# Historical Site Assessment

## Buffalo Materials Research Center

**Prepared for:**

University at Buffalo
The State University of New York

**Buffalo Material Research Center**
**Office of Environment, Health, and Safety Services**

**Completed by:**

ENERCON
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**4490 Old William Penn Hwy**
**Murrysville, PA 15668**



**Revision 1**
**May 31, 2011**

## Summary of Changes

Revisions to the Historical Site Assessment will be tracked when revisions are issued. Changed sections will be identified by special demarcation in the margin. A summary description of each revision will be noted in the following table.

| Revision Number | Date | Description of Change |
|---|---|---|
| 0 | March 17, 2010 | Initial Issue |
| 1 | May 31, 2011 | • Added picture demonstrating existence of a concrete berm surrounding the 10K tank in the Tank Farm.<br>• Revised Tank Farm description on page 17.<br>• Changed the phrase "MARSSIM termination process" to "MARSSIM process" throughout the document.<br>• Revised formatting throughout document. |

# Table of Contents

## GLOSSARY OF TERMS, ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| BMRC | Buffalo Materials Research Center |
| Co | Cobalt |
| Cs | Cesium |
| DCGL | Derived Concentration Guideline Level |
| DOE | Department of Energy |
| Fe | Iron |
| FSS | Final Status Survey |
| HEPA | High Efficiency Particulate Air |
| HSA | Historical Site Assessment |
| MARSSIM | Multi-Agency Radiation Survey and Site Investigation Manual |
| MTR | Materials Testing Reactor |
| Ni | Nickel |
| NRC | Nuclear Regulatory Commission |
| NYSDOH | New York State Department of Health |
| Pu | Plutonium |
| PuBe | Plutonium |
| PULSTAR | Pulse Training Assembled Reactor |
| UB | State University of New York at Buffalo |

## 1.0 EXECUTIVE SUMMARY

The Buffalo Materials Research Center (BMRC) is owned by The State University of New York at Buffalo (UB) and is located on the south edge of the South Campus of the University in the City of Buffalo, New York. The BMRC was a Research and Test Reactor Facility that was built between 1959 and 1961. The unit has been in Possession Only status since June 6, 1997, with all the fuel being removed from the site in 2005.

The reactor at UB was placed into operation in 1961 under AEC License Number R-77 and operated until 1963 with materials-testing-reactor (MTR)-type fuel elements with a maximum steady-state power level of 1 MWt. In 1963 the reactor was shut down and the core and control systems were modified so that the reactor could operate with Pulse Training Assembled Reactor (PULSTAR)-type fuel at power levels of up to 2 MWt. In 1964, the facility was re-issued operating license R-77, for its newly modified reactor. The operating license was subsequently renewed for a period of 20 years in 1984. The reactor operated with PULSTAR-type fuel until the facility was shutdown in 1994. The reactor facility has undergone several name changes over the years. The Office of Environment, Health and Safety at UB is currently the organization that is responsible for maintaining the BMRC and its decommissioning.

The BMRC is in the planning and preparatory phase of the MARSSIM process. The BMRC maintains two Nuclear Regulatory Commission (NRC) Licenses, Possession Only License Number R-77 and Special Nuclear Material License Number SNM-273 for possession of a Plutonium-Beryllium (PuBe) neutron source. The BMRC also maintains a New York State Department of Health (NYSDOH) radioactive material license Number 1051 for calibration and check sources.

This Historical Site Assessment (HSA) is being prepared as the site's first step in the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) process. The MARSSIM, Nuclear Regulatory Guide-1575 (NUREG-1575), provides guidance to assemble a statistically accurate final status survey plan to support the ultimate goal of terminating the NRC licenses. The NYSDOH license will be transferred to a different department within UB. The NRC SNM license is to be terminated in the near future provided that the PuBe source can be transferred to the NYSDOH license. The HSA documents the collection of information regarding the site and its operational history.

Data from the HSA investigation suggests that the land areas that have been impacted by the operation of the reactor lie within close proximity to the Containment and Laboratory Wings. The migration of surface and subsurface contamination appears to be limited to areas very near to the BMRC, however, the full nature and extent needs to be determined. The data also suggests that the BMRC will most likely require remediation of the surfaces in the Containment Building, portions of the underground tanks and structures, portions of the Laboratory Wing, and require removal of neutron activated portions of the reactor bioshield.

The recommended next step in the MARSSIM process is to initiate a site characterization effort to determine the full nature and extent of contamination, both radiological and non-radiological, and activated materials at BMRC. Data from the characterization effort will be utilized to develop accurate dismantlement plans, facility remediation plans, waste management plans, cost estimates, and radiation protection plans for the MARSSIM process of the BMRC facility.

## 2.0 PURPOSE OF THE HISTORICAL SITE ASSESSMENT

The purpose of this HSA is to document a comprehensive review that identifies, collects, organizes, and evaluates historical information relevant to the BMRC site and its operational history. The HSA uses this historical information to provide initial classifications, based on guidance contained in NUREG-1575 (MARSSIM) that will be used to plan the characterization and remediation efforts. Final structure and land area classifications used for the final status survey will be based on this HSA and future characterization information.

As stated in MARSSIM, the HSA:

- identifies potential, likely, or known sources of radioactive material and radioactive contamination based on existing or derived information
- identifies sites that need further action as opposed to those posing no threat to human health
- provides an assessment for the likelihood of contaminant migration
- provides information useful to scoping and characterization survey designs
- provides initial classification of the site or survey unit as impacted or non-impacted

The following sections of the HSA will describe the site's physical characteristics and environmental setting, the methodology used in the HSA, and the site history and current usage. The sections will also describe the findings of the investigation regarding potential radiological contaminates of concern, potential contaminated areas, potential contaminated media, and other related environmental concerns.

# 3.0 PROPERTY IDENTIFICATION

## 3.1 Physical Characteristics

### 3.1.1 License Holder

The State University of New York at Buffalo

220 Winspear Avenue

Buffalo, New York, 14215-1034

### 3.1.2 Location

The BMRC is located, as shown in Figure 4-1, on the southwest edge of The State University of New York at Buffalo South Campus in the City of Buffalo in Erie County, New York. The facility consists of a cylindrical Containment Building and the attached rectangular Laboratory Wing which is oriented on the long axis to the north east of the Containment Building and any surface and subsurface exterior support systems.

The South Campus is in the northeast corner of the city limits of Buffalo, New York which is situated at the eastern end of Lake Erie along the Niagara River on a gently sloping plane. The area is bounded by the communities of Kensington and LaSalle to the south, Station Central to the west, Snyder to the east and Amherst to the north. The facility is approximately six miles northeast of the center of Buffalo, and six miles west of the Greater Buffalo International Airport.

The BMRC is approximately 680 feet above mean sea level and the geographical coordinates of the centerline of the Containment Building are approximately:

Latitude: North: 42 degrees, 57 minutes, 0 seconds

Longitude: West: 78 degrees, 49 minutes, 8 seconds

### 3.1.3 Topography

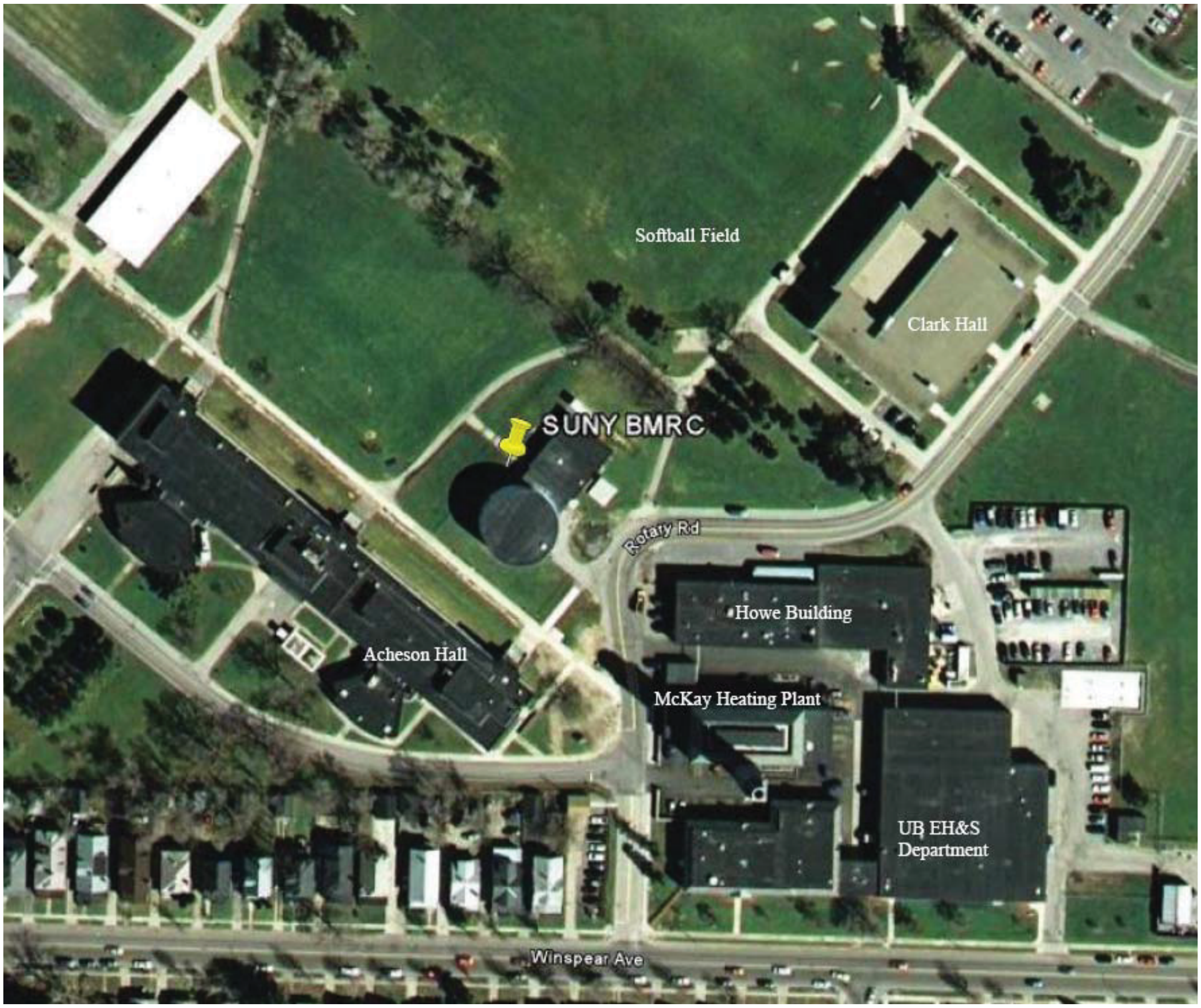
The local terrain of the site is a slightly elevated mound at the southern border of a level student athletic field with the Howe Building and the Mackay Heating Plant maintenance garage across the access road (Rotary Road) to the southeast and Kapoor Hall (formerly named Acheson Hall) to the southwest. Across the street from these facilities (approximately 400 feet) is residential area.

