.303 kg] TOTAL 4.847 [0.303 kg]	A U
T-2	3Plastic Drum or Pail	0.019	4.6	0.02	<3.34E-7	<1.67E-5	59. INCINERABLES	0.019	100	Oxides	N/P	N/P	C-14 0.370 Co-60 3.700 Cs-137 3.700 Ba-133 3.700 U-238 3.700 [0.303 kg] TOTAL 15.170 [0.303 kg]	A U

NOTE: Container Description Codes: For containers/waste requiring disposal in approved structural overpacks, the numerical code must be followed by "OP."

1. Wooden Box or Crate
2. Metal Box
3. Plastic Drum or Pail
4. Metal Drum or Pail
5. Metal Tank or Liner
6. Concrete Tank or Liner
7. Polyethylene Tank or Liner
8. Fiberglass Tank or Liner
9. Demineralizer
10. Gas Cylinder
11. Bulk, Unpackaged Waste
12. Unpackaged Components
13. High Integrity Container
19. Other. Describe in item 6, or additional page.

NOTE 1A: Process Type Codes Are Specific To Biomedical and Only Apply To How The Waste Will Be Processed / Handled By The Clinician. Use up to two process codes and one disposal site.

- 1A. Supercompact
- 11A. Barriwell
- 2A. Incineration
- 12A. Richard
- 3A. Transfer
- 13A. Envelopes
- 4A. Solidify
- 14A. Return
- 5A. Encapsulate
- 20A. Other. Specify in the block or on an attached page.
- 6A. Metal Melt
- 7A. Sort
- 8A
- 9A
- 10A. Other. Specify in the block or on attached page.

NOTE 2: Waste Descriptor Codes: (Choose up to three predominate by volume.)

20. Chemical
21. Indicator Aft
22. Soil
23. Gas
24. Oil
25. Aqueous Liquid
26. Filter Media
27. Mechanical Filter
28. EPA or State Hazardous
29. Demolition Rubble
30. Cation Ion-exchange Media
31. Anion Ion-exchange Media
32. Mixed Bed Ion-exchange Media
33. Concentrated Equipment
34. Organic Liquid
35. Glassware or Labware
36. Sealed Source / Device
37. Paint or Plating
38. Evaporator Bottoms / Sludges / Concentrates
39. Compactable Trash
40. Noncompactable Trash
41. Animal Carcasses
42. Biological Material (except animal carcasses)
43. Activated Material
56. Other. Describe in item 11, or additional page.

NOTE 3: For solidification media that meet disposal site structural stability requirements, the numerical code must be followed by "S". For all solidification media, the vendor (manufacturer and brand name must also be identified in item 13. Code 100=NONE REQUIRED.

50. Speed-Dri
61. Calstron
62. Floor Dry
63. Hi Dri
64. Safe T Sort
65. Safe N Dri
66. Floro
67. Floro X
68. Solid A Sort
69. Chemall 30
70. Chemall 60
71. Chemall 3030
72. Disaperl HP200
73. Disaperl HP500
74. Petrocoat
75. Petrocoat II
76. Aqueal
77. Aqueal II
78. Other
79. Describe in item 13, or additional page.
80. Concrete (encapsulation)
81. Bitumin
82. Bitumin
83. Vinyl Chloride
84. Other. Describe in item 13, or additional page.
85. None Required
100. None Required

UNIFORM LOW-LEVEL RADIOACTIVE MANIFEST
WASTE MANIFEST

PAGE 2 OF 2 PAGE(S)

A. SHIPPER NAME

TAYLOR UNIVERSITY

DISPOSAL CONTAINER DESCRIPTION

WASTE DESCRIPTION FOR EACH WASTE TYPE IN CONTAINER

[illegible]

Sealed Since,

NOTE 3: For solidification media that meet disposal site structural stability requirements, the numerical code must be followed by "S." For all solidification media, the vendor (manufacturer) and brand name must also be identified in item 13. Code 100=NONE REQUIRED.

