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U.S. Army Environmental Center

FINAL REPORT

HISTORICAL SURVEY REPORT FOR NUCLEAR REGULATORY COMMISSION LICENSE TERMINATION

U.S. ARMY GARRISON, FITZSIMONS AURORA, COLORADO

Contract No. DACA31-94-D-0068, D.O. 0003

Prepared for

U.S. Army Environmental Center

Aberdeen Proving Ground, Maryland

Prepared by

Parsons Engineering Science, Inc.
Denver, Colorado

November 1996

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EXECUTIVE SUMMARY

This historical survey is intended to support the termination of the Nuclear Regulatory Commission (NRC) license issued to the United States Army Garrison, Fitzsimons (Fitzsimons) in Aurora, Colorado by documenting the historical storage, use, and disposal of radioisotopes. Fitzsimons has held an Atomic Energy Commission or NRC license to possess radioactive byproduct materials since 1956. However, the first documented radioisotope received at Fitzsimons was radium in 1946.

Fitzsimons was formerly known as Fitzsimons Army Medical Center (FAMC), which was selected for closure by the Secretary of Defense in 1995 under the Base Realignment and Closure (BRAC) Act. Following official discontinuation of medical services in July 1996, the U.S. Department of the Army (Army) has been pursuing the suitability for lease or transfer of ownership of certain properties within Fitzsimons. The Army has an obligation by law to identify and remediate environmental hazards prior to the lease or transfer of the property. This historical survey is the first step in identifying the potential for radioactive contamination within certain buildings, areas, or property; the need for further radiation surveys; and the suitability for lease or transfer of these properties. In the interest of determining the suitability for lease, the Army will follow the BRAC Closure Laws and terminate the NRC license.

The results of this historical survey will provide the basis for developing the radiological survey plans required for termination of the NRC license pursuant to NUREG/CR-5849. This survey supplements the site-wide Environmental Baseline Survey (EBS) which identified those buildings that had the potential for the use, storage, or disposal of radioisotopes. The final site-wide EBS for Fitzsimons was published in May 1996.

This historical survey provides the basis for identifying specific rooms or areas within buildings, versus just the buildings identified in the EBS, at Fitzsimons that have been exposed to radioisotopes. The EBS was also more of a preliminary review, while the historical survey focuses on a detailed review of available records. Historical activities were documented through the review of interviews with current and former employees, visual inspection, and review of Fitzsimons and regulatory documentation. Previous NRC inspections, U.S. Army Center for Health Promotion and Preventive Medicine (CHPPM), formerly U.S. Army Environmental Hygiene Agency (CHPPM), and Fitzsimons records were reviewed to assist in the identification of areas where the use, storage, release, or disposal of radioisotopes has occurred.

Tables were compiled to reflect the radioisotopes authorized for use, inventories of sealed and unsealed sources, building locations of radioisotopes, and a breakdown of radioisotope decay daughter products. An analysis was performed to determine which short half-life radioisotopes and daughter products could be removed from further consideration during future surveys and remediation efforts based on guidance provided by amendments to NRC license 05-00046-13.

The subsequent surveys to be performed following this historical survey include a scoping survey, characterization survey, remediation survey, and a final status survey.

The scoping survey will be used to provide a preliminary assessment of the site conditions. The scoping survey typically consists of limited direct measurements and samples that will only delineate "affected" and "unaffected" areas. The characterization survey is performed to more precisely define the extent and magnitude of contamination in the areas defined as "affected" in the scoping survey. The characterization survey typically concentrates on the site locations which have documented use of radioisotope use, storage, or disposal. The characterization survey results are generally limited to differentiating a surface as "contaminated" or "non-contaminated." Actual remediation efforts will usually begin after the conduct of the characterization survey. Remediation surveys will be performed during the course of decommissioning efforts to confirm cleanup levels and to ensure the health and safety of the workers, public, and environment. Following the complete decommissioning activities, the final status survey will be performed to demonstrate that all of the radiological parameters (total surface activity, removable surface activity, exposure rate, and radioisotope concentrations in soil and other bulk material) satisfy the established guideline values and conditions for license termination.

Based on the historical records search, 18 radioisotopes and 51 daughter products (as shown in Table ES1.0) will potentially need to be considered during subsequent survey and decommissioning activities. The buildings identified by this historical survey as having used, stored, or disposed of radioisotopes include Buildings Nos. 265, 404, 500, 505, 511, 600, 601, 602, 603, 610, and 616. Other areas exposed to radioisotopes include Landfill No. 5, Lagoon Nos. 271 and 272, Tollgate Creek, and the golf course. Historical records to support past use were not available for several areas. These areas will be further addressed during the subsequent survey efforts and include the sanitary sewer and heating, air conditioning, and ventilation systems within each building which have historically been used for disposal or ventilation of radioisotopes.

TABLE ES1.0
RETAINED RADIOISOTOPES AND DAUGHTER PRODUCTS
HISTORICAL SURVEY REPORT
U.S. ARMY GARRISON, FITZSIMONS
AURORA, COLORADO

Parent Radioisotope	Half-Life[a]
H-3	12.35 y
C-14	5730 y
Na-22	2.602 y
Ca-47	4.53 d
Fe-55	2.7 y
Co-57	270.9 d
Co-60	5.271 y
Ni-63	96 y
Sr-90	29.12 y
I-125	60.14 d
Gd-153	242 d
Ra-226	1600 y
Th-229	7340 y
Th-230	7.7e4 y
Th-232	1.405e10 y
U-234	2.445e5 y
U-235	7.038e8 y
U-238	4.468e9 y

Daughter Radioisotope	Half-Life[a]
Y-90	64 h
Tc-99	2.13e5 y
Te-123m	119.7 d

Daughter Radioisotope	Half-Life[a]
Tl-207	4.77 m
Tl-208	3.07 m
Tl-209	2.2 m
Pb-209	3.253 h
Pb-210	22.3 y
Pb-211	36.1 m
Pb-212	10.64 h
Pb-214	26.8 m
Bi-210	5.012 d
Bi-211	2.14 m
Bi-212	60.55 m
Bi-213	45.65 m
Bi-214	19.9 m
Po-210	138.38 d
Po-211	0.516 s
Po-212	0.305 µs
Po-213	4.2 µs
Po-214	164.3 µs
Po-215	0.00178 s
Po-216	0.15 s
Po-218	3.05 m
At-217	0.0323 s
Rn-219	3.96 s
Rn-220	55.6 s
Rn-222	3.8235 d
Fr-221	4.8 m
Fr-223	21.8 m

Daughter Radioisotope	Half-Life[a]
Ra-223	11.434 d
Ra-224	3.66 d
Ra-225	14.8 d
Ra-226	1600 y
Ra-228	5.75 y
Ac-225	10 d
Ac-227	21.773 y
Ac-228	6.13 h
Th-227	18.718 d
Th-228	1.9131 y
Th-229	7340 y
Th-230	7.7e4 y
Th-231	25.52 h
Th-234	24.10 d
Pa-231	3.276e4 y
Pa-233	27 d
Pa-234	6.7 h
Pa-234m	1.17 m
U-233	1.585e5 y
U-234	2.445e5 y
Np-237	2.14e6 y

a/ Half-Lives from *Annals of the ICRP, Radionuclide Transformations, Energy and Intensity of Emissions, ICRP Publication 38* and the *Radiological Health Handbook*, 1970.
(y = year, d = day, h = hour, m = minute, s = second, µs = microsecond)

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LIST OF ACRONYMS

AECL	Atomic Energy of Canada Limited
Ac	Actinium
ALARA	As-Low-As-Reasonably-Achievable
AMCOM	Armament, Munitions, and Chemical Command
At	Astatine
Am	Americium
Army	United States Department of the Army
Au	Gold
B	Boron
Ba	Barium
Be	Beryllium
Bi	Bismuth
Br	Bromine
BRAC	Base Realignment and Closure (Act)
C	Carbon
Ca	Calcium
Ce	Cerium
Cd	Cadmium
Co	Cobalt
Cr	Chromium
CDPHE	Colorado Department of Public Health and Environment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CHPPM	U.S. Army Center for Health Promotion and Preventive Medicine (formerly U.S. Army Environmental Hygiene Agency (CHPPM)
Cl	Chlorine
CRS	Cultural Resource Study
Cs	Cesium
Cu	Copper
DARA	Department of the Army Radioactive Material Authorization
DCI	Department of Clinical Investigation
DEH	Directorate of Engineering and Housing
DoD	Department of Defense
DPW	Directorate of Public Works
EBS	Environmental Baseline Survey
EPA	U.S. Environmental Protection Agency
ES&E	Environmental Science & Engineering, Inc.
FAMC	Fitzsimons Army Medical Center

Fe	Iron
Fitzsimons	U.S. Army Garrison, Fitzsimons
FR	Federal Register
Fr	Francium
FRA	Fitzsimons Redevelopment Authority
Ga	Gallium
Gd	Gadolinium
H-3	Tritium (Hydrogen-3)
Hg	Mercury
I	Iodine
In	Indium
Ir	Iridium
IRP	Installation Restoration Program
K	Potassium
Kr	Krypton
mCi	Millicurie
MDA	Minimum Detection Activity
Mg	Magnesium
Mo	Molybdenum
Mn	Manganese
mSv	Millisievert
Na	Sodium
Ni	Nickel
NORM/NARM	Naturally occurring and accelerator-produced radioactive materials
NPDES	National Pollutant Discharge Elimination System
NRC	Nuclear Regulatory Commission
P	Phosphorus
Pa	Protactinium
Parsons ES	Parsons Engineering Science, Inc.
Pb	Lead
PCB	Polychlorinated biphenyl
Po	Polonium
Ra	Radium
Rb	Rubidium
RCC	Radiation Control Committee
RIA	RadioImmunoAssay
Rn	Radon
RPO	Radiation Protection Office
S	Sulfur
Sb	Antimony
Se	Selenium
Sr	Strontium

SOP	Standard Operating Procedure
SSEBS	Site-Specific Environmental Baseline Survey
Tc	Technetium
TEDE	Total Effective Dose Equivalent
Te	Tellurium
Th	Thorium
Tl	Thallium
Tm	Thulium
U	Uranium
U.S.	United States
USAEC	United States Army Environmental Center
CHPPM	U.S. Army Environmental Hygiene Agency
USAMRNL	U.S. Army Medical Research and Nutrition Laboratory
WWTP	Wastewater Treatment Plant
Xe	Xenon
Y	Yttrium
Yb	Ytterbium
Zn	Zinc
μCi	Microcurie

SECTION 1

INTRODUCTION

1.1 PURPOSE

In accordance with the Atomic Energy Act (AEA), facilities are required to obtain a license from the Nuclear Regulatory Commission (NRC) (formerly the Atomic Energy Commission) to possess and use radioactive materials that are regulated under the AEA. Radioactive materials have been used at the United States (U.S.) Army Garrison, Fitzsimons (Fitzsimons) (formerly known as the Fitzsimons Army Medical Center [FAMC], the Fitzsimons General Hospital, and the Fitzsimons Army Hospital), for medical treatment, radiation therapy, and research studies involving nutrition and metabolic affects. For simplicity, the site and facilities will be commonly referred to as Fitzsimons for the purpose of this report. Fitzsimons has held a license for these activities since 1956. Other non-regulated radioactive materials, including radium and cobalt (Co)-57, have been used and managed internally by the Army at Fitzsimons. The earliest documented use of radioactive materials is radium, which dates back to 1946.