### 3.1.4 Stratigraphy

The south campus is positioned on the edge of the Onondaga Cuesta which follows a northeast to southwest course in the immediate area. The BMRC sits on a slope of the Cuesta which has been modified by glacial deposits to slope at an approximate rate of ten feet per half mile in a southerly direction. The general area is flat, and as a consequence, streams in the area are slow flowing and widely spaced. Approximately four miles east of the campus at Williamsville, NY is Elliot Creek which flows north. Another small unnamed creek headwater is approximately two miles north of the campus. There are no other streams in close proximity to the BMRC facility.

**Figure 4-1 UB South Campus**

**Figure 4-2 BMRC and Adjacent Buildings**




## 3.2 Environmental Setting

The Hazard Summary Report Revision II from September of 1963 provides information from studies of the environmental setting performed with the following results:

### 3.2.1 Geology

The south campus and the Buffalo area in general is covered with dense glacial clay overburden which is generally 10 to 20 feet thick.

The bedrock of the area consists of Silurian and Middle Devonian marine shale, dolomite and limestone with a southerly drop of 50 feet per mile. The rock formation is a joint system consisting of two joint sets arranged in a north-south east-west configuration intersecting at approximately 90 degrees. This is underlain by a similar marine series of Ordovician and Cambrian age to a depth of 3,000 feet which rests on a pre-Cambrian deposition.

The overburden from the bedrock to the surface averages about 15 feet in the area of the BMRC. The soil proper occupies the first 14 inches with subsoil which is made of dense boulder and clay extending uniformly to the bedrock.

The soil from the surface to a depth of nine inches consists of moderately compacted, brown-gray, heavy, silty clay loam. Beneath this is a roughly five inch stratum of compact dull yellowish-brown silty clay with a considerable amount of fine pebbles. Beneath this is a layer of dull brown clastic, heavily compacted, silty clay containing crystalline pebbles disbursed throughout. This clay material extends to bedrock without any significant change.

### 3.2.2 Hydrogeology

For all practical purposes surface water penetration ceases below a depth of 13 inches. Water will move through the saturated and undisturbed material in the first eight inches of topsoil at an average rate of 0.02 to 0.2 inches per hour. In the next five inch layer, the penetration decreases sharply to zero.

The underlying Onondaga and substrata are not known to contain water in the immediate vicinity, but it is not impervious. In previous core drilling to establish the geological underlayment in this area, all drill water was lost at 4.5 feet in the rock. Based on observations several miles east of the campus, the water was presumed to move to the escarpment edge.

Water movement within the overburden including the soil proper is extremely slow. Only within the first 13 inches water percolation takes place very slowly, 0.2 inches per hour. In the next 15 feet permeability ceases for all practical purposes.

Surface water flows in a southerly direction into established storm drains.

### 3.2.3 Meteorology

Data provided by NOAA, indicates that the Niagara Frontier, including Buffalo and vicinity, experiences a fairly humid, continental- type climate, but with a definite "maritime" flavor due to strong modification from the Great Lakes. Lake Erie lies to the southwest of the facility and functions to moderate the temperatures. The average temperatures measured at the Buffalo International Airport range from 18 degrees to 80 degrees Fahrenheit with maximums recorded of -20 degrees and 99 degrees Fahrenheit. Annual rainfall averages 38.5 inches in the Buffalo area and snowfall averages 93.3 inches per year

Winters in Western New York are generally cloudy, cold, and snowy but are changeable and include frequent thaws and rain as well. Over half of the annual snowfall comes from the "lake-effect" process and is localized. Due to the prevailing winds, areas south of Buffalo receive much more lake-effect snow than locations to the north.

As the prevailing air flow is mostly southwesterly, areas near the lake are often as much as 20 degrees colder than inland locations. The cool lake waters act as a strong stabilizing influence, so areas near the lake shore, which includes the city of Buffalo, experience more sunshine and fewer thunderstorms than inland areas.

Summer is also influenced by the stabilizing effect of Lake Erie. It inhibits thunderstorms and enhances sunshine in the immediate Buffalo area. The lake also modifies the extreme heat that approaches from the Ohio Valley.

Wind rose data for the area indicates that the predominant wind direction is from the southwest; approximately 61 percent of the time.

### 3.2.4 Adjacent Land Usage

The following paragraphs describe the features and uses of land within five miles of the plant. Included is a summary of the population centers within ten miles of the BMRC site.

#### 3.2.4.1 Bodies of Water

Four miles east of the campus at Williamsville is Elliot Creek which flows north. An unnamed creek has its headwaters approximately two miles north of the campus. There are no other streams in close proximity to the BMRC facility. The nearest water access is Lake Erie which is five miles to the southwest of the BMRC site. The Niagara River on which Niagara Falls lie is 4.6 miles to the southwest. Lake Ontario is approximately 30 miles from the facility. These bodies of water are not anticipated to be impacted by any activities at the BMRC.

#### 3.2.4.2 Land Use

The nearest housing population is approximately 400 feet south of the facility. The Department of Veteran Affairs Medical Facility is located about 2,000 feet northeast of the BMRC. Adjacent to the BMRC to the southwest is Kapoor Hall (undergoing reconstruction). The Howe Building, the MacKay Heating Plant, the Service Building and the Service Center Building all lie to the southeast of the facility. The gymnasium named Clark Hall is located northeast of the building.

**Demography**

The population distribution and projections for areas around the BMRC site are based on the Year 2000 census. The city of Buffalo has a population of approximately 300,000 while the greater metropolitan area has a population of approximately 1.2 million people.

As can be expected of a large metropolitan area, there are numerous undergraduate and graduate schools in the area hospitals and research centers all within ten miles of the BMRC.

In addition to the resident population, there is a seasonal influx of vacation and weekend visitors within a 30-mile radius, especially during the summer months. The influx is heaviest in the area around Niagara Falls, but also includes the shore lines of Lakes Erie and Ontario.

**Land Access**

The BMRC site is on University property in a triangle formed by Winspear Avenue to the south, Bailey Avenue to the east, and Main Street on the west.

The major travel access in the vicinity of the BMRC site is Interstate 90 to the east about 2.6 miles; Interstate 290 about 2.7 miles to the north and west; and Interstate 190 about five miles to the south.

**Air Access**

Commercial air traffic into and out of the Buffalo Metropolitan area is through the Buffalo Niagara International Airport located in Cheektowaga about six miles east of the site. The air transportation system in the Buffalo Metropolitan area serves a range of aircraft types and aeronautical uses.

# 4.0 HISTORICAL SITE ASSESSMENT METHODOLOGY

## 4.1 Approach and Rationale

This HSA documents those events and circumstances occurring during the history of the facility that may have contributed to the contamination above background levels of portions of the site environs. Information relevant to changes in the radiological status of the site following publication of the HSA will be considered a part of the ongoing characterization evaluations and license termination activities. These activities include the evaluations of subsurface contamination. The results of the investigations into the extent of subsurface contamination will drive continuing remediation and/or mitigation efforts as appropriate.

The HSA involved collecting, organizing, and evaluating information that described the BMRC site in terms of physical configuration and the extent to which the site was radioactively contaminated as a result of reactor operations and Possession Only activities. During the Final Status Survey (FSS) phase, survey areas for structures and land will be delineated into multiple survey units, where appropriate, in order to meet the survey unit size limitations recommended by NUREG-1575 (MARSSIM) prior to final status surveys. The HSA information will be used, along with characterization data, to bound and classify these survey areas. The boundaries of the identified survey areas are based on operational history, including recorded significant events, and the area's radiological status.