Sorption				Solidification			
60. Speed Dri	64. Safe T Sorb	68. Chemsil 30	74. Retrosorb	88. Other:	90. Cement	94. Vinyl Ester Styrene	
61. Calcium Chloride	65. Safe N Dri	70. Chemsil 50	75. Retrosorb II	Describe in item 13, or additional page	91. Concrete (encapsulation)	95. Other: Describe in item 13, or additional page	
62. Floor Dry Superliner	66. Flocco	72. Dicerapi HP200	76. Aqueaset	92. Bitumen	96. Vinyl Chloride	100. None Required	
63. Hi Dri	67. Flocco X	73. Dicerapi HP500	77. Aqueaset II				
64. Solid A Sorb							

Estimated burden per response to comply with this information collection request: 45 minutes. This uniform manifest is required by NRC to meet reporting requirements of Federal and State Agencies for the safe transportation and disposal of low-level waste. Send comments regarding burden estimate to the Records and FOIA/Privacy Services Branch (T-6 F52), U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, or by internet e-mail to infocoll@nrc.gov, and to the Desk Officer, Office of Information and Regulatory Affairs, NIOB-10202, (3150-0154), Office of Management and Budget, Washington, DC 20503. If a means used to impose an information collection does not display a currently valid OMB control number, the NRC may not conduct or sponsor, and a person is not required to respond to, the information collection.

NRC FORM 540 (7-2007) PRINTED ON RECYCLED PAPER SHIPPER COPY

Estimated burden per response to comply with this information collection request: 3.3 hours. This uniform manifest is required by NRC to meet reporting requirements of Federal and State Agencies for the safe transportation and disposal of low-level waste. Send comments regarding burden estimate to the Records and Financial Privacy Service Branch (1-F52), U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, or by internet e-mail to infocenters@nrc.gov, and to the Desk Officer, Office of Information and Regulatory Affairs, NEOP-10202, (3150-0166), Office of Management and Budget, Washington, DC 20503. If a means used to impose an information collection does not display a currently valid OMB control number, the NRC may not conduct or sponsor, and a person is not required to respond to, the information collection.

Sorptions				Solidification			
60. Speedi Dri	64. Safe T Sorb	69. Chemst 30	74. Petroset	89. Other.	90. Cement	94. Vinyl Ester Styrene	
61. Cetelem	65. Safe N Dri	70. Chemst 50	75. Petroset II	Describe in item 13, or additional page	91. Concrete (encapsulation)	99. Other. Describe in item 13, or additional page	
62. Floor Dry Superfine	66. Florco	71. Chemst 3030	76. Aqueset		92. Bluman		
63. Hi Dri	67. Florco X	72. Dicaepi HP200	77. Aqueset II	93. Vinyl Chloride	100. None Required		
	68. Solid A Sorb	73. Dicaepi HP500					

APPROVED BY OMB: NO. 3150-0164
EXPIRES: 07/31/2010

Estimated burden per response to comply with this information collection request: 45 minutes. This uniform manifest is required by NRC to meet reporting requirements of Federal and State Agencies for the safe transportation and disposal of low-level waste. Send comments regarding burden estimate to the Records and FOIA/Privacy Services Branch (T-6 P52), U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, or by internet e-mail to infocollections@nrc.gov, and to the Desk Officer, Office of Information and Regulatory Affairs, NEOB-10202, (3150-0164), Office of Management and Budget, Washington, DC 20503. If a means used to impose an information collection does not display a currently valid OMB control number, the NRC may not conduct or sponsor, and a person is not required to respond to, the information collection.