The NRC license issued to Fitzsimons (05-00046-13) is being terminated to allow the facilities and equipment used to manage radioactive materials under this license to be leased or transferred. To achieve this goal, NRC's release criteria for unrestricted use must be met. The proposed criteria for unrestricted use is that the total effective dose equivalent (TEDE) be as-low-as-reasonably-achievable (ALARA), but no more than 15 millirems per year (mrem/year) [0.15 millisieverts per year (mSv/year)]. An average individual who could potentially receive the greatest exposure from any residual activity within a facility or onsite is used to calculate the TEDE. This approach includes evaluating all significant risks to human health and the environment based on residual radioactivity levels, and comparing these risks against those resulting from the decommissioning process.

The purpose of this report is to identify the buildings and specific rooms where radioisotopes were used, stored, or disposed of during medical treatment and research activities at Fitzsimons. The conclusions presented in this report are based on reviewing historical files and interviewing previous and current personnel. The information provided in this document will be used to establish the radiological surveys required to terminate the NRC license pursuant to the *Manual for Conducting Radiological Surveys in Support of License Termination* (NUREG/CR-5849). This document, and the termination of the NRC license, will also be used to support

requirements of the Base Realignment and Closure (BRAC) Act Closure Laws and ultimately the lease or transfer of property at Fitzsimons.

In pursuing the suitability for lease or transfer of ownership of certain properties within Fitzsimons, the U.S. Department of the Army (Army) has an obligation by law to identify and remediate environmental hazards prior to the lease or transfer of the property. This historical survey is the first step in identifying the potential for radioisotope contamination within certain buildings, areas, or property; the need for further radiation surveys, and the suitability for lease or transfer. A site-wide Environmental Baseline Survey (EBS) (Parsons Engineering Science, Inc. [Parsons ES], May 1996) for Fitzsimons, which identified the buildings that had the potential for the use, storage, or disposal of radioisotopes, was used as reference for this survey.

This document was prepared by Parsons ES under Contract No. DACA31-94-D-0068, Delivery Order No. 0003, between the U.S. Army Environmental Center (USAEC) and Parsons ES.

1.2 BACKGROUND

Fitzsimons Army Medical Center (FAMC) was deactivated on 8 June 1996. It then became known as U.S. Army Garrison, Fitzsimons (Fitzsimons). Until medical service was discontinued, Fitzsimons provided health care services to authorized personnel assigned or attached to area U.S. Department of Defense (DoD) activities since 1918, including inpatient and outpatient medical care to active military personnel and, within its capabilities, to dependents of active-military personnel, retired military personnel, and other personnel as authorized by the Army.

On 28 February 1995, the Secretary of Defense submitted a recommendation that Fitzsimons be selected for closure under BRAC. Public Laws 100-526 and 101-510 designated more than 100 Army facilities for closure and realignment. In pursuit of those activities, and in accordance with the BRAC Closure Laws, it is necessary to investigate and clean up environmental contamination prior to lease, transfer, or reuse of Army property. The BRAC environmental restoration program was established in 1989 after the first round of base closures (BRAC I) was announced. Since 1989, subsequent rounds of BRAC have been identified through public law every two years (BRAC 91, BRAC 93, and BRAC 95). The BRAC environmental restoration program is patterned after the Army's Installation Restoration Program (IRP) except that it has been expanded to include categories of contamination such as asbestos, radon, polychlorinated biphenyl's (PCBs), radiological hazards, unexploded ordinance, and other environmental concerns which are not normally addressed under the Army IRP. Both the BRAC and IRP programs are patterned after the U.S. Environmental Protection Agency's (EPA's) Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) process.

Property transfer is scheduled to be completed by the year 2001. The Fitzsimons Redevelopment Authority (FRA) has been established to provide master planning and to coordinate and organize efforts by parties interested in leasing or purchasing buildings or property at Fitzsimons. In order to support the property transfer of

ownership, the NRC license must be terminated, and the existence and extent of present and former environmental contamination and environmental and health hazards must be identified, with subsequent remediation.

1.3 SITE DESCRIPTION

Fitzsimons is located in Aurora, Colorado (Figure 1.1). Figure 1.2 presents an overall site map of Fitzsimons. Fitzsimons is located approximately 8 miles east of downtown Denver in northwestern Aurora, Colorado.

The facility covers an area of 576 acres at the northeast corner of East Colfax Avenue and Peoria Street in Section 36, Township 3 South, Range 67 West, 6th Principal Meridian, in Adams County, Colorado. The elevation of the installation ranges from 5,387 feet (1,642 meters) above mean sea level along the central section of the southern boundary to 5,318 feet (1,621 meters) along the central section of the northern boundary. The installation includes 289 acres of buildings, 141 acres of improved grounds, and 146 acres of unimproved grounds. Land uses at Fitzsimons have included medical, commercial, industrial, residential, and recreational uses.

Fitzsimons has been divided by the Army into nine land divisions. The building numbering system at Fitzsimons is based upon the land area division that the building is located within. The land area divisions are described as follows:

- Area 0-99 is located in the southwest corner of the installation and includes residential and recreational facilities.
- Area 100 is in the northwest corner of Fitzsimons and is comprised of residential, administrative, recreational, and maintenance facilities. A golf course occupies 75 percent of the land in Area 100.
- Area 200 is situated on the north side of the property and contains the majority of industrial and maintenance facilities and softball fields.
- Area 300 is on the northeast corner of Fitzsimons and includes administration, recreation, and residential facilities.
- Area 400 is located on the west side of Fitzsimons and contains residences and administration buildings.
- Area 500 is in the center of Fitzsimons and includes the main hospital and support facilities.
- Area 600 is on the east side of Fitzsimons and contains administration, hospital clinics, clinical research, environmental laboratories, and residences.
- Area 700 is on the south end of Fitzsimons and contains a helicopter pad, residences, and agricultural land.

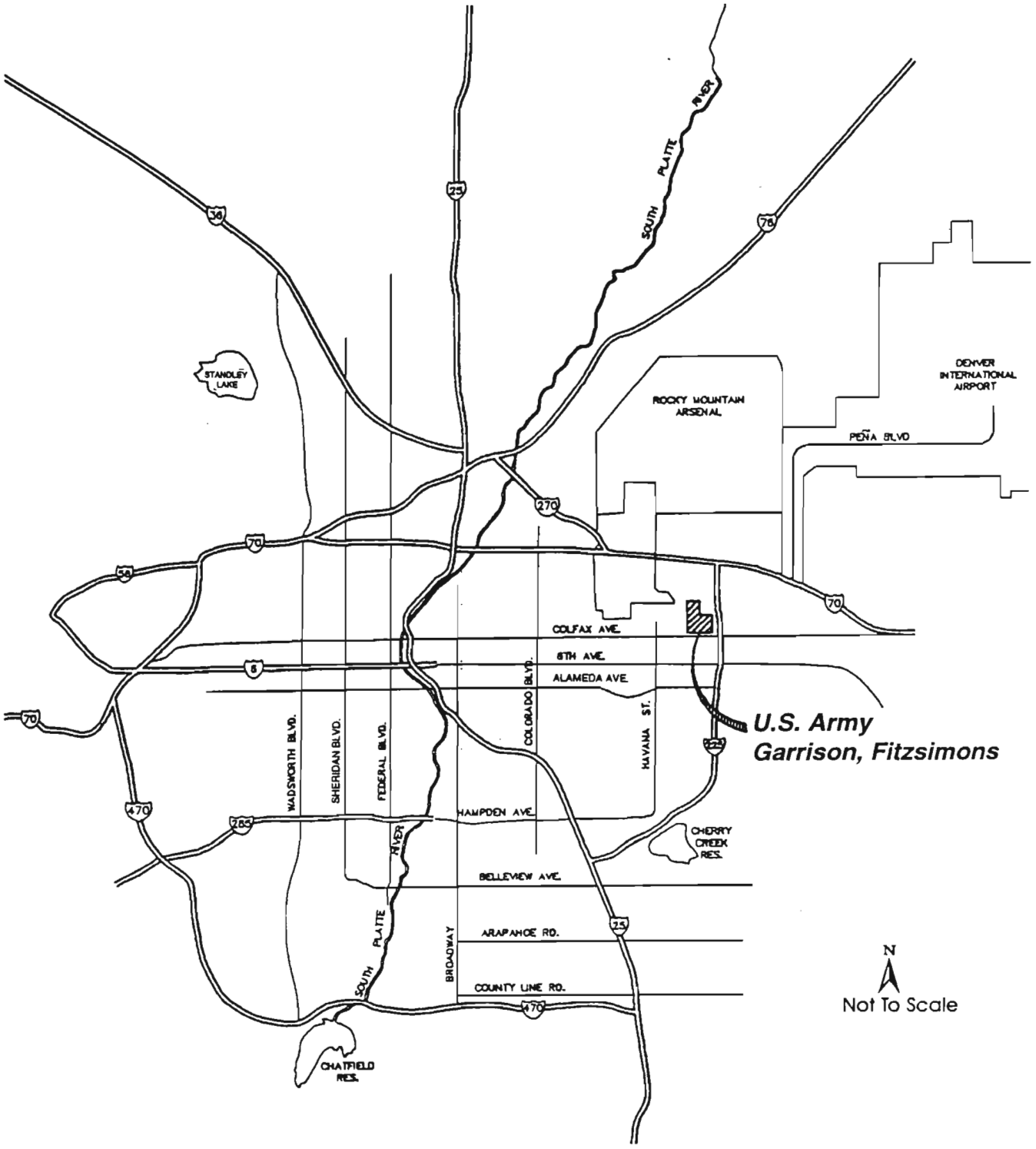

FIGURE 1.1

VICINITY MAP

U.S. Army Garrison, Fitzsimons
Aurora, Colorado

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

Legend

- Golf Course
- Recreational
- Roads
- Buildings
- Drainage
- Fences
- Building and Area Locations of Suspected Historical Radioisotope Use, Storage, or Disposal

N

100 0 100 200 300 400

SCALE IN METERS

REVISION	DATE	DESCRIPTION	BY

HISTORICAL SURVEY
U.S. Army Garrison, Fitzsimons

SOURCE: PELIMINARY DRAFT Survey Plan (Parsons ES, 1996)

SITE MAP OF FITZSIMONS
Location of Historical Radioisotope Use, Storage, or Disposal

Projection: UTM - NAD27

Figure 1.2

- Area 800 is located at the southern corner of Fitzsimons and is comprised of residential, administration, and commercial facilities.