The general criterion used to identify the areas is from the MARSSIM as follows:

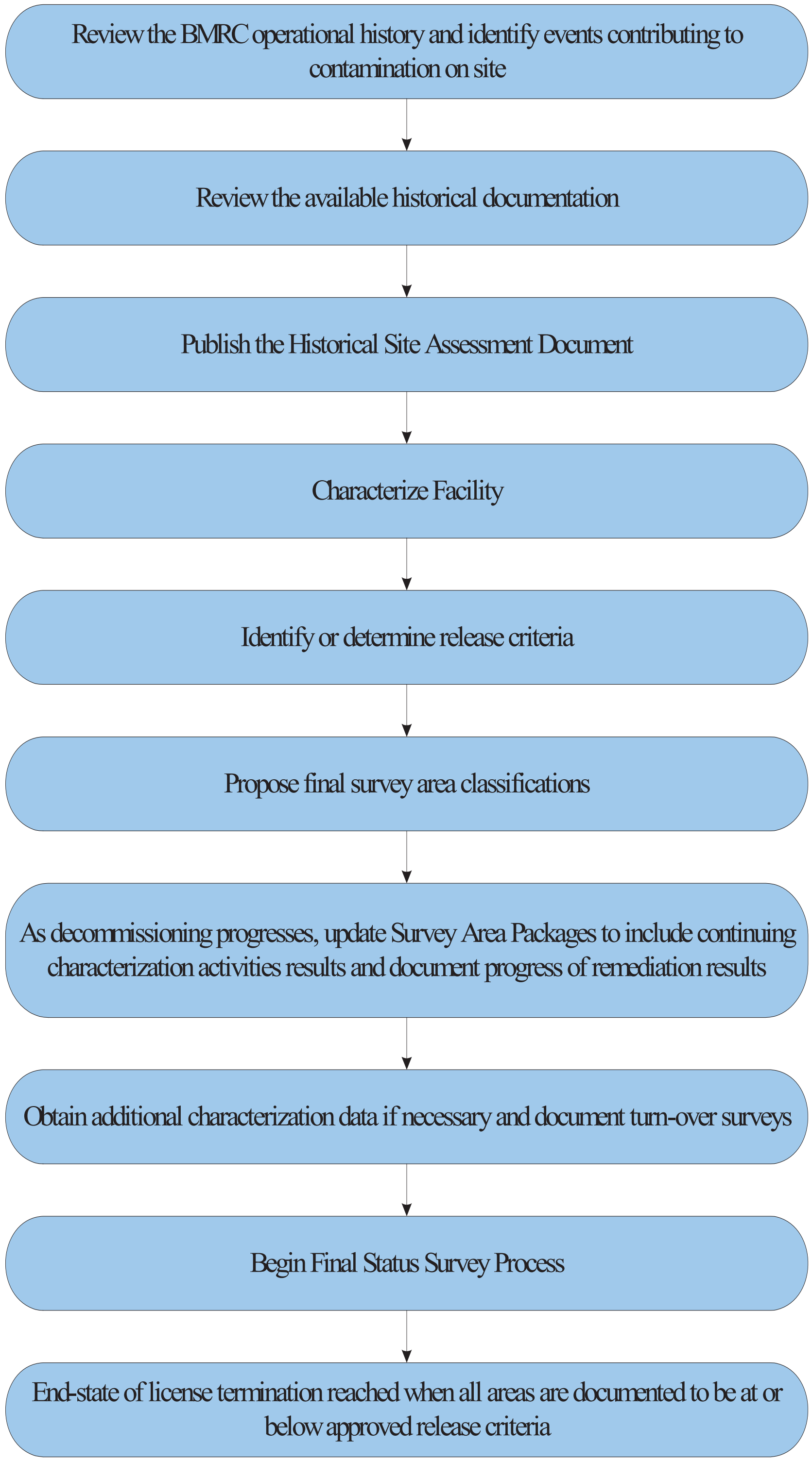
**Non-impacted Areas:** These are areas where there is no reasonable possibility (extremely low probability) of residual contamination. Non-impacted areas are typically non-operations and off-site areas. These areas can be used as background reference areas.

**Impacted Areas:** These are areas that possibly contain residual radioactivity in excess of natural background or fallout levels. All impacted areas will be classified as Class 1, 2 or 3 as described in NUREG-1575.

Information collected for an area for the FSS will include a description of the survey area, an operational history, an evaluation of past and current translocation pathways, and a description of the current status. The findings section for each survey area will include an assessment of radiological contaminants, contaminated media, current radiological status, results of any subsurface mitigation or remediation efforts, and remaining activities.

The general process for integrating the HSA with continuing characterization, Derived Concentration Guideline Level (DCGL) Development, and the FSS is shown in the flowchart on the following page. All processes, i.e.., characterization, free release of items, and FSS, will be conducted using plans and procedures approved by the University.

PROCESS FOR THE BMRC MARSSIM TERMINATION PROCESS



### 4.2 Documents Reviewed

In performing the BMRC HSA, the documents discussed in 5.2.1 through 5.2.8 were reviewed:

#### 4.2.1 Annual Facility Technical Reports

The 42 available Annual Technical Reports from 1960 through 2008 were reviewed and provided the majority of the information on events that impacted the current radiological and environmental status of the BMRC

#### 4.2.2 Historical/Construction Photographs

Approximately 500 historical and construction photographs were reviewed to determine the historical uses of the facility and the surrounding area. The construction photographs provided information regarding the subsurface layout of the Tank Farm and the Containment Building subsurface structures and pipes.

#### 4.2.3 Topographical Maps

Topographical maps of the UB South Campus and the greater Buffalo area were reviewed to include the affect of the terrain on the current status of BMRC.

#### 4.2.4 Construction Drawings

Numerous construction drawings were reviewed to look at the original construction layouts of the facility and to review facility modifications.

#### 4.2.5 Plant Safety Analyses

Plant Safety Analysis reports were reviewed for information regarding the hydrology and environmental setting of the facility. Specifically, the NRC's Safety Evaluation Report, (Reference 2), was used for this HSA.

#### 4.2.6 Radiological Surveys

Routine contamination control radiological surveys were reviewed to determine the current radiological status of the building surfaces within the Reactor Building and the Laboratory Wing. The radiological status of the building surfaces is used to assess the potential MARSSIM classifications for the facility.

#### 4.2.7 Plant Operating Logs

The Plant Operating Logs were reviewed to validate specific dates of importance for the reactor. Specifically, the initial criticality of both cores and the final criticality for the facility were reviewed. Information used in the Annual Technical Reports was also validated by the review of the plant Operating logs. Random log books were selected and reviewed for the general day to day operations of the reactor.

### 4.2.8 Environmental Reports

Environmental Reports were reviewed for consideration of potential impact to BMRC of non-radiological activities.

The information derived from these reviews was used to develop the information in Sections 6.0 History and 7.0 Findings in this report.

## 4.3 Property Inspections

The facility modification activity to date lies in two areas. The Stack Ventilation System maintained a constant negative pressure to the hot cell, hot chemistry laboratory, beam tubes, rabbit transfer tubes, the thermal column and the medical facility cavity (dry chamber) in the Containment Building. The Stack Ventilation piping in the 167-foot stack and the system fan and motor and muffler that were in the Mackay Heating Plant were removed during previous MacKay Building renovations. A horizontal section of the pipe under the floor of the MacKay Building is still intact and capped at both ends. All accessible surfaces of the piping were surveyed before removal. Any piping that had elevated readings is stored on the Neutron Deck.

During recent installation of new sewers, waterlines, and fire protection lines under the Rotary Road in support of the Kapoor Hall reconstruction, the portion of the Stack Ventilation System that ran under the Rotary Road were removed from the curb near the BMRC to the Mackay Heating Plant. These piping sections were placed on the Gamma Deck.

The Cooling Tower and its associated above grade piping have been removed. The concrete portion of the above grade section of the tower basin was demolished and the debris was used to fill in the basin to re-establish the original grade. The wooden portions of the cooling tower were released and disposed of as construction debris. The underground piping that ran from the Cooling Tower to the In-Line Heat Exchanger was left in place. The associated heat exchanger was removed and disposed of as radioactive waste in 1993.

All the spent fuel was shipped to the Department of Energy (DOE) in September of 2005. The unused fuel was sent to North Carolina State University in July of 1998.

The Containment Building currently has a significant amount of legacy waste on all three levels. All the reactor components remain in the pool and the components from the 1991 reactor rebuild are currently stored on the Neutron Deck of the building. The Laboratory Wing also has radioactive materials stored in various areas. In addition, the UB radiological instrument calibration facility is located in the Laboratory Wing.

## 4.4 Personal Interviews

Personal interviews of current site personnel were held during the site inspection and via telephone during the HSA process. Personnel were selected based on their employment history at the BMRC site. Interview efforts were focused on personnel who were employed during the time the facility was in operation. Personnel were interviewed that held positions as qualified reactor operators, and radiation protection. Undocumented events were not discovered during this process, but the interviews did prove helpful in assessing the historical operations.

# 5.0 HISTORY

## 5.1 Licensing History

The State University of New York at Buffalo is the holder of the Buffalo Materials Research Center's NRC Licenses for Possession Only Number R-77 and Special Nuclear Material License Number SNM – 273 and a New York State By-Product Material License Number 1051. During its operating history, the Buffalo Materials Research Center has had multiple uses:

- Training and education,
- Transient fuel performance testing,
- Materials radiation damage research,
- Isotope production, and
- Neutron interrogation through activation analysis, radiography and delayed fission assay

The following is a chronological history of significant licensing events that have occurred:

| | | |
|---|---|---|
| 1959 | - | Initial construction began under license approved by the Atomic Energy Commission. Licensee name: the Western New York Nuclear Research Center. |
| 1960 | - | Initial criticality was achieved at 2051 hours, on March 24. |
| 1960 | - | Full power was first achieved at 1220 hours, on June 1. |
| 1964 | - | Reactor modifications to utilize PULSTAR-type fuel; Unused fuel transferred to McMaster University in Ontario, Canada. |
| 1973 | - | Facility name change: Nuclear Science and Technology Center. |
| 1984 | - | Vertical 10K tank placed into service. Old Tank Farm system placed in wet layup. |
| 1985 | - | Facility name change: Buffalo Materials Research Center. |
| 1991 | - | Reactor cavity and Primary Coolant System modified to present configuration. |
| 1994 | - | Reactor activities suspended. Last shutdown on June 23, 1994 at 0600 hours. Primary Coolant heat exchanger removed and disposed of as radioactive waste. A spool piece was installed in its place. |
| 1997 | - | NRC License R-77 amended to Possession Only Status. |
| 1998 | - | Unused fuel shipped to North Carolina State University |
| 2005 | - | Spent fuel shipped to Idaho National Engineering and Environmental Laboratory. |

## 5.2 Current Site Status

The BMRC Laboratory Wing is currently used infrequently for two purposes. One purpose is an ion chamber calibration facility that is located in the basement of the Laboratory Wing. Secondly, the top floor of the Laboratory Wing has asbestos containing floor tile. The UB

Maintenance Department uses this floor to train personnel how to safely strip and wax this type of floor tile.