NRC FORM 540 (7-2007)		U.S. NUCLEAR REGULATORY COMMISSION		5. SHIPPER - NAME AND FACILITY		SHIPPER I.D. NUMBER		7. NRC FORM 540 AND 540A PAGE 1 OF 1		8. MANIFEST NUMBER (Use this number on all continuation pages)	
UNIFORM LOW-LEVEL RADIOACTIVE WASTE MANIFEST SHIPPING PAPER				Taylor University 236 W. Randle Ave. Upland, IN 46789		COLLECTOR PROCESSOR GENERATOR TYPE (Specify) A		NRC FORM 541 AND 541A NRC FORM 542 AND 542A ADDITIONAL INFORMATION		PAGE(S) PAGE(S) PAGE(S)	
				USER PERMIT NUMBER SHIPMENT NUMBER		TELEPHONE NUMBER (Include Area Code) (765) 998-5273		EPA I.D. NUMBER 140922116493		SIGNATURE - Authorized consignee acknowledging waste receipt	
1. EMERGENCY TELEPHONE NUMBER (Include Area Code) (812) 220-8520				CONTACT DAN HAMMOND		SHIPPING DATE 5-6-11		9. CONSIGNEE - Name and Facility Address ENERGY SOLUTIONS 15605 Bear Creek Rd. Oak Ridge, TN 37831		CONTACT Donnie Brachett TELEPHONE NUMBER (Include Area Code) (865) 481-0222	
2. IS THIS AN "EXCLUSIVE USE" SHIPMENT? <input checked="" type="checkbox"/> YES <input type="checkbox"/> NO				3. TOTAL NUMBER OF PACKAGES IDENTIFIED ON THIS MANIFEST 11		6. CARRIER - Name and Address Bionomics Inc. 1550 Bear Creek Rd. Oak Ridge, TN 37830		10. CERTIFICATION This is to certify that the herein-named materials are properly classified, described, packaged, marked, and labeled and are in proper condition for transportation according to the applicable regulations of the Department of Transportation. This also certifies that the materials are classified, packaged, marked, and labeled and are in proper condition for transportation and disposal as described in accordance with the applicable requirements of 10 CFR Parts 20 and 61, or equivalent state regulations.		DATE	
4. DOES EPA REGULATED WASTE REQUIRING A MANIFEST ACCOMPANY THIS SHIPMENT? If "Yes," provide Manifest Number				EPA MANIFEST NUMBER		CONTACT John D. McCormick		AUTHORIZED SIGNATURE		TITLE	
11. U.S. DEPARTMENT OF TRANSPORTATION DESCRIPTION (including proper shipping name, hazard class, UN ID number, and any additional information)				12. DOT LABEL "RADIOACTIVE"		13. TRANSPORT INDEX		14. PHYSICAL AND CHEMICAL FORM		15. INDIVIDUAL RADIOCLIDES	
Radioactive Material, low specific activity (LSA-II), 7 (60) 3271				NA		NA		Solid/liquid		Cs-137, Ag-108m	
16. TOTAL PACKAGE ACTIVITY IN SI UNITS				17. LSA/SCO CLASS		18. TOTAL WEIGHT OR VOLUME (Use appropriate units)		19. IDENTIFICATION NUMBER OF PACKAGE			
74.148 MBq				LSA-II		6.02 m ³		TH-2			
FOR CONSIGNEE USE ONLY											

APPROVED BY OMB: NO. 3150-0186
EXPIRES: 07/31/2010

Estimated burden per response to comply with this information collection request: 3.3 hours. This uniform manifest is required by NRC to meet reporting requirements of Federal and State Agencies for the safe transportation and disposal of low-level waste. Send comments regarding burden estimate to the Records and Privacy Service Branch (T-6 P62), U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, or by Internet e-mail to infocoll@nrc.gov, and to the Desk Officer, Office of Information and Regulatory Affairs, NE08-10202, (3150-0186), Office of Management and Budget, Washington, DC 20503. If a means used to impose an information collection does not display a currently valid OMB control number, the NRC may not conduct or sponsor, and a person is not required to respond to, the information collection.