1.4 REPORT ORGANIZATION

This report is divided into four sections and five appendices. Section 2 presents the survey method, Section 3 identifies the radioisotopes and daughter products relevant to the site, and Section 4 identifies areas requiring radiological surveys. Appendix A contains license summaries, Appendix B contains building maps, Appendix C contains the Landfill No. 5 contractor report, Appendix D contains references cited in this report, and Appendix E includes a summary of the personnel interviews.

1.5 NRC LICENSE TERMINATION PROCEDURE

The NRC license termination process consists of a series of planning documents and surveys to identify the required decommissioning activities, followed by surveys demonstrating that the NRC's criteria for unrestricted use is achieved. These surveys include a scoping survey, characterization survey, remediation survey, and a final status survey. These survey types are discussed within NUREG/CR-5849, *Manual for Conducting Radiological Surveys in Support of License Termination.* Figure 1.3 provides a flow diagram for the series of radiological surveys required for license termination. This historical survey report, in conjunction with the scoping survey, fulfills the tasks associated with the second step depicted in the flow diagram.

The scoping survey will provide a preliminary assessment of site conditions, relative to guideline values, and enables initial guidance in the classification of the site into "affected" and "unaffected" areas. It also provides the basis for initial estimates of the level of effort required for decommissioning and for planning the characterization survey. To achieve this goal, a limited number of direct radiation measurements (e.g., general radiation field rates and surface activity levels), smears for removable contamination, and samples of media (e.g., soils, water, sewer sediments, ventilation ducts) will be obtained from locations that are considered to be the most likely to contain residual activity. Areas immediately adjacent to areas of known radioactive material use will also be surveyed. Areas not expected to have been affected by site operations will be randomly sampled to determine background radiation levels.

After locations which may require decontamination have been identified, a characterization survey is performed to more precisely define the extent and magnitude of contamination. Characterization is typically concentrated on those portions of the site which are known to have been, or are suspected of having been, affected by site operations involving radioactive materials. The characterization survey will be performed in sufficient detail to provide data for planning the decontamination effort, including the decontamination techniques, schedules, costs, waste volumes, and necessary health and safety considerations during decontamination. The type of information obtained from a characterization survey is used to differentiate whether a surface is "contaminated" or "non-contaminated" and to confirm the presence or absence of suspected radioisotopes.

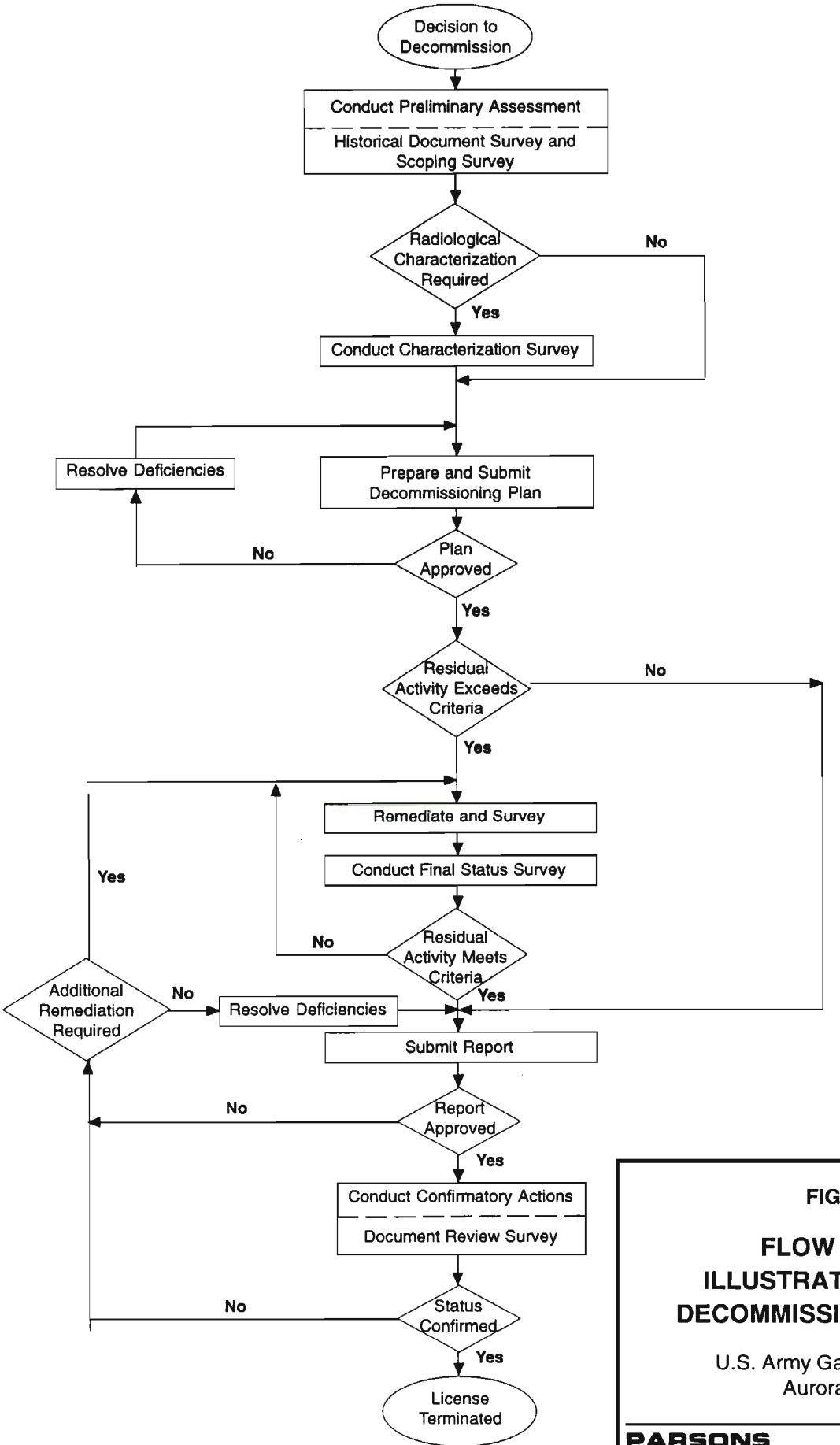

FIGURE 1.3

FLOW DIAGRAM ILLUSTRATING GENERAL DECOMMISSIONING PROCESS

U.S. Army Garrison, Fitzsimons
Aurora, Colorado

PARSONS ENGINEERING SCIENCE, INC.

Denver, Colorado

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The effectiveness of the decontamination efforts in reducing residual radioactivity to acceptable levels is monitored as the decontamination is in progress by a remediation control survey. This type of survey guides the cleanup in a real-time mode; it also ensures that remediation workers, the public, and the environment are adequately protected against exposures to radiation and radioactive materials arising from the decontamination activities. The survey measurements will provide reasonable assurance that the unrestricted release criteria is attained.

After the completion of any required decontamination activities, the final status survey will be performed to determine the final condition of the site. The final status survey provides data to demonstrate that all of the radiological parameters (total surface activity, removable surface activity, exposure rate, and radioisotope concentrations in soil and other bulk materials) satisfy the established unrestricted use criteria and other conditions for license termination. The results of this survey will be documented in a detailed report which becomes a part of the licensee's documentation to terminate the NRC license and thereby release the facility for unrestricted use. The NRC may also elect to conduct a verification survey to check the results of the final status survey prior to terminating the NRC license.

1.6 HISTORICAL SURVEY REPORT METHODOLOGY

1.6.1 Regulatory and Fitzsimons Records

Historical activities were documented through interviews with current and former employees, visual inspection, and review of Fitzsimons and regulatory documentation. Records from prior NRC inspections, the U.S. Army Center for Health Promotion and Preventive Medicine (CHPPM) (formerly known as the U.S. Army Environmental Hygiene Agency [USAEHA]), and the Fitzsimons Radiation Protection Office (RPO) were reviewed to assist in the identification of areas where the use, storage, release, or disposal of radioisotopes has occurred. In all cases, an effort was made to confirm building and room numbers, and radioisotope usage, from two independent sources. Historical survey activities included the review of the following:

- Atomic Energy Commission and NRC licenses,
- Atomic Energy Commission and NRC Audit Findings,
- Radioisotope Inventory Reports,
- Department Requests for Authorization to use Radioactive Materials,
- Patient Surveys,
- Radiation Survey Reports,
- Disposition Forms,
- Radioisotope Entry Receipts,

- Disposal Records,
- Building Design Drawings,
- Clinical Investigations Records,
- Quarterly Inventory Reports,
- Shielding Evaluations,
- Radiation Surveys, and
- Radiation Control Committee meeting minutes.

Previous research performed during the Environmental Baseline Survey (EBS, Parsons 1996a) and the Site-Specific Environmental Baseline Survey, Building No. 500 (SSEBS, Parsons 1996b) were also used in consolidating historical radioisotope data for this survey. The records and sources reviewed during those surveys consisted of the following:

- United States Environmental Protection Agency (EPA);
- Colorado Department of Public Health and Environment (CDPHE);
- Adams County;
- Tri-County Health Department; and
- City of Aurora.

1.6.2 Environmental Documents

Over the course of its history, Fitzsimons has prepared or contracted the development of numerous environmental surveys, investigations, and reports on both individual buildings and the installation as a whole. A document search was conducted in the environmental files at Fitzsimons. Six documents were identified as applicable to the development of the historical survey at Fitzsimons. These documents were reviewed with respect to the locations of the use, storage, release, or disposal of radioisotopes. The documents were:

- *Installation Environmental Baseline Conditions and Compliance Study* (TechLaw, 1994);
- *U.S. Army Environmental Hygiene Agency, Environmental Compliance Assessment System External Assessment No. 43-21-N18F-93, Draft Findings Report* (U.S. Army Environmental Hygiene Agency [CHPPM], 1993);
- *Analytical/Environmental Assessment Report for Future Development Plans* (Fitzsimons, 1985a);

- *Capability Analytical/Environmental Assessment Report* (Fitzsimons, 1985b);
- *Installation Assessment of Fitzsimons Army Medical Center* (Environmental Science and Engineering, Inc. [ES&E], 1984); and
- *Analysis of Existing Facilities/Environmental Assessment Report* (Higginbotham & Assoc., 1977).