The Containment Building is only accessed for routine Technical Specification inspections.

## 5.3 Buildings and Systems

**<u>The Containment Building</u>**

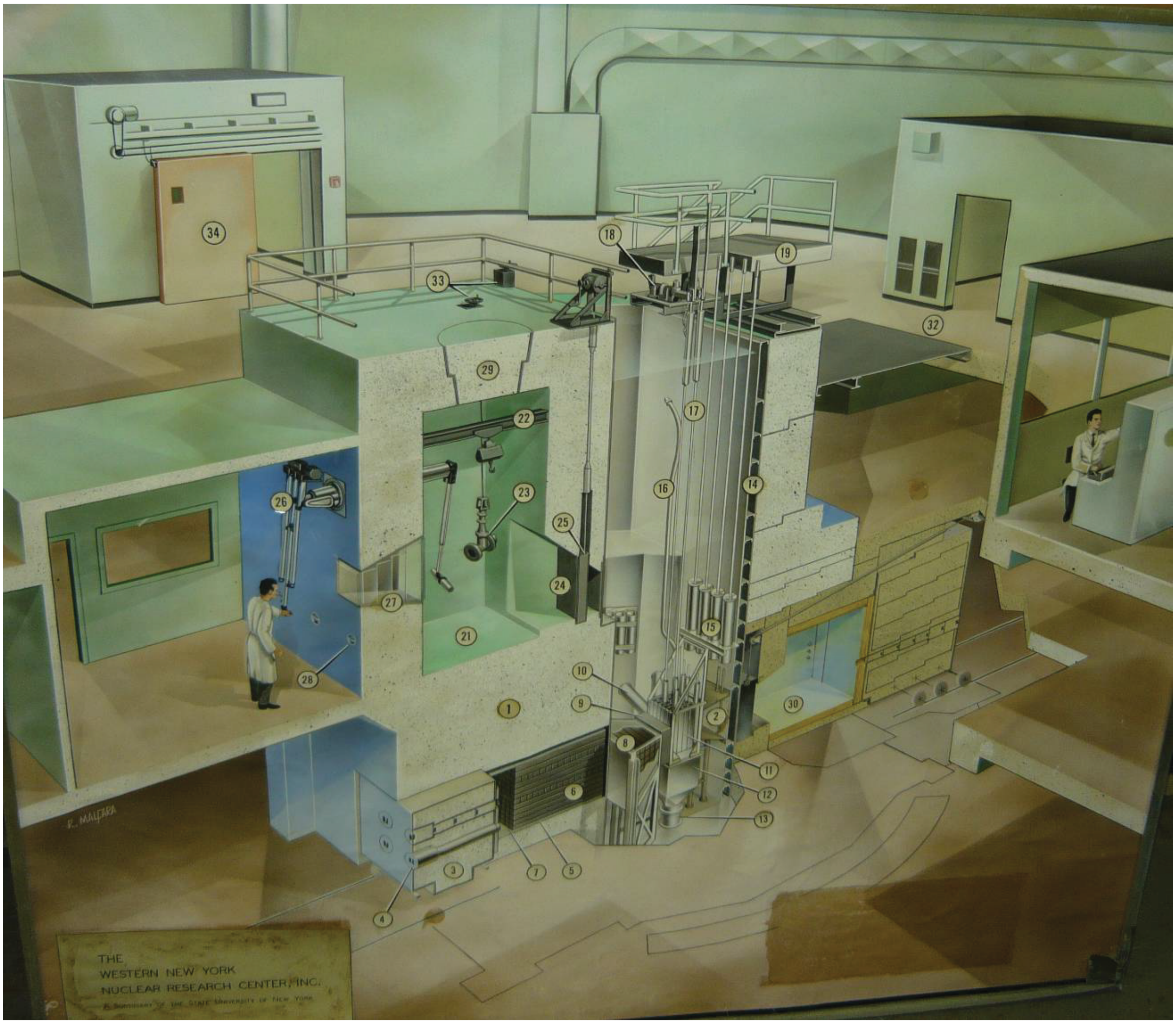
**The Reactor**

The reactor is a PULSTAR heterogeneous open-pool type water-cooled reactor using solid 6% enriched uranium fuel similar to nuclear power reactor fuel. The core was cooled by forced convective cooling at high power levels and by natural convection at lower power levels. The coolant/moderator is light water and the reflector may be either water or graphite.

The core is immersed in a 13,000 gallon aluminum lined tank pool surrounded by both high density and normal concrete. It was cooled by a 5,000 gallon circulating water system exiting from the reactor pool bottom via pumps to a subsurface 5,000 gallon hold up tank for N-16 decay. The water then went through a heat exchanger connected to an external cooling tower located on the southeast side of the Laboratory Wing. The cooled water was then circulated back to the top of the pool. After a 1989 reoccurrence of a leak at the point where the coolant piping penetrated the bottom of the reactor pool, bottom modifications were made to the cavity lower liner and the piping was rerouted to exit out of the side of the pool and through the lower of the Neutron Deck of the Containment Building. All the spent and unused fuel has been shipped off-site. The reactor and all its associated components remain in the pool in the normal operational configuration as they were during operation. Reactor components from repairs done in 1991 are stored under shielding on the Neutron Deck.

The reactor is housed in a three level Containment Building as shown in Figure 6-1, an artist's rendition of the interior of the original building. This building is constructed of concrete and forms a right cylinder 70 feet in diameter and 52-feet high. The walls are two foot thick reinforced concrete. The roof of the Containment Building is 4-inch thick reinforced concrete supported by concrete beams. The walls and the lowest level are laid on bedrock. Containment Building construction photos from 1959 have been included in Appendix A, Construction Photos.

**Figure 6-1 Artist's Rendition – Interior Cut Away View of the Reactor and Containment**




**NOTE: Point 34 is the Control Deck Airlock access to the Laboratory Wing**

## The Control Deck

The Control Deck (top level) houses a dual-hook over head crane with a 10-ton and a 2-ton hook on tracks at the ceiling level. Crane access to the lower levels was via a floor plate on the Control Deck and a webbing cover on a floor penetration from the Gamma Deck to the Neutron Deck. In addition to the reactor pool, the Control Deck houses the Reactor Control Room (Room 205), the Superintendent's Office (Room 207), two labs (Rooms 202 and 203), the Fan Room (Room 204), another office (Room 206) and an Airlock (Room 201B) for access to the upper or First Floor of the Laboratory Wing. The New Fuel Storage Room (Room 201A) is located between the inner and outer door of the airlock.

**The Gamma Deck**

The middle level or Gamma Deck houses the Hot Cell, the Hot Cell Work Room (Room 105), a Locker Room (Room 106), the Hot Chemical Lab (Room 108), the Medium Chemical Lab (Room 104), the Activation Analysis Lab (Room109), the Lower Fuel Vault (Room 101A) and the Chemical Lab (Room 103). This level also has an Airlock (Room 101) for access to the lower and Basement Floor of the Laboratory Wing and a Truck Lock for access to the outside. This level also housed the waste compaction system. The waste generated at BMRC and under the site-wide radiological program were collected and compacted for volume reduction in this system.

**The Neutron Deck**

The Neutron Deck (lower level) is divided by caging into two sections. The open area includes access to the "Patient Treatment Room" which is lined with wood. The Patient Treatment Room was included in the original design of the BMRC to be a location to provide neutron treatments to cancer patients. No history was found that it was ever used for this purpose. The enclosed area includes the rerouted Primary Coolant Piping and access to the seven Beam Storage Tubes. The Beam Storage Tubes extend 10 feet through the Containment Building wall into the surrounding soil. They are used as storage-for-decay of high dose reactor components or experiments. At the point where they exit the Containment Building wall, they are approximately 10 feet underground. The balance of the Neutron Deck is open area. The Neutron Deck is the area where the majority of radioactive contaminated materials awaiting disposal are being stored.

**The Ventilation**

The ventilation for the portions of the Containment Building which housed the medical facilities cavity, the hot cells, the hot chemistry laboratory, the beam tubes, the rabbit tubes and the thermal column was discharged via underground piping to the 167-foot stack on the Mackay Heating Plant southeast of the facility. Portions of this system have been removed as discussed in Section 5.3.

The balance of the Containment Building ventilation passes through a bank of roughing and absolute filters prior to being discharged from a point on the southeast side of the Containment Building Roof above the Truck Lock door. Ventilation ducts are equipped with hydraulic dampers that would isolate the Containment Building at the activation of alarms. The electrical conduit was sealed with epoxy at the point of building penetration to maintain containment integrity should over-pressurization occur.

Analysis activities occurred in the Activation Lab involving the use of mercury in conjunction with radiological constituents.

**Liquid Waste Drains**

Liquid waste from the hot cell drain, hot chemistry laboratory, and the service area drains were collected in 250-gallon sampling tanks. Liquid waste from Gamma Deck and Control Deck laboratories, the change area sinks and the Truck Lock door drain were collected in 600-gallon sampling tanks. These tanks could be sampled for radioactive or chemical constituents and discharged to either the sanitary sewers or to a 10,000-gallon waste holding tank. These tanks are buried southeast of the Containment Building west of the Truck Lock door. Use of these tanks was suspended in 1984, and the system placed in wet layup. Presently the drains go to the

1K Tank in the Foundation Area of the Laboratory Wing and from there to the 10K Tank at the side of the Laboratory Wing. The 10K Tank is then sampled for discharge to the sewage system.