NRC FORM 541 (7-2007)										U.S. NUCLEAR REGULATORY COMMISSION							1. MANIFEST TOTALS							2. MANIFEST NUMBER	
UNIFORM LOW-LEVEL RADIOACTIVE WASTE MANIFEST CONTAINER AND WASTE DESCRIPTION Additional Nuclear Regulatory Commission (NRC) Requirements for Control, Transfer and Disposal of Radioactive Waste										NUMBER OF DISPOSAL CONTAINERS		NET WASTE VOLUME (m ³)		NET WASTE WEIGHT (kg)		SPECIAL NUCLEAR MATERIAL (grams)				TOTAL		PAGE <u>1</u> OF <u>1</u> PAGE(S)			
										U-233		U-235		Pu		TOTAL		ACTIVITY (MBq)		SOURCE (kg)					
										ALL NUCLIDES		TRITIUM		C-14		Tc-99		I-129		SHIPPER I.D. NUMBER					
										74.148		NP		NP		NP		NP		NP		Taylor University			
DISPOSAL CONTAINER DESCRIPTION										WASTE DESCRIPTION FOR EACH WASTE TYPE IN CONTAINER										18. WASTE CLASSIFICATION					
6. CONTAINER IDENTIFICATION NUMBER/GENERATOR ID NUMBER(S)	7. CONTAINER DESCRIPTION (See Note 1)	8. VOLUME (m ³)	9. WASTE AND CONTAINER WEIGHT (kg)	10. SURFACE RADIATION LEVEL (μSv/hr) (mSv/hr)	11. ALPHA	12. BETA-GAMMA	13. PHYSICAL DESCRIPTION	14. CHEMICAL DESCRIPTION	15. RADIOLOGICAL DESCRIPTION	16. INDIVIDUAL RADIONUCLIDES AND ACTIVITY (MBq) AND CONTAINER TOTAL, OR CONTAINER TOTAL ACTIVITY AND RADIONUCLIDE PERCENT		17. WASTE CLASSIFICATION AS-Class A Stable AU-Class A Unstable B-Class B C-Class C													
TH-2	3	0.02	3	0.1	935.7	41.66	59 Paper Plastic 0.002 m ³	OXIDES/NP	NP	Cs137 = 0.148 Ag108m = 74 TOTALS 74.148	A4														

NOTE 1: Container Description Codes. For containers/waste requiring disposal in approved structural overpacks, the numerical code must be followed by "OP."

- | | |
|-------------------------------|---|
| 1. Wooden Box or Crate | 9. Demineralizer |
| 2. Metal Box | 10. Gas Cylinder |
| 3. Plastic Drum or Pail | 11. Bulk Unpackaged Waste |
| 4. Metal Drum or Pail | 12. Unpackaged Components |
| 5. Metal Tank or Liner | 13. High Integrity Container |
| 6. Concrete Tank or Liner | 19. Other. Describe in Item 6, or additional page |
| 7. Polyethylene Tank or Liner | |
| 8. Fiberglass Tank or Liner | |

NOTE 2: Waste Descriptor Codes. (Choose up to three which predominate by volume.)

- | | | |
|----------------------------|----------------------------------|--|
| 20. Charcoal | 29. Demolition Rubble | 38. Evaporator Bottoms/Sludges/Concentrates |
| 21. Incinerator Ash | 30. Cation Ion-exchange Media | 39. Compactible Trash |
| 22. Soil | 31. Anion Ion-exchange Media | 40. Noncompactible Trash |
| 23. Gas | 32. Mixed Bed Ion-exchange Media | 41. Animal Carcass |
| 24. Oil | 33. Contaminated Equipment | 42. Biological Material (except animal carcass) |
| 25. Aqueous Liquid | 34. Organic Liquid (except oil) | 43. Activated Material |
| 26. Filter Media | 35. Glassware or Labware | 59. Other. Describe in Item 11, or additional page |
| 27. Mechanical Filter | 36. Sealed Source/Device | |
| 28. EPA or State Hazardous | 37. Paint or Plating | |

NOTE 3: For solidification media that meet disposal site structural stability requirements, the numerical code must be followed by "S." For all solidification media, the vendor (manufacturer) and brand name must also be identified in Item 13. Code 100-NONE REQUIRED.

- | Sorption | | | Solidification | | |
|--------------------------|------------------|-------------------|-----------------|--|--|
| 60. Speedi Dri | 64. Safe T Sorb | 69. Chemsil 30 | 74. Petroset II | 79. Other. Describe in item 13, or additional page | 94. Vinyl Ester Styrene |
| 61. Celatom | 65. Safe N Dri | 70. Chemsil 50 | 75. Petroset II | | 95. Other. Describe in item 13, or additional page |
| 62. Floor Dry/ Superline | 66. Florco | 71. Chemsil 3030 | 76. Aqueset | | 96. Bitumen |
| 63. H Dri | 67. Florco X | 72. Dicaper HP200 | 77. Aqueset II | | 97. Vinyl Chloride |
| | 68. Solid A Sorb | 73. Dicaper HP500 | | | 100. None Required |

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Materials Licensing Branch
U.S. Nuclear Regulatory Commission, Region
III
2443 Warrenville Road, Suite 210
Lisle, Illinois, 60532-4352