In addition, the *Cultural Resources Study for Fitzsimons Army Medical Center* (Simmons, 1991) (CRS) provided information pertaining to buildings at Fitzsimons that are older than 50 years. This report was used as the primary reference for historical information regarding past operations conducted in buildings older than 50 years.

1.6.3 Interviews and Visual Inspections

Interviews and visual inspections were conducted during the development of the EBS and SSEBS for Building No. 500 to assist in determining the environmental condition of property at Fitzsimons and to determine if any areas required radiological surveys not previously documented during the review of records. Information gathered during the review of records was assimilated and evaluated.

Interviews were conducted both by telephone and in person. In-person interviews (summarized in Appendix E) were conducted with personnel who had worked at Fitzsimons for many years (to obtain historical information). Interviews specific to the development of this historical survey report were limited due to the recent deactivation of FAMC and subsequent relocation of Fitzsimons personnel.

SECTION 2

RADIOLOGICAL HISTORY

2.1 HISTORY OF THE SITE RADIOLOGICAL PROGRAMS AND ATOMIC ENERGY COMMISSION/NRC LICENSES

Based on a review of the records maintained by the RPO at Fitzsimons, at least 10 different Atomic Energy Commission/NRC licenses (excluding amendments) have been issued to Fitzsimons for the possession and use of various radioactive byproduct materials under the provisions of Title 10 Code of Federal Regulations (CFR) 30. The earliest license (No. 5-46-1) on file was issued to the Fitzsimons Army Hospital Medical Nutrition Laboratory by the Atomic Energy Commission in March 1956. Several other Atomic Energy Commission licenses were issued to various departments and users between 1957 and 1963, as indicated in Table 2.1. Starting in 1964, it appears that all of the individual user licenses were combined into a single byproduct license (05-00046-13). Under this combined license, the Radioisotope Committee (now known as the Radiation Control Committee) was formed to approve the possession and use of byproduct materials by individual Fitzsimons users.

It is probable that radioisotopes were used at Fitzsimons prior to the issuance of the first documented Atomic Energy Commission License in 1956. Shipping records indicate that radium was received at Fitzsimons as early as 1946. A 1966 document entitled *Laboratory Facility Information* indicates that a unit of the Medical Nutrition Laboratory was established at Fitzsimons as early as 1944. This document also indicates that all of the Laboratory's functions were transferred from Chicago to Fitzsimons in 1953 (U.S. Army Medical Research and Nutrition Laboratory [USAMRNL], 1966). Without additional documentation, it is postulated that any activities that may have been conducted prior to 1956 were similar to the documented activities that occurred after 1956.

The Atomic Energy Commission/NRC licenses and associated amendments authorized the possession and use of byproduct materials. Table 2.1 identifies the licensee, issuance and expiration dates, number of the last amendment on file, and authorized uses for each Atomic Energy Commission/NRC license obtained from the Fitzsimons files. A more detailed summary of the licenses and associated amendments reviewed is presented in Appendix A. License 05-00046-15 is not being considered as part of this historical report or the subsequent decommissioning efforts. License 05-00046-15 was for the possession and use of a Co-60 sealed source and was previously terminated by the NRC in January 1994. Table 2.2 identifies the authorized radioisotopes with the associated chemical/physical forms, and Table 2.3 provides a chronology of the activity limits (established by the licenses) for the radioisotopes that were allowed at Fitzsimons.

TABLE 2.1
ATOMIC ENERGY COMMISSION/NRC LICENSE INFORMATION
HISTORICAL SURVEY REPORT
U.S. ARMY GARRISON, FITZSIMONS
AURORA, COLORADO

License Number	Original Licensee	Date of Issue	Expiration Date	Number of Amendments	Authorized Uses
5-46-1	Fitzsimons Army Hospital, Medical Nutrition Laboratory	Mar 1956	Mar 1958	2	Use of C-14 and S-35 for chemical and biological laboratory studies in lower animals.
5-46-3	Fitzsimons Army Hospital, Biochemistry Branch, Chemistry Division, Medical Nutrition Laboratory	Jan 1957	Jan 1959	2	Use of H-3, C-14, P-32, S-35, Ca-45, Sr-89, and Sr-90 for laboratory studies of the intermediary metabolism of compounds in microorganisms and lower animals.
5-46-6	Fitzsimons Army Hospital, Metabolic Research Division, Medical Nutrition Laboratory	Dec 1957	Dec 1959	None	Use of I-131 labeled human serum albumin to measure the turnover rate of albumin of ten normal young men in various nutritional states. [NOTE: A hand written note on the license indicates that the license was canceled on September 2, 1960 via a letter from the Atomic Energy Commission.]
5-46-8	Fitzsimons Army Hospital, Medical Research and Nutrition Laboratory	Feb 1959	Feb 1964	None	Use of H-3, C-14, P-32, S-35, Ca-45, Sr-89, and Sr-90 for laboratory studies of the intermediary metabolism of compounds in microorganisms and lower animals.
5-46-9[a/]	Fitzsimons Army Hospital, Radiology Department, Radioisotope Section	Not on File	Apr 1963	4	Use of P-32, Cr-51, Fe-59, Co-60, I-131, and Au-198 in a number of chemical forms to conduct clinical investigations involving disease processes and new treatment procedures.
5-46-11	Department of Army, U.S. Army Medical Research and Nutrition Laboratory, Fitzsimons Army Hospital	Sept 1959	Aug 1963	4	Use of H-3, C-14, P-32, S-35, Ca-45, Cr-51, Fe-55, Fe-59, Co-60, Zn-65, Se-75, Br-82, Sr-85, Sr-89, Sr-90, I-131, and Au-198 for research and development in chemistry, biochemistry, and related fields.

TABLE 2.1 (Continued)
ATOMIC ENERGY COMMISSION/NRC LICENSE INFORMATION
HISTORICAL SURVEY REPORT
U.S. ARMY GARRISON, FITZSIMONS
AURORA, COLORADO

License Number	Original Licensee	Date of Issue	Expiration Date	Number of Amendments	Authorized Uses
5-46-12	Department of Army, U.S. Army Medical Research and Nutrition Laboratory, Fitzsimons Army Hospital	Dec 1959	Dec 1963	6	Use of C-14 labeled glucose, glucuronic acid, glucuronolactone, and ascorbic acid in human metabolism and physiological tracer studies. License was expanded in Oct. 1961 to include C-14 labeled glycine, cholesterol, mevalonic acid, acetate, and carbon monoxide. The use of tritiated water was also permitted under this license to determine the total amount of body water in human volunteers at Ft. Carson, Colorado.
05-00046-13	Department of the Army, Fitzsimons General Hospital and U.S. Army Medical Research and Nutrition Laboratory	Feb 1964	Dec 1999	58	Use of various radioisotopes for nutrition and metabolism tracer studies in human volunteers and laboratory animals; radiation therapy; radiological treatment and medical diagnosis; and other research and development activities.
05-00046-14	Department of the Army, Fitzsimons General Hospital and U.S. Army Medical Research and Nutrition Laboratory	Sept 1965	Sept 1975	1	Use of a Co-60 sealed source (28,000 curies) in an Atomic Energy of Canada Limited (AECL) Model Gammacell 220 for in vitro research.
05-00046-15[b/]	Department of the Army, Fitzsimons Army Medical Center	Apr 1974	Jan 1994	28	Use of Co-60 sealed source (20,000 curies) for radiation treatments. The Co-60 source was transferred to an off-site licensee and License 05-00046-15 was terminated on January 14, 1994 by NRC.

a/ Only Amendment No. 4 of License 5-46-9 was on file.
b/ Licensing records started with Amendment No. 4.

TABLE 2.2
ATOMIC ENERGY COMMISSION/NRC RADIOISOTOPE AUTHORIZATIONS
HISTORICAL SURVEY REPORT
U.S. ARMY GARRISON, FITZSIMONS
AURORA, COLORADO

	Chemical/Physical Form For	License Number									
Radioisotope	**All Atomic Energy Commission/NRC License Authorizations**	**5-46-1**	**5-46-3**	**5-46-6**	**5-46-8**	**5-46-9**	**5-46-11**	**5-46-12**	**05-00046-13**	**05-00046-14**	**05-00046-15**
H-3 [a/]	Any, water, and vitamins		●		●		●	●	●	●	●
C-14 [a/]	Any, glucose, glucronic acid, glucuronolactone, ascorbic acid, glycine, mevalonic acid, acetate, carbon monoxide, carbon dioxide, bicarbonate, cholestrol, vitamins, carbohydates, amino acids, and lipids.	●	●		●		●	●	●	●	●
Na-24 [a/]	Sodium chloride								●	●	●
Mg-28	Magnesium oxide, magnesium chloride, magnesium citrate								●	●	●
P-32	Any, soluble phosphate, and colloidal chromic phosphate.		●		●	●	●		●	●	●
S-35 [a/]	Any	●	●		●		●		●	●	●
K-42 [b/]	Not specified.								●	●	●
Ca-45	Any and calcium chloride.		●		●		●		●	●	●
Ca-47	Calcium chloride								●	●	●
Cr-51 [a/]	Sodium chormate, chromic chloride, and labeled human serum albumin.					●	●		●	●	●
Fe-55	Any						●				

TABLE 2.2 (Continued)
ATOMIC ENERGY COMMISSION/NRC RADIOISOTOPE AUTHORIZATIONS
HISTORICAL SURVEY REPORT
U.S. ARMY GARRISON, FITZSIMONS
AURORA, COLORADO

	Chemical/Physical Form For	License Number									
Radioisotope	**All Atomic Energy Commission/NRC License Authorizations**	**5-46-1**	**5-46-3**	**5-46-6**	**5-46-8**	**5-46-9**	**5-46-11**	**5-46-12**	**05-00046-13**	**05-00046-14**	**05-00046-15**
Fe-59	Any, ferric chloride, and ferrous citrate.					●	●		●	●	●
Co-58	Vitamin B12								●	●	●
Co-60	Any, vitamin B12, and sealed sources.					●	●		●	●	●
Zn-65	Any						●				
Se-75	Any, selenomethionine, and selenite.						●		●	●	●
Br-82 [a/]	Any						●		●	●	●
Sr-85 [a/]	Any, strontium nitrate, and strontium chloride.						●		●	●	●
Sr-89	Any		●		●		●				
Sr-90	Any and sealed sources		●		●		●		●	●	●
Mo-99	Squibb Model 08871 Generator								●	●	●
Tc-99m	Any, pertechnetate, technetium sulfur colloid, labeled albumin microspheres, labeled polyphophates, iron-ascorbate diethylenetriamine pentaacetic acid, and labeled disodium etidronate.								●	●	●

TABLE 2.2 (Continued)
ATOMIC ENERGY COMMISSION/NRC RADIOISOTOPE AUTHORIZATIONS
HISTORICAL SURVEY REPORT
U.S. ARMY GARRISON, FITZSIMONS
AURORA, COLORADO