Analysis activities occurred in the Activation Lab involving the use of mercury in conjunction with radiological constituents.

**The Laboratory Wing**

**The Upper Floor**

The Laboratory Wing housed the Locker Rooms (Rooms 209, 221 and 221A), Conference Room (Room 212), offices (Rooms 208, 210, 214 and 216), the Reception Area (Room 208A), Upper Air Conditioning Equipment Room (Room 209B), the Janitors Closet (Room 209A) and two low level labs (Rooms 213 and 215) on the Upper Floor.

**The Basement Floor**

On the lower or Basement Floor there was a Horizontal Accelerator (Room 118) with an adjacent cave area. This area has supported multiple functions; i.e., a lab, a Class Room (Room 114), a Health Physicist Office (Room 117), Counting Room, The Vertical Accelerator Room (Rooms 115 and 115A) and a Machine Shop (Room 113). The Electrical Service Room (Room 110) is also located on this level. There is a tunnel off of the Electrical Service Room (Room 110) that connects to the Campus Service Tunnel system and is locked to prevent access.

**Foundation Level**

The space below the Basement Floor level is the area designated as the Foundation. This area has rooms housing the Holdup Tank Cubicle (Room N16), the Cooling Water Equipment Room and the Facility Sumps (Room N03), the lower Air Conditioning Equipment Room (Room N02), the Air Handling Duct Room (Room N04) and access to the 10K tank enclosure (Room N05).

**The Ventilation**

Ventilation from the Laboratory Wing general area is directed to the roof of the building. Lab hood generally exhaust individually through High Efficiency Particulate Air (HEPA) filters to the roof, except for the Machine Shop hood and the Vertical Generator Room. These two were exhausted via a duct on the southeast side of the Laboratory Wing. None of these pathways were monitored for radiological material. In addition, the present configuration of the ventilation system on the Basement Elevation is a of the modification that was done to the system to support a remodeling for creation of the Teaching Lab area. During this remodeling the Waste Tank Manifold System was relocated to the Pump Room. The piping penetrations for this system may have been abandoned in place.

Among the activities that occurred in the Machine Shop was lead smelting for the making of unique shielding which may have resulted in the deposition of lead contamination in this ventilation and hood system.

**The Drains**

All septic, floor, sink, and hood drains in the Laboratory Wing passed directly to the South Campus sewer system. Activities in the Laboratory Wing have included use of H-3 and C-14 in the First Floor Labs and H-3 in the Teaching Lab (Room 114). Prior to it's conversion to a Teaching Room, Room 114 was used for material testing. This room also contains the abandoned Waste Tank Gauging System which experienced leaks when in service. In addition, drain system backups due to check valve failure during times of heavy rains resulted in events where water contaminated with radioactive material, associated with the abandoned Tank Farm discharges, was introduced into the Basement Floor Level sinks in the Van de Graaff Proton Accelerator Room resulting in some fixed contamination on the floor.

**The Tank Farm**

The Tank Farm lies subsurface south of the Containment Building and extends towards the southeast of the Containment Building as shown in the Construction Photos on page A-4, A-5, and A-6 and as shown on the layout on page B-2. The Tank Farm consists of two 250 gallon stainless steel tanks and two 600 gallon stainless steel tanks in connected concrete enclosures. There is also a 10,000 gallon carbon steel tank (10K Tank) outside of the enclosures, but within its own concrete berm. The 250 gallon tanks were connected to the Isotope Processing Labs and the Hot Cell. The 600 gallon tanks supported the drains from the lower level labs and the floor drains. The tanks were interconnected by a manifold and pump system that allowed any combination of water transfer. The normal movement was to pump the small tanks to the 10,000 gallon tank for blending prior to discharging into the sewer system. A sample of the sludge from the 10,000 gallon tank has been sent for analysis.

The tanks were placed in wet layup by pumping them at least half-full of water to minimize oxygen degradation in 1985. This method of storage was recommended by personnel at the DOE's Hanford Site. Sampling ports known as Tell-Tale sampling ports were installed in the original configuration to sample any liquids that may have entered the enclosures and concrete berm to verify tank and piping integrity. No indications of loss of integrity have been detected.

## 6.0 FINDINGS

Data from the HSA investigation suggests that the land and structures that may require remediation are the Containment Building, portions of the Laboratory Wing, the exterior substructures and the land area that lies very near to these structures. The extent will be influenced by the DCGL's established after characterization. The migration potential of surface and subsurface contamination is anticipated to be limited to areas very near to the BMRC due to the clay-like nature of soil, but further investigations to evaluate this are warranted.

### 6.1 Potential Contaminates

The primary contaminants of concern for the BMRC site are $H^3$, $C^{14}$, $Mn^{54}$, $Co^{58}$, $Co^{60}$, $Eu^{152}$, $Eu^{154}$, $Ag^{108m}$, $Ag^{110m}$, $Sb^{124}$, $La^{140}$, and $Ni^{63}$. Since the plant has been shutdown since June 23, 1994, the $Co^{58}$, $Sb^{124}$, $Ag^{110m}$ and the $La^{140}$ have decayed significantly due to their short half-life. The actual isotopic mixture and abundance will be determined during future characterization activities.

### 6.2 Area Classifications

During the operation of BMRC, events occurred that affected facility conditions and need to be considered during the MARSSIM process. The following paragraphs describe some of the known events and how they relate to the MARSSIM process effort. None of these events caused conditions that would prevent the BMRC site from being decommissioned with current technologies and work practices.

All areas and structures were classified according to available radiological characterization data, historical site operations, and personal interviews. Classifications are designed to be conservative. All areas, or sections of an area, can and may be changed when new radiological sample data becomes available. Appropriate documentation shall be provided for the justification of changes. All classifications are subject to change as new data becomes available. Site procedures will be developed to ensure that proper documentation occurs for a change in classification to a building, structure, system, or land area.

### 6.3 Impacted Areas

#### 6.3.1 Buildings and Structures

The Containment Building and the Laboratory Wing roof, interior and all the systems and structures in the building are designated as Impacted Areas. These areas and/or components have been designated as Impacted due to elevated levels of radioactive contamination or the potential for the presence of contamination and are expected to require, in part or whole, remediation and/or disposal at an NRC licensed disposal facility.

The following paragraphs describe events and/or operations that led to the determination that these are buildings and structures are impacted from historical operations at BMRC.

In 1975, and again in 1989, a leak developed in the primary cooling piping at the point where the pipe penetrates the reactor pool tank. The leakage is thought to have traversed the primary piping exterior to a point where it emerged from the foundation concrete in Room N16 and then to the sumps associated with the Cooling Water Equipment Room (Room N03). The 1978 Annual Report states that the NRC considered this a leak to the environment.

Construction photographs (see Appendix A) show a pit just below the first elbow directly beneath the 1975 and 1989 leak point as the piping begins its horizontal run across the ground in a trench towards the Holdup Tank in Room N16. A second trench can be seen proceeding from the same central location at the elbow, 180 degrees in the opposite direction, to what is believed to be the "future elevator" pit at the border of the Containment Building exterior wall. Subsequent construction photographs show the trenches back filled and the elbow and the coolant return piping being held up by planking prior to concrete being poured for the bottom of the Containment Building. Interviews revealed that the piping was wrapped in mastic and the depressions were then back filled with sand and the concrete flooring was poured over it. In the 1978 Annual Report in discussions of the leak at the point where the Primary Coolant Pipe exits the reactor cavity it is stated that the NRC took the position that the sub-Containment Building structure area was impacted by the leak as a release to the environment. This location needs further evaluation during the characterization process

In 1993, the Primary Coolant Heat Exchanger located in Room N02 of the Laboratory Wing lower level, developed a primary to secondary leak that permitted small amounts of coolant to transfer to the water cascading in the cooling tower. The cooling tower and its above grade concrete structure have since been removed. The concrete basin was left in place and backfilled to grade.

In the Laboratory Wing, the drains in the Vertical Accelerator Room (Room 115) are posted as contaminated as a result of drains backing up during operation. In addition, the pathways for exhaust to the roof for the Laboratory Wing hoods, building general air and the Vertical Accelerator Room were not monitored for the release of radioactive material. This poses a high potential for residual contamination on the roof.

Events were discussed during interviews that relate to airborne contamination events with the Containment Building. These events resulted in areas or levels of the Containment Building being designated in whole or part as contaminated. One event pertained to an airborne release of $Co^{60}$ to the entire Control Deck. Decontamination occurred in all areas of the Containment Building except for areas near the ceiling and the ceiling. The second event was a release of $Sr^{90}$ that contaminated areas of Room 202. The walls adjacent to the California hood in this room have plexiglas mounted to provide shielding from the Strontium. There was also at least one event where $H^3$ was wide spread throughout the Containment Building.

### 6.3.2 Land Areas

From the information reviewed, the potential for radiological contamination at the BMRC site is likely to be within close proximity to the BMRC facility. This area includes the Beam Tubes Storage Tubes, the abandoned waste Tank Farm, the cooling tower pad area, the air discharge from the Laboratory Wing air handling systems and hood systems and the 10K tank enclosure. The land exterior of the Containment Building and the Laboratory Wing meets the MARSSIM Impacted definition due to elevated levels of radioactive contamination, or the high potential for elevated levels subsurface. These areas may require remediation and/or disposal at an NRC licensed disposal facility. The extent of the involvement of the surrounding subsurface land area will have to be evaluated during characterization.

The following paragraphs describe events and/or operations that led to the determination that the land areas under the BMRC are impacted from historical operations at BMRC.