	Chemical/Physical Form For	License Number									
Radioisotope	**All Atomic Energy Commission/NRC License Authorizations**	**5-46-1**	**5-46-3**	**5-46-6**	**5-46-8**	**5-46-9**	**5-46-11**	**5-46-12**	**05-00046-13**	**05-00046-14**	**05-00046-15**
I-125 [a/]	Any, iodide, iodinated human serum albumin, labeled renal function compounds (i.e., hippuran), labeled fats and/or fatty acids (i.e., triolein and/or oleic acid), cholografin, p-toluidine polyvinylpyrrolidone, thyroxine, and rose bengal.								●	●	●
I-131 [a/]	All forms listed for I-125, triiodothyronine, macroaggregated human serum albumin, and I-6B-iodomethynor-cholestrol (NP 59).			●		●	●		●	●	●
Xe-133	Free gas and dissolved in saline.								●	●	●
Cs-137	Any and sealed sources.								●	●	●
Ce-141 [b/]	Not specified.								●	●	●
Gd-153	Sealed sources.								●	●	●
Yb-169 [b/]	Not specified.								●	●	●
Au-198	Any, colloidal, and seeds.					●	●		●	●	●
Hg-197	Chlormerodrin								●	●	●
Hg-203	Chlormerodrin								●	●	●
Am-241	Sealed sources.								●	●	●

TABLE 2.2 (Continued)
ATOMIC ENERGY COMMISSION/NRC RADIOISOTOPE AUTHORIZATIONS
HISTORICAL SURVEY REPORT
U.S. ARMY GARRISON, FITZSIMONS
AURORA, COLORADO

	Chemical/Physical Form For	License Number									
Radioisotope	**All Atomic Energy Commission/NRC License Authorizations**	**5-46-1**	**5-46-3**	**5-46-6**	**5-46-8**	**5-46-9**	**5-46-11**	**5-46-12**	**05-00046-13**	**05-00046-14**	**05-00046-15**
Atomic Nos. 1-83	Any								●	●	●
Atomic Nos. 4-84	Sealed sources								●	●	●
Any byproduct material listed in 10 CFR 35.100 Sch A, Groups I/II [c/]	Any radiopharmacceutical listed in Groups I/II								●	●	●
Any byproduct material listed in 10 CFR 35.100 Sch A, Group III [c/]	Any form listed in Group III								●	●	●
Any byproduct material listed in 10 CFR 35.100 Sch A, Group IV [c/]	Any radiopharmacceutical listed in Group IV								●	●	●
Any byproduct material listed in 10 CFR 35.100 Sch A, Group V [c/]	Any radiopharmacceutical listed in Group V								●	●	●

TABLE 2.2 (Continued)
ATOMIC ENERGY COMMISSION/NRC RADIOISOTOPE AUTHORIZATIONS
HISTORICAL SURVEY REPORT
U.S. ARMY GARRISON, FITZSIMONS
AURORA, COLORADO

	Chemical/Physical Form For	License Number									
Radioisotope	**All Atomic Energy Commission/NRC License Authorizations**	**5-46-1**	**5-46-3**	**5-46-6**	**5-46-8**	**5-46-9**	**5-46-11**	**5-46-12**	**05-00046-13**	**05-00046-14**	**05-00046-15**
Any byproduct material listed in 10 CFR 35.100 Sch A, Group VI [c/]	Any sealed source listed in Group IV.								●	●	●

NOTES:

a/ Isotope also authorized for use on Pikes Peak.

b/ Authorization for the radioisotope was specifically identified for usage on Pikes Peak.

c/ Any byproduct material in these Groups are identified in 10 CFR 35.100, Schedule A between 1969 and 1985.

Groups I/II includes: Na-24, K-42, Cr-51, Fe-59, Co-58, Co-60, Sr-85, Tc-99m, I-125, I-131, Au-198, Hg-197, and Hg-203.

Group III includes: Mo-99/Tc-99m.

Group IV includes: P-32 and I-131.

Group V includes: I-131 and Au-198.

Group VI includes: Co-60, Sr-90, I-125, Cs-137, Ir-192, Au-198, and Am-241 as sealed sources.

TABLE 2.3
RADIOISOTOPE POSSESSION LIMITS AUTHORIZED IN ATOMIC ENERGY COMMISSION/NRC LICENSES FOR FITZSIMONS [a]
HISTORICAL SURVEY REPORT
U.S. ARMY GARRISON, FITZSIMONS
AURORA, COLORADO

Radioisotope	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996 (10)
H-3				5,000	10,000	10,000	10,000	10,000	10,150	5,075	5,075	5,075	5,100	5,100	5,125	5,125	5,125	5,125	5,125	5,125	5,025	5,025	5,025	5,025	5,025	5,025	5,025	5,025	5,025	5,025	5,025	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000
C-14		1	55	55	258	258	269	269	269	70	70	70	50	50	50	50	50	50	50	50																						
Na-24										1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1											
Mg-28										10	10	10	(2)	(2)					(2)	(2)																						
P-32				5	105	105	170	170	170	55	50	50	50	50	50	50	50	50	50	100	100																					
S-35		1	1	6	205	205	205	205	205	5																																
Ca-45				5	10	10	10	10	10	15	10	10	10	10	10	10	10	10	10	10																						
Ca-47										10	10	10	10	10	10	10	10	10	10	10																						
Cr-51					25	25	105	105	105	4	4	4	10	14	10	10	10	10	10	10	10																					
Fe-55					5	5	5	5	5																																	
Fe-59					5	5	7	7	7	1	1	1	1	1																												
Co-58										10	10	10	10	10																												
Co-60					5	5	6	6	6	10	28,010	28,010	28,010	28,010	28,000	28,000	28,000	28,000	28,000	28,000	28,000																					
Zn-65					5	5	5	5	5																																	
Se-75							100	100	100	10	10	10					2	2	2																							
Br-82							200	200	200																																	
Sr-85								5	5	1	1	1	1	3																												
Sr-89				5	10	10	10	10	10	5																																
Sr-90				5	10	10	10	10	10	30	25	25	38	38	38	38	63	63	63	63	50																					
Mo-99													600	600	600	600	1,000	1,000	1,000	2,000	2,000											5,000	5,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Tc-99m													300	300	100	200	200	200	400	1150	1150											5,000	5,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
I-125										7	7	8	7	7	2	2	2	2	7	7	7	1	1	1	1	1	1	1	1	1	1	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
I-131			1	1	201	200	356	356	356	267	267	270	268	279	257	257	257	257	262	262	262	2	2	2	2	2	2	2	(4)	(4)	(4)	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000
Xe-133										2	2	2	52	52	52	52	52	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000
Cs-137														1	1	1	1	1	627	627	627	1	1	1	1	1	1	1	1	1	1											
Gd-153																															(7)											
Au-198							300	350	350	250	250	250	250	250	250	250	250	250	250	250	350																					
Hg-197										10	10	10	10	10																												
Hg-203										10	10	10	10	10																												
Am-241																																					2	2	2	2	2
Uranium (Natural/Depleted)																																		(9)	(9)	(9)	(9)	(9)	(9)	(9)	(9)	(9)
Atomic Nos. 1-83										(1A)	(1A)	(1A)	(1A)	(1A)	(1A)	(1A)	(1A)	(1A)	(1A)	(1A)	(1A)	(1A)	(1A)	(1A)	(1A)	(1B)	(1B)	(1B)	(1B)	(1B)	(1B)	(1B)	(1B)	(1B)	(1B)	(1B)	(1B)	(1B)	(1B)	(1B)	(1B)
Atomic Nos. 4-84																																(8)	(8)	(8)	(8)	(8)	(8)	(8)	(8)	(8)	(8)	(8)
Groups I/II (3)															(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)											
Group III (3)																					(5A)	(5A)	(5A)	(5A)	(5A)	(5B)	(5B)	(5B)	(5B)	(5B)	(5B)											
Group IV (3)																					(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)											
Group V (3)																					(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)											
Group VI (3)																					(6A)	(6A)	(6A)	(6A)	(6A)	(6B)	(6B)	(6B)	(6B)	(6B)	(6B)											

\a All values provided in millicuries (mCi) [1 mCi = 2.703e-14 becquerel (Bq)]. Table does not include terminated License 05-00046-15.

(1A) 500 mCi each isotope, total not to exceed 10 Ci.

(1B) 500 mCi each isotope

(2) 10 mCi each form.

(3) Any byproduct material in this Group as identified in 10 CFR 35.100, Schedule A.

Groups I/II include: Na-24, K-42, Cr-51, Fe-59, Co-58, Co-60, Sr-85, Tc-99m, I-125, I-131, Au-198, Hg-197, and Hg-203.

Group III includes: Mo-99/Tc-99m.

Group IV includes: P-32 and I-131.

Group V includes: I-131 and Au-198.

Group VI includes: Co-60, Sr-90, I-125, Cs-137, Ir-192, Au-198, and Am-241 as sealed sources.

(4) As necessary for authorized uses.

(5A) 2,000 mCi for each radiopharmaceutical listed in Group IV.

(5B) 5,000 mCi for each radiopharmaceutical listed in Group IV.

(6A) 1,000 mCi for all sealed sources listed in Group VI.

(6B) 2,000 mCi for all sealed sources listed in Group VI.

(7) Not to exceed 1,500 mCi per source.

(8) Not to exceed 2,000 mCi per source.

(9) Not to exceed 999 kg for shielding Mo-99/Tc-99 generators

(10) Starting on July 1, 1996, current license limits activities to decommissioning.

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TABLE 2.4
ATOMIC ENERGY COMMISSION/NRC RADIOISOTOPE AUTHORIZATIONS (mCi) FOR PIKES PEAK[a/]
HISTORICAL SURVEY REPORT
U.S. ARMY GARRISON, FITZSIMONS
AURORA, COLORADO

Radioisotope	Chemical/Physical Form	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
H-3	All Forms			5	5	5	5	5	5	5	5	5
C-14	All Forms	1	1	1	1	1	2	2	2	2	2	2
Na-24	All Forms							10	10	10	10	10
S-35	All Forms			5	5	5	5	5	5	5	5	5
K-42	All Forms							10	10	10	10	10
Cr-51	All Forms			1	1	1	1	3	3	3	3	3
Br-82	All Forms			5	5	5	5	5	5	5	5	5
Sr-85	All Forms							2	2	2	2	2
I-125	All Forms	0.5	1	1	1	1	1	3	3	3	3	3
I-131	All Forms	0.5	1	1	1	1	1	1	1	1	1	1
Ce-141	All Forms							2	2	2	2	2
Yb-169	All Forms							2	2	2	2	2

a/ Values provided in this table represent the total usage limits in mCi of each radioisotope authorized to be used on the summit of Pikes Peak.

Naturally-occurring and accelerator-produced radioactive materials (NORM and NARM) and other non-licensed materials have also been used at the site. The possession and use of these materials were internally controlled by the Army through the issuance of a Department of the Army Radioactive Material Authorization (DARA). These radioactive materials include Co-57 and radium.

Radioisotopes were also used by Fitzsimons personnel for nutrition and metabolism studies on the summit of Pikes Peak near Colorado Springs, Colorado. The radioisotopes and authorized limits specifically identified in the license for use on Pikes Peak are presented in Table 2.4. Specific references to the authorized usage of radioisotopes at Pikes Peak ceased in 1974. Information about receipt and preparation of these radioisotopes at Fitzsimons prior to use at Pikes Peak was not available in the historical documents.

Based on review of the Fitzsimons records, a chronology of the significant occurrences and historical events is listed below.

<u>1961</u> **{Reference: Radioactive Material Standard Operating Procedure dated October 25, 1961.}**

Listed below is a summary of the standard operating procedures (SOPs) that were adopted for the USAMRNL in 1961 governing the possession and use of radiological materials under the Atomic Energy Commission license.

- All radioactive materials were procured through the Radioisotope Section by the USAMRNL Supply Office.
- The Chief of the Radioisotope Section was responsible for the storage, handling, and disposal of radioactive materials within the Radioisotope Laboratory after they were delivered to him or his designated representative.
- The Radiation Safety Officer was responsible for the disposal of all radioactive waste within the USAMRNL.
- The Radioisotope Laboratory was to be monitored weekly, and other areas within the USAMRNL were to be monitored monthly. The areas specifically identified to be monitored included:
  - Surgery [Building No. 402, East (currently designated as Building No. 601)];
  - Pathology [Building No. 402, East (currently designated as Building No. 601)];
  - Physiology [Building No. 402, West (currently designated as Building No. 601)];
  - Animal Facility [Building No. 403, West (currently designated as Building No. 602)];

- Chemistry [Building No. 403, East and West (currently designated as Building No. 602)].

- Radioisotope Laboratory [Building No. 405 (currently designated as Building No. 603)].

- The SOP established requirements for radioactive waste management and decontamination.

1964 **{Reference: Atomic Energy Commission License 05-00046-13 dated February 1964.}**

License 05-00046-13 stipulated that each sealed source containing byproduct material, other than H-3, with a half-life greater than 30 days and in any form, other than gas, be tested for leakage and/or contamination at intervals not to exceed 6 months. Sealed sources were also not to be transferred or placed into use without a current test. If the test revealed the presence of 0.005 microcurie (μCi) or more of removable contamination, the licensee was required to immediately withdraw the sealed source from use for decontamination, repair, or disposal. A report also needed to be filed with the Atomic Energy Commission for any sealed sources that leaked.

1964 **{Reference: Atomic Energy Commission License 05-00046-13, Amendment**

This license amendment is the first approval for using radioisotopes on the summit of Pikes Peak for nutrition and metabolism studies. Subsequent license amendments also provided special conditions and authorizations for using radioisotopes at Pikes Peak.

1965 **{Reference: Letter from Kenneth E. Kinnamon, Captain VC, Chief, Radioisotope Laboratory, Physiology Division dated July 5, 1965.}**

The referenced letter indicates that the building numbers for the floor plan sketches included with the Atomic Energy Commission license amendment package needed to be changed to conform to the building number changes. For example, Building No. 405 was changed to 603.

1966 **{Reference: Laboratory Facility Information, dated August 1, 1966.}**

This reference provides the overall mission of the USAMRNL and identifies the associated divisions. The mission statement indicates that the USAMRNL was responsible for studying and assessing the nutritional requirements to optimize performance and to prevent illness or injury. The laboratory was also charged with conducting research on medical and surgical problems of special interest to the Army. In carrying out its mission, the laboratory used, at a minimum, radioisotopes in tracer studies and to irradiate food. The functions of the divisions that handled radiological materials are as follows:

- The **Chemistry Division** (Building No. 600 - East, first and second floors and Building No. 602 - East and West, second floor) conducted research projects in biochemistry and nutrition and provided analytical chemistry support for the entire Laboratory. The research projects specifically included: amino acid requirements, imbalances, and toxicities; fundamental aspects of lipid metabolism; vitamin nutrition, metabolism, and requirements; nutritional value of cellulose trace mineral metabolism; and carbohydrate, protein, and macromolecular biochemistry.

- The **Physiology Division** (Building No. 600 - West, second floor and Building No. 601 - West, first floor) conducted research in environmental, nutritional, and performance physiology. The environmental work was primarily directed toward cardiopulmonary, metabolic, endocrine, and cellular (intermediary metabolism) responses of humans and animals to high altitude and cold exposure. Work in nutritional physiology was concerned with effects of various nutritional and environmental stresses on body functions. The performance physiology studies included an assessment of the physiological and psychological variables that control and limit work capacity, psychomotor skills, and their interrelationships. Studies involving physical training, drug action, environmental stresses, intermediary metabolism, and cardiovascular and pulmonary functions were also included.

- The **Microbiology Division** (Building No. 601 - West, second floor) worked very closely with the hospital on tuberculosis, mycology, virology, and clinical microbiology projects. This division also collaborated with other USAMRNL divisions in studying the nutritional aspects of microbiology. The studies included evaluating the microbial metabolic events leading to developing or losing antibiotic resistance.

- The **Pathology Division** (Building No. 601 - East, second floor) provided pathology and animal service to the USAMRNL and conducted an active program dealing with the toxicology of solutions for intravenous alimentation, techniques in histochemistry and irradiated food research.

<u>1973</u> {Reference: NRC License 05-00046-13, Amendment No. 30.}

Condition 18 was amended on 31 July 1973 to add reference to the 12 April 1973 application. This application requested the use of byproduct material for in-vitro testing at locations other than those specified in the June 25, 1973 application after a safety survey was conducted by the RPO and approval was granted by the Radiation Control Committee.

<u>1979</u> {Reference: 1979 NRC License Renewal Application.}

Nuclear Medicine Services SOPs included iodination procedures, preparation of therapeutic iodine doses, opening of sealed containers, and preparation and assay of patient doses. Preparation of radiopharmaceuticals, generator elution, and related procedures in Nuclear Medicine were performed behind the shields in the Radioisotope

Laboratory (including the generator prep area, storage area, and fume hood). These areas were used to store the Tc-99m generators (that contained Mo-99 parent radioisotopes), I-131 doses, Xe-133 vials, and other radioisotopes for diagnostic doses. Shielding was provided by 2-inch interlocking lead brick. Access to any area where radioactive materials were stored was controlled by physical security methods (e.g., locked or barred doors) or administratively controlled by the principal user.

1985 {Reference: NRC License 05-00046-13, Amendment No. 42}

This amendment authorized Fitzsimons to hold radioactive material with a half-life of less than 65 days for decay in storage prior to disposal with ordinary trash, provided that: (A) radioactive waste was held for decay a minimum of 10 half-lives; (B) monitoring of the waste was conducted to ensure that it could not be distinguished from background; and (C) generator columns were segregated and monitored separately.

1990 {Reference: NRC License 05-00046-13, Amendment No. 52}

This amendment included a condition that requires Fitzsimons to maintain records that are important to the safe and effective decommissioning in accordance with the provisions of 10 CFR 30.35(g). [NOTE: It appears that the enhanced decommissioning record keeping requirements contained in 10 CFR 30.35(g) were promulgated in 53 Federal Register (FR) 24044, June 27, 1988.] Per the NRC transmittal letter, these requirements include: identifying areas or locations where contamination remains after cleanup procedures have been implemented or at locations where there is a likelihood that contamination may have spread to inaccessible sites. These documents must identify spills or other unusual occurrences involving the spread of contamination in and around equipment, facilities, or sites; include as-built drawings and outline modifications of structures and equipment in restricted areas where radioactive materials are used and/or stored; identify specific locations of possible inaccessible contamination such as buried pipes, concrete in existing physical plant structures (floor, walls, ceilings, etc.), and storage vaults; and provide information relative to the identification, quantity, chemical or physical form, and concentration of nuclides involved in contaminating incidents.

1990 {Reference: Memo dated December 11 from Christopher J. Clayton}

This memo states that the sink in Building 600A, Room 107, is authorized for use as a "Hot" sink once the work request is completed.

1995 {Reference: RCC Meeting Minutes}

The RadioImmunoAssay (RIA) Laboratory, located in Building No. 511W, Room 127 was transferred to Nuclear Medicine Services in February.

1995 {Reference: NRC License 05-00046-13, Amendment No. 56}

The frequency for leak-testing sealed sources that emit alpha particles was changed from every 6 months to every 3 months. A new condition was added to require

Fitzsimons to conduct a physical inventory every 3 months to account for all sources and/or devices received and possessed pursuant to 10 CFR 35.59, 35.400 and 35.500; and every 6 months for all other sources and/or devices. [NOTE: Inventory records for sealed sources maintained in the RPO files date back to March 1989.]

1995 {Reference: Report entitled Control of Air Concentrations of Xe-133, dated November 1994}

The above referenced report provides calculations for maintaining negative air pressures in Building No. 511, Room 136 (Department of Radiology, Nuclear Medicine Service). This report also provides calculations for occupational and public health exposures. The report concludes that the ventilation is adequate and the maximum potential exposures are below the required 10 CFR 20 limits.

1995 {Reference: RCC Minutes dated June 22}

The meeting minutes note that the refrigerator in Building No. 603 is used to store urine from patients that have been administered I-131. The urine is disposed of as non-radioactive waste after 3 months of storage to allow for radioactive decay.

1995 {Reference: RPO Quarterly Report for the third quarter of 1995}

This quarterly report indicates that a new treatment room was approved for Tl-201 and Tc-99m use. The new proposed treatment room is located in Building No. 511W adjacent to the elevator on the second floor.

1996 {Reference: NRC License 05-00046-13, Amendment No. 57}

The license expiration date was extended to December 1999; however, Condition 23 only authorizes activities that are related to the decommissioning of the facilities for unrestricted use to be conducted after July 1, 1996. The NRC transmittal letter requires the following items be maintained in a single-document decommissioning record that is certified for completeness and accuracy:

- Onsite areas designated or formerly designated as restricted areas as defined in 10 CFR 20.3(a)(14) or 20.1003.
- Onsite areas, other than restricted areas, where radioactive materials in quantities greater than the amounts listed in Appendix C to 10 CFR 20.1001-20.2401 have been used, possessed, or stored.
- Onsite areas, other than restricted areas, where spills or other unusual occurrences involving the spread of contamination in and around the facility, equipment, or site have occurred that required reporting pursuant to 10 CFR 30.50(b)(1) or (b)(4), including areas where subsequent cleanup procedures have removed the contamination.
- Specific locations and radioisotope contents of previous and current burial areas within the site, excluding radioactive material with half-lives of 10 days or less,

depleted uranium used only for shielding or as penetrators in unused munitions, or sealed sources authorized for use at temporary job sites.