In 1972, the original Holdup Tank failed due to the suction pump not being interlocked. During excavation by a bulldozer for tank replacement and construction of a vault for the new tank on September 1, 1972, one of the Beam Storage Tubes was sheared off and another experienced a 3-inch diameter puncture.

In 1984, the waste water vent pipe, which runs up the exterior of the Containment Building on the southeast side of the building in the area of the Truck Lock to the roof of the Containment Building, ruptured and released a small amount of material to the ground and to the asphalt paving in this area.

The N-16 Vault Sump receives water that comes through the wails of the vault. Water from is directed from this sump to the sump pit in the Primary Pump Pit. This sump pumps water to the 1K Holding Tank located in the Primary Pump Pit. The 1K Holding Tank is then manually pumped to the 10K Holding Tank. This 10K Holding Tank is sampled and discharged to the sanitary sewer at various times throughout the year. The 10K Tank discharges are documented in the Annual Technical Reports and have shown radiological contamination in minute concentrations. Currently, the concentration consists of unknown Beta radionuclides.

## 6.4 Non-Impacted Areas

The buildings and structures that are not physically connected to the BMRC Facility and controlled by UB meet the definition of non-impacted areas based on historical operations at the BMRC. Unplanned airborne releases to the atmosphere have not occurred based on reviewed documentation, operating reports and personnel interviews. Although there have been documented airborne releases inside the Containment Building, these releases are not considered to have impacted adjacent UB Buildings or the environment external to the Containment Building.

Based on available data, property outside of the UB South Campus boundaries is not anticipated to be impacted in any way by activities at BMRC.

## 6.5 Related Environmental Concerns

During the HSA investigation, non-radiological environmental concerns for the MARSSIM process of the BMRC were noted. These concerns will have to be addressed prior to or during facility remediation. The known non-radiological environmental concerns include:

- Asbestos-containing materials associated with floor tile and mastic. The piping and duct work insulation may also contain asbestos.

- Lead shielding that is prevalent throughout the BMRC.

- Potential mercury chloride contamination in the high level hoods.

The presence of other hazardous wastes may be encountered and should be evaluated during the site characterization effort.

## 7.0 CONCLUSIONS AND RECOMMENDATIONS

The HSA investigation suggests that the land areas that have been impacted by the operation of the reactor lie within close proximity to the Containment and Laboratory Wings. The migration potential of any surface and subsurface contamination is anticipated to be limited to areas in very close proximity to the BMRC due to the clay-like nature of soil, however, the full nature and extent needs to be determined during characterization. The data also suggests that the BMRC will most likely require remediation of the surfaces in the Containment Building, the underground tanks and structures, portions of the Laboratory Wing, and will require removal of neutron activated sections of the reactor bioshield.

The next step in the MARSSIM process is to perform scoping/characterization surveys followed by DCGL development. Prior to this, loose materials that may interfere with the characterization measurements should be removed from the site as much as possible. These materials include the reactor components and the free standing radioactive material in both the Containment Building and the Laboratory Wing. The scoping/characterization surveys will need to be performed on building interior surfaces, tank sludge's, and land areas to determine the extent of radiological contamination. This information will be used in determining the appropriate release criteria for the BMRC.

Characterization will determine the magnitude of contamination and help delineate classification boundaries both inside and outside the Containment and Laboratory Wings. These surveys will also assist in determining the dismantlement process and waste stream disposition. Scoping/characterization survey data may be used as the MARSSIM FSS data for the MARSSIM process if it is performed to the same pedigree as the future FSS plan. This will take foresight, coordination and planning as the FSS plan has not been written.

## 8.0 REFERENCES

1. State University of New York at Buffalo Nuclear Science and Technology Center Hazard Summary Report Revision II September 23, 1963.

2. NUREG-0982, Safety Evaluation Report Related to the Renewal of the Operating License for a Nuclear Reactor at the State University of New York at Buffalo, Docket No. 50-57, May, 1983.

3. Buffalo Materials Research Center Safety Review- Reactor Modifications, June, 1992.

4. Operations and Maintenance Manual, Volume One, AMF Tank-Type Research Reactor Facility, Western New York Nuclear Research Center, December. 1960.

5. NUREG-1575, Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), Rev. 1, August, 2000.

6. Annual Facility Technical Reports to the Atomic Energy Commission and the Nuclear Regulatory Agency for the reactor at the State University of New York at Buffalo, 1960 – 1969, 1973 – 1992, and 1997 – 2008.