- Location and description of all contaminated equipment involved in the licensed operations that is to remain onsite after license termination.

SECTION 3

SECTION 3

IDENTIFICATION OF RADIOISOTOPES USED AND POTENTIAL DAUGHTER PRODUCTS

Radiological records obtained from the Fitzsimons RPO and CHPPM were reviewed to identify the radioisotopes that were used, stored, or disposed of at Fitzsimons. This section identifies the sources of the information used to identify the radioisotopes that were likely to be present at Fitzsimons over its operational history. Section 3.1 discusses the records reviewed that relate to the overall possession and usage of radioisotopes at Fitzsimons. Section 3.2 addresses specific information related to the use and handling of sealed sources. Section 3.3 provides a summary of the sealed and unsealed radioisotopes suspected to have been used and addresses the potential daughter products associated with these radioisotopes. The information obtained in the development of this section was also used as the basis for determining the areas in which specific radioisotopes were used.

3.1 OVERALL LIST OF RADIOISOTOPES USED AT FITZSIMONS

The radioisotopes identified in the documents reviewed are summarized in Table 3.1. Details regarding the historical documents reviewed and the results of this review are listed below. Radioisotopes listed in the waste disposal logs that are daughter products of the radioisotopes that were used were not included in Table 3.1. The identification of daughter products is provided in Section 3.3.

- The Atomic Energy Commission/NRC licenses span the longest time period for any historical document from 1956 to 1996. The licenses and amendments that were issued prior to 1975 were more specific about the types of radioisotopes used. Starting in 1964, general radioisotope uses were included as part of the license. For example, from 1964 to 1985, byproduct materials (any form) with Atomic Numbers 1 through 83 were allowed to be used for laboratory research in-vitro and in lower animals. After 1985, the authorized usage of these byproduct materials was expanded to include medical research, diagnosis, and therapy in addition to in-vitro studies and studies in laboratory animals. Between 1975 and 1985, the license allowed the possession and use of radioisotopes listed in Groups I through VI of 10 CFR 35.100, Schedule A. [NOTE: Authorization for Group I and II radioisotopes began in 1969.] Finally, starting in 1986, byproduct materials with Atomic Numbers 4 through 84 were allowed to be possessed and used as sealed sources. Although the license allowed the possession and use of a broad category of byproduct materials, the radioisotopes that were specifically identified in the Atomic Energy Commission/NRC licenses

TABLE 3.1
SITE WIDE RADIOISOTOPE/RADIOACTIVE MATERIAL INVENTORIES
HISTORICAL SURVEY REPORT
FITZSIMONS ARMY MEDICAL CENTER
AURORA, COLORADO

Radioisotope or Radioactive Material	AEC/NRC Licenses (1956-1996)	Radioactive Material SOP (1961)	Liquid/Sewage Disposal Records (1961-1974)	Landfill 5 Disposal Records (1961-1962)	Radiological Inventory Records (1968-1995)	Radioisotope Receipt Records (1974-1986)	EBS Site-Wide Inventory (1994)
H-3	●	●	●	●	●	●	●
Be-7		●					
B-12						●	
C-14 [1]	●	●	●	●	●	●	●
Na-22		●	●		●	●	
Na-24	●						
Mg-28	●						
P-32	●	●	●		●	●	●
S-35	●	●	●	●	●		
Cl-36					●		
K-42	● [3]						
Ca-45	●	●	●		●	●	
Ca-47	●		●				
Cr-51	●	●	●		●	●	●

TABLE 3.1 (Continued)
SITE WIDE RADIOISOTOPE/RADIOACTIVE MATERIAL INVENTORIES
HISTORICAL SURVEY REPORT
FITZSIMONS ARMY MEDICAL CENTER
AURORA, COLORADO

Radioisotope or Radioactive Material	AEC/NRC Licenses (1956-1996)	Radioactive Material SOP (1961)	Liquid/Sewage Disposal Records (1961-1974)	Landfill 5 Disposal Records (1961-1962)	Radiological Inventory Records (1968-1995)	Radioisotope Receipt Records (1974-1986)	EBS Site-Wide Inventory (1994)
Mn-54					●	●	
Fe-55	●	●	●				
Fe-59	●	●	●		●	●	●
Co-57		●	●		●	●	●
Co-58	●					●	
Co-60	●	●			●		
Ni-63			●		●		●
Cu-64			●				
Zn-65	●	●	●	●	●		
Ga-66						●	
Ga-67					●	●	
Ga-68						●	
Se-75	●	●	●				
Br-82	●	●					

TABLE 3.1 (Continued)
SITE WIDE RADIOISOTOPE/RADIOACTIVE MATERIAL INVENTORIES
HISTORICAL SURVEY REPORT
FITZSIMONS ARMY MEDICAL CENTER
AURORA, COLORADO

Radioisotope or Radioactive Material	AEC/NRC Licenses (1956-1996)	Radioactive Material SOP (1961)	Liquid/Sewage Disposal Records (1961-1974)	Landfill 5 Disposal Records (1961-1962)	Radiological Inventory Records (1968-1995)	Radioisotope Receipt Records (1974-1986)	EBS Site-Wide Inventory (1994)
Kr-85					●		
Rb-86			●				
Sr-85	●	●	●		●		
Sr-89	●	●	●		●		
Sr-90	●	●	●		●		
Mo-99	●		●		●	●	●
Tc-99m [2]	●				●	●	
Cd-109					●	●	
In-111					●	●	
I-123					●	●	
I-125	●		●		●	●	●
I-129					●		
I-131	●	●	●	●	●	●	●
Xe-133	●				●	●	●

TABLE 3.1 (Continued)
SITE WIDE RADIOISOTOPE/RADIOACTIVE MATERIAL INVENTORIES
HISTORICAL SURVEY REPORT
FITZSIMONS ARMY MEDICAL CENTER
AURORA, COLORADO

Radioisotope or Radioactive Material	AEC/NRC Licenses (1956-1996)	Radioactive Material SOP (1961)	Liquid/Sewage Disposal Records (1961-1974)	Landfill 5 Disposal Records (1961-1962)	Radiological Inventory Records (1968-1995)	Radioisotope Receipt Records (1974-1986)	EBS Site-Wide Inventory (1994)
Cs-137	●				●	●	
Ba-133					●	●	
Ce-141	● [3]		●				
Gd-153	●				●		
Yb-169	● [3]		●				
Ir-192	●				●	●	
Au-198	●		●	●			
Hg-197	●					●	
Hg-203	●		●				
Tl-201					●	●	
Po-210					●		
Ra-226					●		
Am-241	●				●		
Thorium Nitrate							●

TABLE 3.1 (Continued)
SITE WIDE RADIOISOTOPE/RADIOACTIVE MATERIAL INVENTORIES
HISTORICAL SURVEY REPORT
FITZSIMONS ARMY MEDICAL CENTER
AURORA, COLORADO

Radioisotope or Radioactive Material	AEC/NRC Licenses (1956-1996)	Radioactive Material SOP (1961)	Liquid/Sewage Disposal Records (1961-1974)	Landfill 5 Disposal Records (1961-1962)	Radiological Inventory Records (1968-1995)	Radioisotope Receipt Records (1974-1986)	EBS Site-Wide Inventory (1994)
Uranyl Acetate/Nitrite							●
Irradiated Food				●			

NOTES:

1 Records indicate that items containing C-14 were also incinerated between November 12 through 14, 1961.
2 Depleted uranium was used as a shielding material for the Tc-99m generators.
3 Authorization for the radioisotope was specifically identified for usage on Pikes Peak.

and amendments were considered to represent the actual usage at Fitzsimons; especially between 1956 and 1975. Other radioisotopes were retained in Table 3.1 if their usage was documented in one of the other sources.

- The U.S. Army Medical Research and Nutrition Laboratory *Procedures for Use of Radioactive Materials,* dated October 25, 1961, was considered to be a good historical reference to confirm the radioisotopes that were used during the early days of the license. Except for Be-7, the radioisotopes listed in the procedure are consistent with the authorized radioisotopes for 1961.

- A hand-written log was reviewed which provided radiological material disposal information (including date, quantity, and radioisotope) for the Radioisotope Section. The log contains entries for wastewater that were discharged to the onsite sewer system via "hot sinks," radioactive waste that was placed into the onsite burial grounds (Landfill No. 5), and C-14 waste that was incinerated. Each log entry includes the date of disposal, responsible investigator, radioisotope, type of material, quantity, activity, and initials of the disposer. The wastewater discharge records span from 1961 to 1974. The burial ground disposal portion of the log appears to include all items that were placed into disposal area (Landfill No. 5). The incineration records are limited to the dates of November 12 through 14, 1961. Other records on file also indicate that incineration was only used for waste containing C-14 for a short period of time. This disposal log is considered to be representative of the radioisotopes that were used by the Radioisotope Section from 1961 to 1974.

- Each Division at Fitzsimons was responsible for maintaining an inventory of radioisotopes. The radioisotopes identified on the available inventory reports are summarized in Table 3.1.

- Based on the various records outlining Fitzsimons procedures, radioisotopes were received at a centralized location prior to being distributed to the various Departments. A hand written radioisotope receipt log for the time period covering 1974 to 1986 was reviewed. The information contained in this log includes: date, radioisotope, activity, supplier, and initials of the logger. The Department that actually received the radioisotope was not recorded. Since the log was probably for the entire site, it is believed that some of the radioisotopes listed in the receipt log were exclusively used by the Perinatal Research Center in Building No. 260. Because the activities associated with the Center are conducted under a separate State of Colorado license, these radioisotopes were not included as part of the decommissioning effort. For example, Sc-46, Nb-95, and Sn-113 were only noted on inventory reports for the Perinatal Research Center (Building No. 260). As such, these radioisotopes were eliminated from future consideration in this historical survey report. Professional judgment was also exercised on incomplete, illegible, and questionable entries. For example, Co-53, Co-67, and Ga-63 are believed to be misentries. These radioisotopes were included in the receipt logs one time and the use of these radioisotopes can not be confirmed by any other documents. These misentries are believed to be for Co-58, Co-57, and Ga-68 which were regularly used at Fitzsimons. Other

misentries include Tc-201, Tl-21 and Th-201 which are surmised to be Tl-201; and Fe-133 which is likely to be Xe-133. Finally, the entries for Np-59 were determined to be I-131. Np-59 is the trade name for I-131, iodomethylnorchestesterol that was obtained from the University of Michigan, Nuclear Pharmacy Department. The results of this evaluation and screening are also summarized in Table 3.1.