## 9.0 APPENDICES

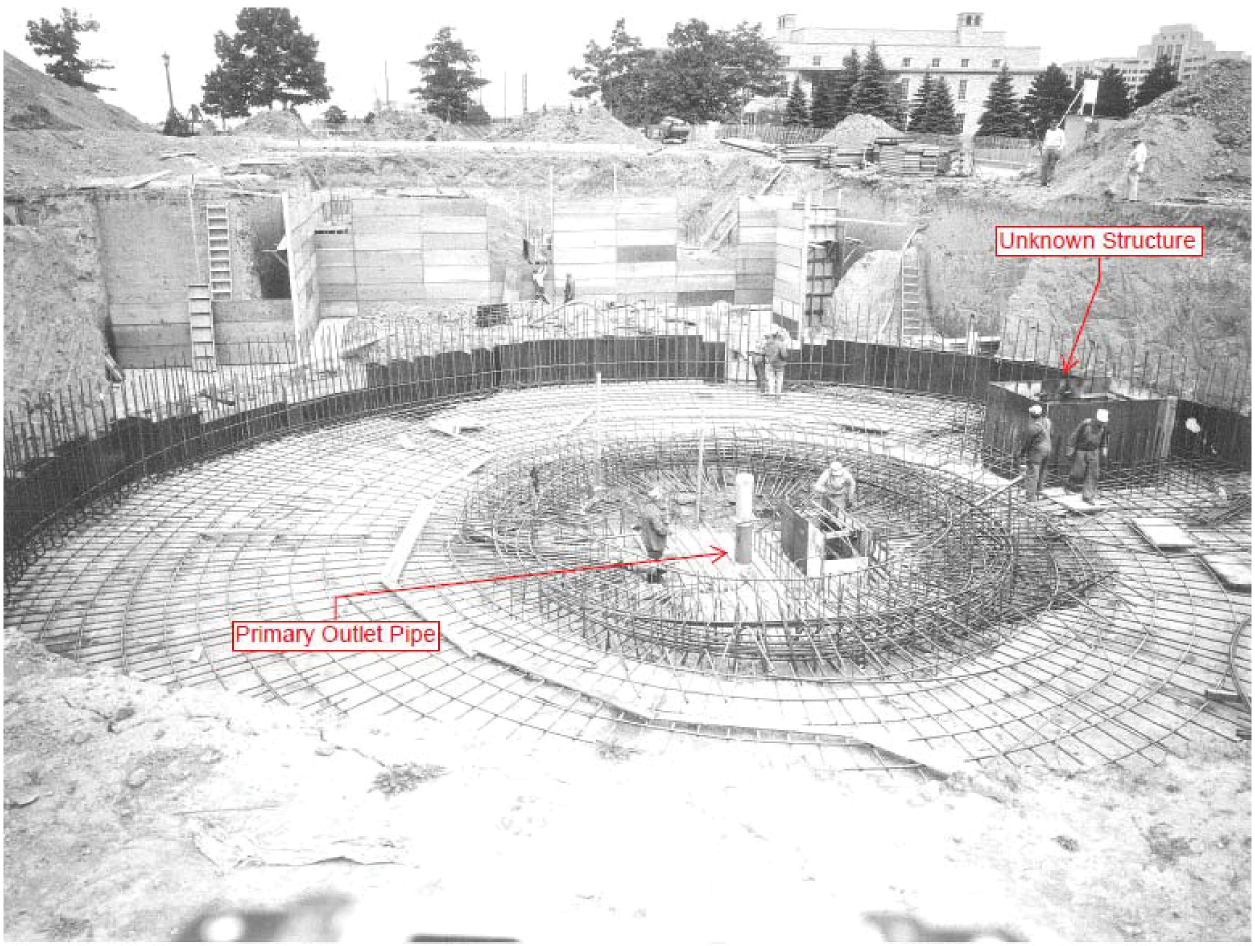
Appendix A – Construction Photographs

Appendix B – Floor Plans

# APPENDIX A

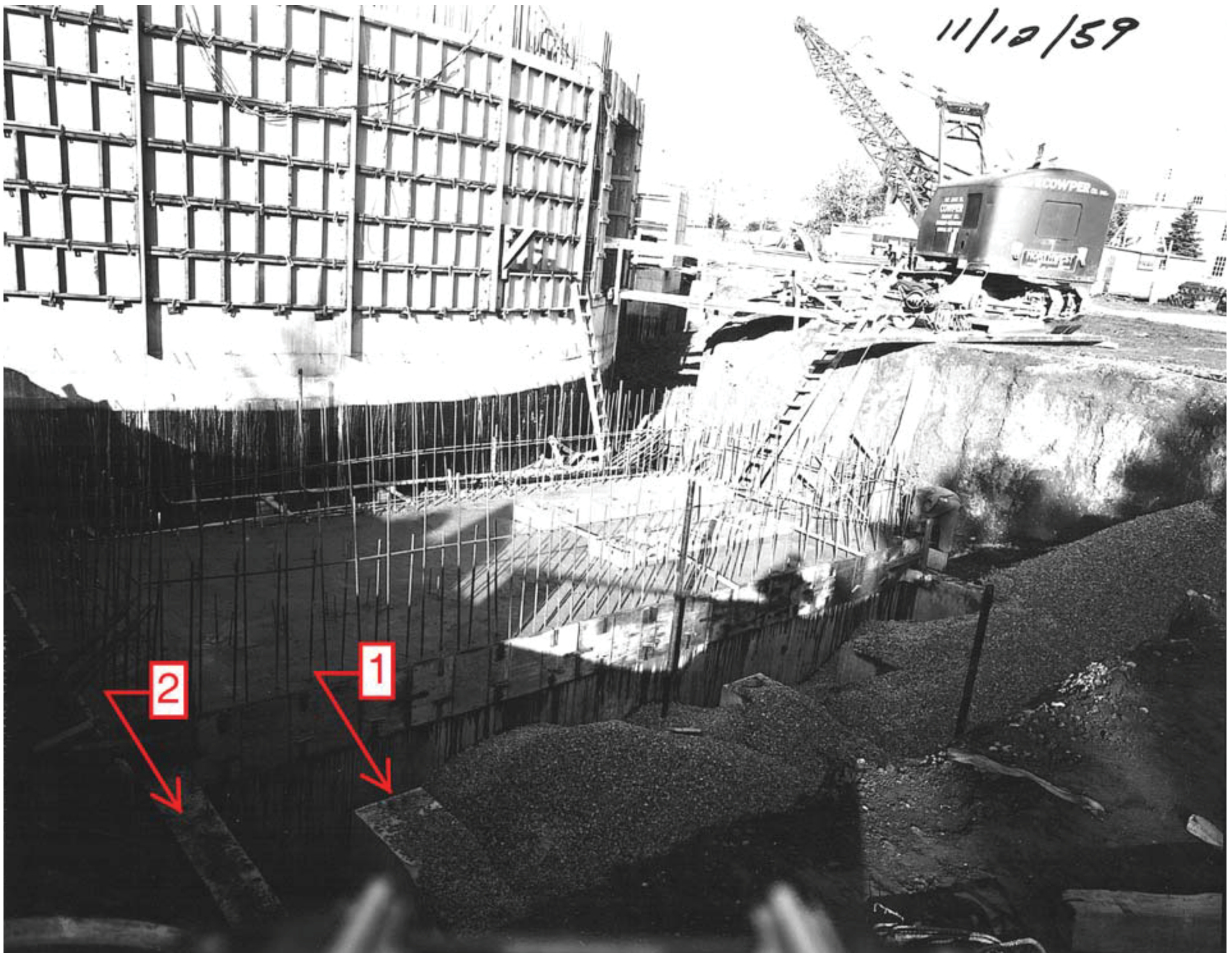
# CONSTRUCTION PHOTOGRAPHS


**A Construction photo from 1959 showing the Primary Piping excavation into the bedrock in the foreground of the pit.**

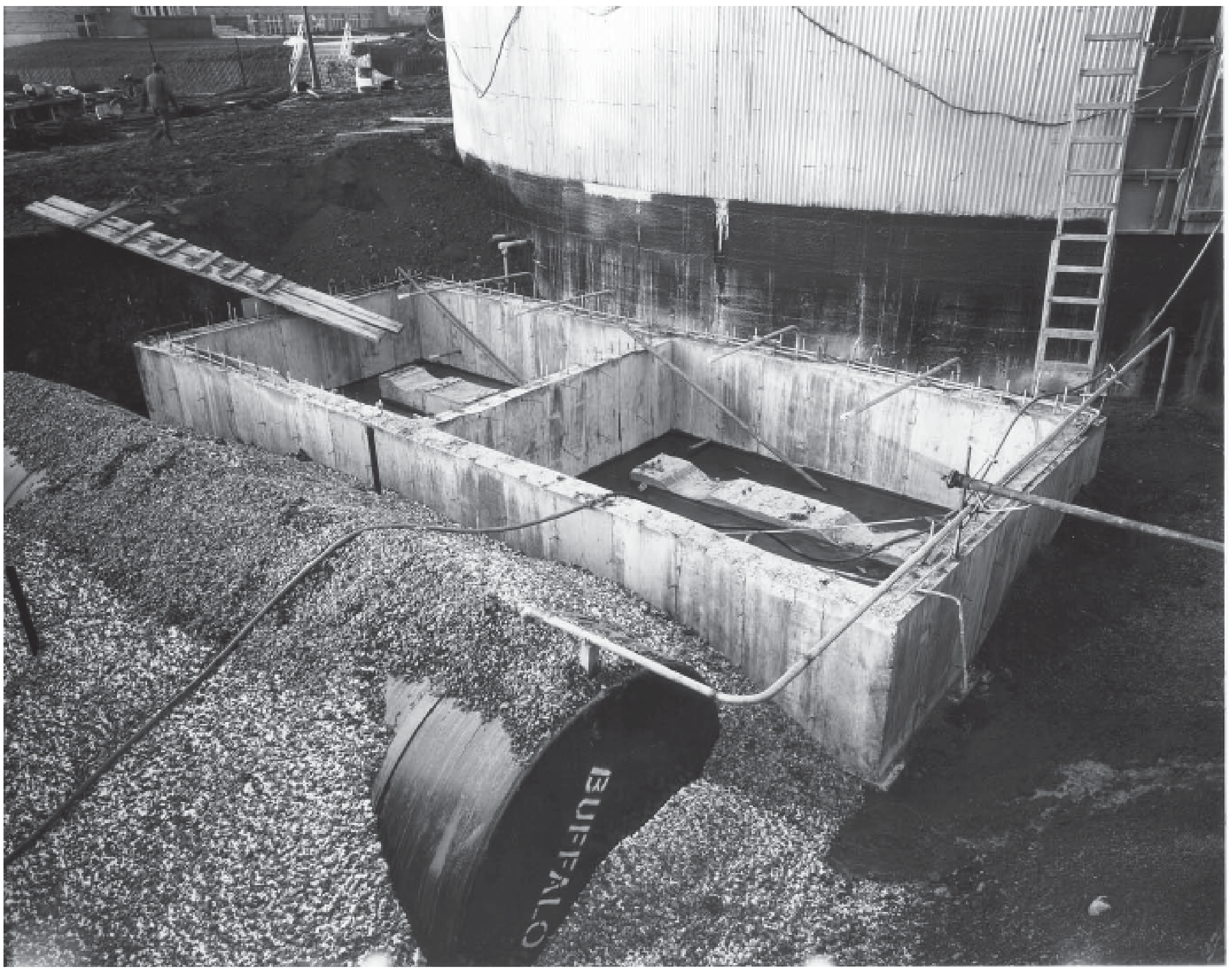



**A Construction photo from 1959 showing the foundation after having been backfilled over the Primary Piping run. The structure next to the Primary Piping is unknown. The item labeled "Unknown Structure" to the right may be the shoring for the proposed Elevator Pit.**


**Construction photo from 1959 showing the Beam Tube Storage Tubes prior to backfill. The original N-16 Decay tank would have been to the left of these tubes. The last two tubes on the left are probably the ones damaged during the replacement of the collapsed tank.**




**Construction Photo from 1959 of the Tank Farm just prior to pouring the concrete berm around the smaller tank area. This photo proves the existence of a concrete berm surrounding the 10K waste tank. The 10K tank rests on concrete "saddles" (1) which are covered in gravel in this picture. In the bottom left hand corner of this picture (2), the concrete berm surrounding the 10K tank area can be seen. The berm height is equal to the height of the saddles.**

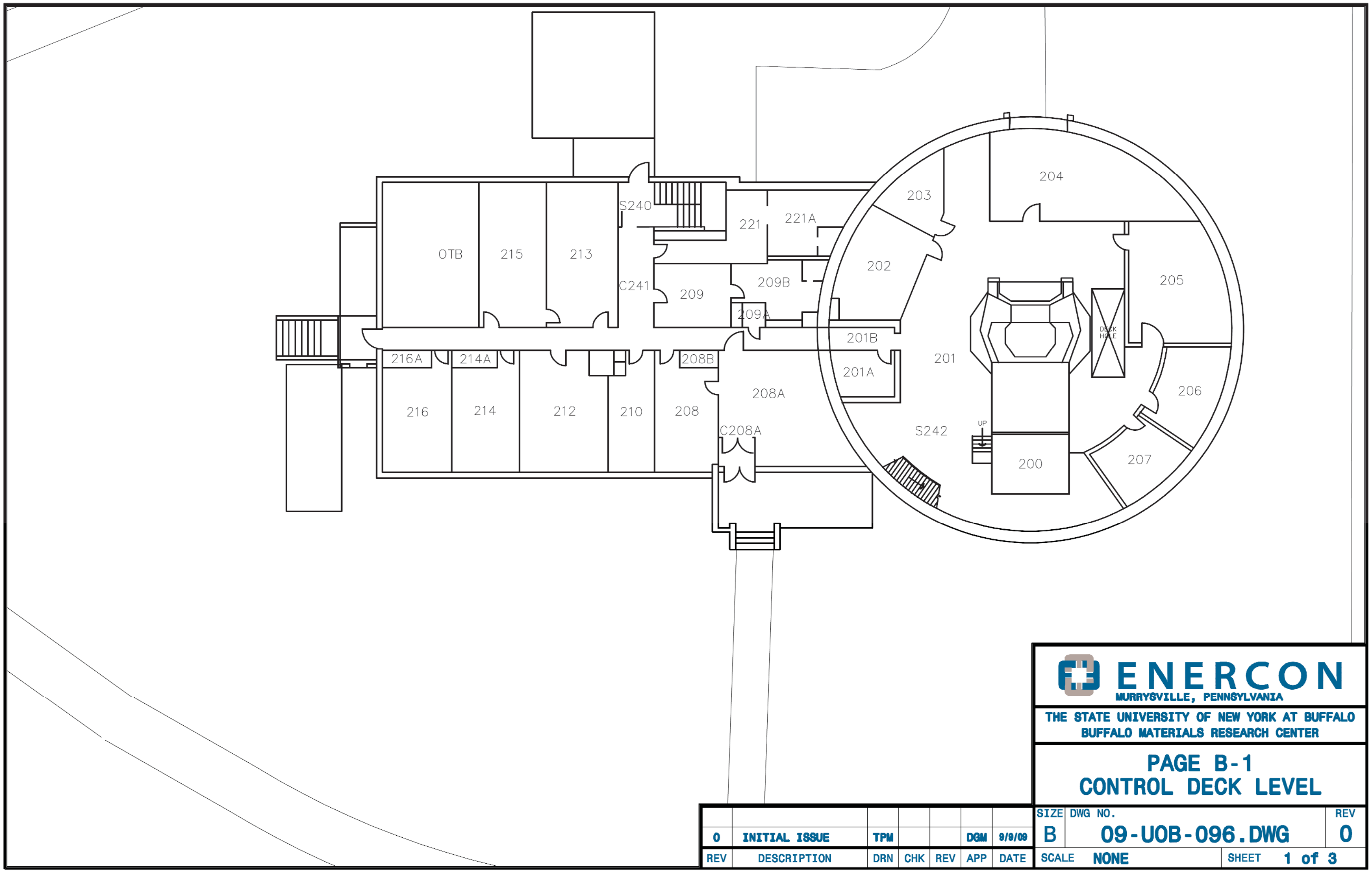



**Construction Photos from 1959 of the Tank Farm following installation of the 10K waste tank.**

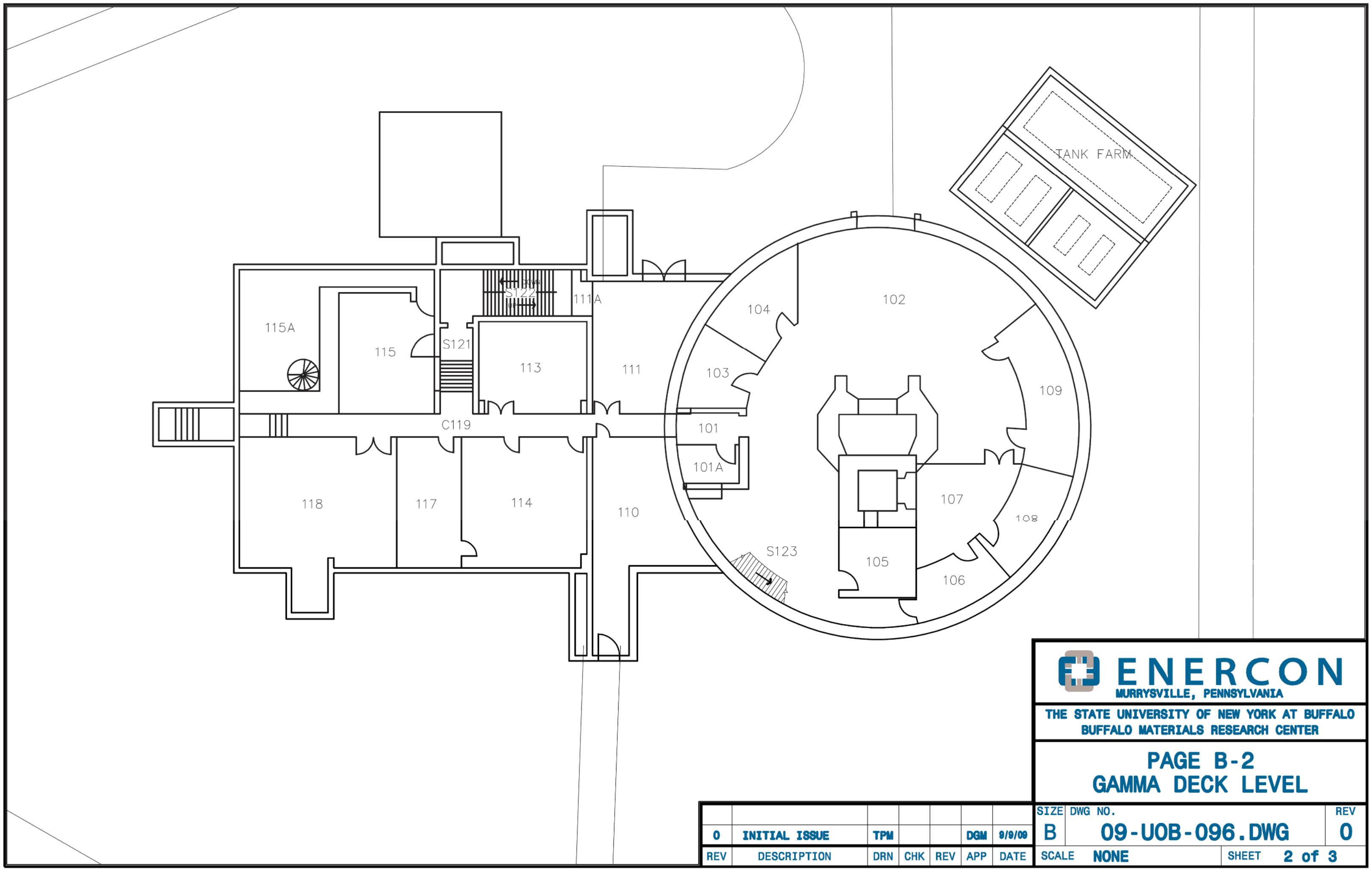

**1960 construction photo showing the Tank Farm with the smaller tanks installed. All these tanks are currently in Wet Layup.**

# APPENDIX B

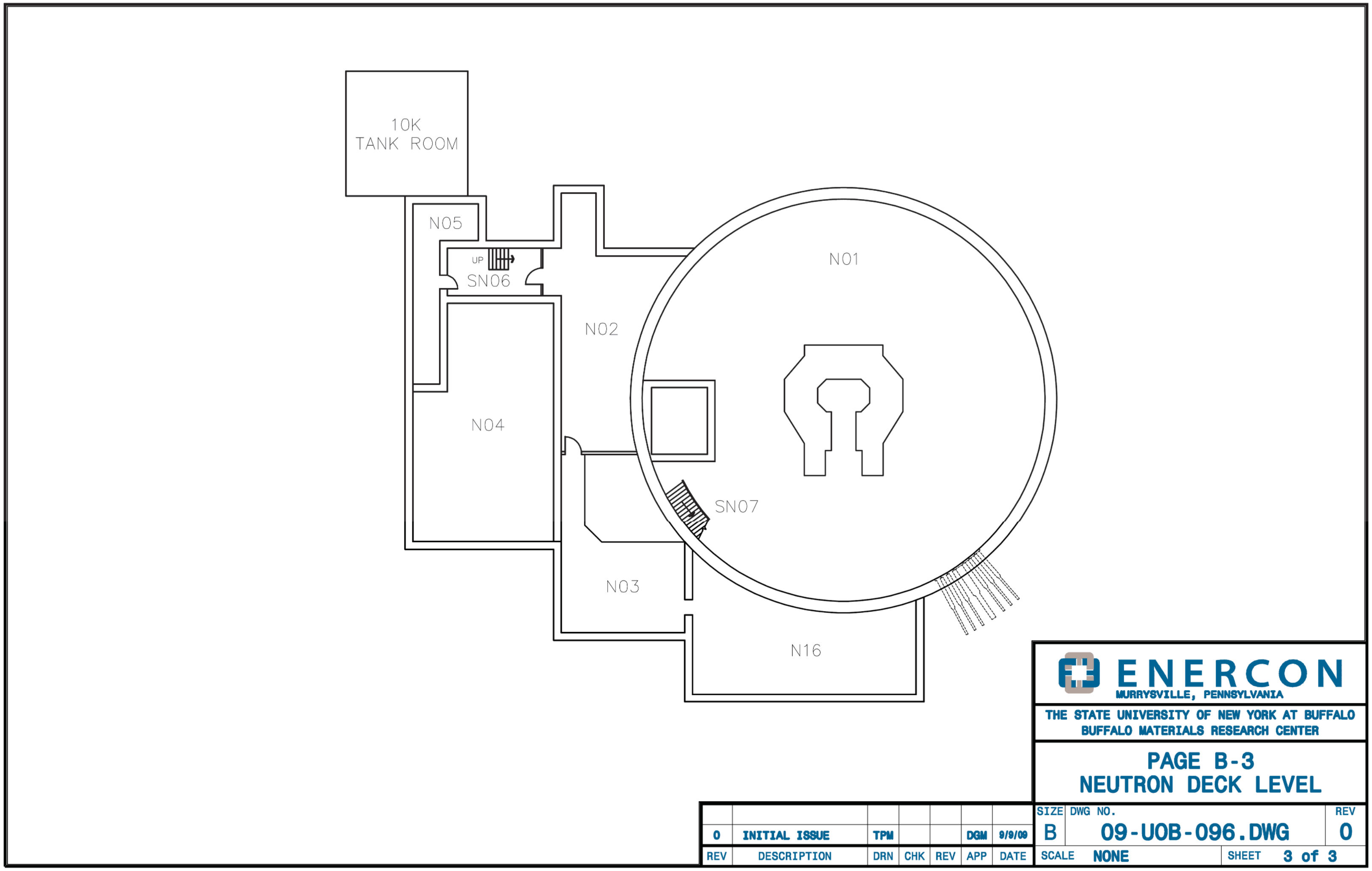
# FLOOR PLANS




**The Control Deck of the Containment Building is connected to the upper floor of the Laboratory Wing via the Airlock, Room 201B.**




**The Gamma of the Containment Building is connected to the lower floor of the Laboratory Wing via the Airlock, Room 101.**




**The Neutron Deck of the Containment Building is not interconnected with the Laboratory Wing at this level.**