- The 1994 site-wide inventory of chemical compounds presented in the EBS was reviewed. The radioisotopes identified in this inventory are summarized in Table 3.1.

The above-mentioned historical records provide overlapping documentation for the radioisotopes from independent sources. Therefore, the list of radioisotopes presented in Table 3.1 is considered to be representative of the operational history of Fitzsimons. The overlaps of the radioisotope inventories from the various documents appear to be consistent with each other.

3.2 SEALED SOURCES

Various sealed sources have been used at Fitzsimons for analytical instrument operations, checks, and calibrations and as radiation therapy implants. Some of the key license conditions for the use and management of these sealed sources are listed below.

- As a condition of License 05-00046-13, each sealed source containing byproduct material, other than H-3, with a half-life greater than 30 days and in any form other than gas, had to be tested for leakage and/or contamination at intervals not to exceed 6 months. The sealed sources also could not be transferred or placed into use without a current leak test. If the leak test revealed the presence of 0.005 μCi or more of removable contamination, the sealed source was to be immediately withdrawn from use for decontamination, repair, or disposal, and a report was to be filed with the Atomic Energy Commission/NRC. The above-mentioned leak test requirement was included as a condition of the original license issued to Fitzsimons in 1964, as well as all subsequent amendments.

- Amendment No. 34, approved in June 1974, exempted sealed sources that contain 100 mCi or less of beta- and/or gamma-emitting material or less than 10 mCi of alpha-emitting material from the leak testing requirements.

- Amendment No.45, approved in August 1986, allowed Fitzsimons to dispose of sealed-source leak test records following NRC inspections (NRC inspections were most recently performed in 1994, 1995, 1996).

- Amendment No. 56, approved in July 1995, changed the frequency for leak testing sealed sources that emit alpha particles from every 6 months to every 3 months. Amendment No. 56 also added a new condition requiring that a physical inventory be conducted every 3 months to account for all sources and/or devices received and possessed pursuant to 10 CFR 35.59, 35.400 and 35.500; and every 6 months for all other sources and/or devices.

Available inventory, leak test, and incident records were reviewed to determine the locations where sealed sources were used and to assess whether the radioisotopes associated with these sealed sources need to be included as part of subsequent surveys. Prior to 1989, actual inventory reports and leak test results could not be located. It is believed that these records may have been disposed of as provided by Amendment No. 45. However, various RCC meeting minutes prior to 1989 indicate that inventories and leak tests of sealed sources were performed in accordance with the license. Neither the RCC meeting minutes nor the incident report files indicate that a sealed source had leaked. After 1989, the following inventory records, given by date, were available for review:

3/89	2/93	3/94	3/95	12/95
7/91	6/93	6/94	6/95	3/96
6/92	9/93	9/94	9/95	6/96
12/92	12/93	12/94	10/95	9/96

The log numbers used to inventory the sealed sources were not sequential and a master log was not maintained to determine the log number that was assigned to each sealed source. Only the current inventory of sealed sources is tracked and reported. Once a sealed source is shipped offsite, the log number is dropped from the inventory reports. The above listed inventory reports do not indicate that any of the sealed sources leaked during this time period. Table 3.2 summarizes the information contained in the inventory reports by identifying the location of the sealed sources by Department. In addition to the radioisotopes listed in this table, records indicate that Ir-192 seeds were used as a sealed implant by the Radiation Therapy Department. Radium needles were also likely used as radiation therapy sources between the mid-1940s to the early-1980s.

Starting in March 1991, individual inventory cards were established to track each sealed source and to document that leak test results were below the 0.005 μCi criterion. When a sealed source was shipped offsite, the inventory card was removed from the log notebook and either filed with the shipping/disposal papers or transferred with the sealed source to the licensed recipient. Although the inventory records, leak test results, and disposition for old sealed sources can be ascertained, the inventory cards were not maintained in a central location and the present inventory reports only track sealed sources that are currently present at Fitzsimons.

Eight sealed source log numbers were randomly chosen to determine the completeness of the inventory records and associated leak test results. The sealed sources chosen and the results of the record search are listed below.

- **HP#12.** This log number was not uniquely assigned to a single sealed source. Instead, this log number was originally assigned to the Norland Bone Densitometer (Model #178A591A) that was located in Nuclear Medicine (Building No. 511W). This device contained an I-125 sealed source with an activity around 200 mCi which was under a metal surface where the patient lays his arm. The I-125 source was periodically replaced due to radioactive decay of the source. The same log number was used to track all of the I-125 sources used

TABLE 3.2
LOCATION OF SEALED SOURCES BY DEPARTMENT
MARCH 1989 TO JULY 1996
HISTORICAL SURVEY REPORT
U.S. ARMY GARRISON, FITZSIMONS
AURORA, COLORADO

Radioisotope	Count Laboratory (Building No. 600, Room 131/131A)	Clinical Investigations (Building No. 600, Room 110)	Waste Storage (Building No. 603, Room 151/158)	Nuclear Medicine (Building No. 511W, Room 127/145A)	RIA Pathology[a/]	Radiation Therapy[b/]	CHPPM (Building No. 602, Rooms W212, W213, and W215)
H-3	●	●					●
C-14	●	●	●				
Na-22	●		●	●			
Cl-36	●		●				
Mn-54	●		●	●			
Co-57	●		●	●	●		
Co-60	●		●	●		●	
Ni-63		●					●
Kr-85			●				
Sr-90						●	
Tc-99m			●				
Cd-109	●		●	●			
I-125	●		●	●			
I-129	●	●	●	●	●		

TABLE 3.2 (Continued)
LOCATION OF SEALED SOURCES BY DEPARTMENT
MARCH 1989 TO JULY 1996
HISTORICAL SURVEY REPORT
U.S. ARMY GARRISON, FITZSIMONS
AURORA, COLORADO

Radioisotope	Count Laboratory (Building No. 600, Room 131/131A)	Clinical Investigations (Building No. 600, Room 110)	Waste Storage (Building No. 603, Room 151/158)	Nuclear Medicine (Building No. 511W, Room 127/145A)	RIA Pathology[a/]	Radiation Therapy[b/]	CHPPM (Building No. 602, Rooms W212, W213, and W215)
Cs-137[c/]	●	●	●	●	●	●	
Ba-133	●	●	●	●			
Gd-153	●		●	●			
Po-210		●					
Ra-226	●	●				●	
Uranium			●				
Am-241	●						

a/ Sealed sources were either located in Building No. 600, first floor-east or Building No. 511W, Rooms 127 or 135A, based on the areas that were occupied by RIA Pathology.

b/ Radiation therapy sealed sources were originally stored in the basement of Building No. 500 in Teletherapy treatment unit area. The sealed sources were also stored in a safe located in Radiology (Building No. 500, Room 3118).

c/ Sealed Cs-137 sources were also stored in radiation meter storage areas, including Building No. 403, Room 212; Building No. 404, second floor-west; and Building No. 600, Rooms 117 and 124.

in bone densitometer testing until 1993. After 1993, a subnumbering system (e.g., 12a, 12b, etc.) was used to track each individual source. Since these log numbers were not always uniquely assigned, determining which tracking and leak test results are associated with each individual I-125 sealed source is not possible prior to 1993. However, none of the results indicate that any of these sources leaked.

- **HP#23.** This log number is for a Cs-137 sealed source that was manufactured by the 3M Corporation and used in the Count Laboratory (Building No. 600, Room 131/131A). This source was received at Fitzsimons in June 1988 and had an initial activity of 64.9 mCi. This source was shipped offsite for disposal by the Industrial Operations Command (IOC) (formerly U.S. Armament, Munitions and Chemical Command [AMCCOM]) in October 1995. Quarterly leak tests that were conducted between March 1991 and June 1995 are documented on the inventory control card. As discussed above, leak test documentation prior to March 1991 was not located in the files. None of the results indicate that any of this source leaked.

- **HP#58.** This log number is for a Co-57 sealed source that was used by Nuclear Medicine (Building No. 511W) and the Count Laboratory (Building No. 600, Room 131/131A). This source was received at Fitzsimons in February 1986 and had an initial activity of 0.093 μCi. This source was transferred to the Ft. Carson RPO Office in January 1993. Because Co-57 is an accelerator material, this sealed source was regulated pursuant to DARA license 05-01-84. The inventory of this source was recorded quarterly on the inventory control card; leak testing of this source was not conducted.

- **HP#66.** This log number is for a Co-60 sealed source for a disk source that was used in Nuclear Medicine (Building No. 511W). This source was received at Fitzsimons in October 1983 and had an initial activity of 1.08 μCi. Because this source is exempt from the leak test requirements, there are no documented leak test results. This source was transferred to Building No. 603 in May 1995 and was shipped offsite for disposal by IOC in October 1995.

- **HP#118.** This log number is for a Cs-137 sealed source that was manufactured by the 3M Corporation and used by Radiation Therapy (Building No. 500). This source was received at Fitzsimons in April 1986 and had an initial activity of 67.3 mCi. This source was shipped offsite for disposal in December 1995. Quarterly leak tests that were conducted between March 1991 and December 1995 are documented on the inventory control card. As discussed above, leak test documentation prior to March 1991 was not located in the files. None of the results indicate that this source leaked.

- **HP#178.** This log number is for a H-3 sealed source that was used as a calibration standard in the Count Laboratory (Building No. 600, Room 131/131A). This source was received at Fitzsimons in November 1991 and had an initial activity of 0.2 μCi. As of June 1996, this source was still onsite in the laboratory. Pursuant to the license conditions, H-3 sealed sources do not need to

be leak tested. The inventory of this source was recorded quarterly on the inventory control card.

- **HP#407.** This log number is for a H-3 sealed source in the form of a normalization plate that is located in Clinical Investigations (Building No. 600, Room 110). This source was received at Fitzsimons in August 1992 and had an initial activity of 15 μCi. As of June 1996, this source was still onsite in Clinical Investigations. Pursuant to the license conditions, H-3 sealed sources do not need to be leak tested. The inventory of this source is recorded quarterly on the inventory control card.

- **Iridium-192 Seeds.** In August 1976, Ir-192 seeds (0.46 mg Radium equivalent per seed) were received at Fitzsimons. The conditions of the NRC license indicate that the Ir-192 seeds were used as implants for treating patients. These implants would have been used by Radiation Therapy (Building No. 500). The Ir-192 sources are not included on inventory reports or control cards since these sources were shipped offsite prior to 1989.

Based on the review of the available Fitzsimons records, a chronology of the significant occurrences and historical events regarding sealed sources is listed below.

1988 {Reference: Memo from Major Ronald R. Bresell (Fitzsimons RPO) dated September 20, 1988}

Several check sources were discovered while cleaning under a sink in Building No. 603. The sources appear to have been intended for disposal in October 1985 but were overlooked. These sources included:

Radioisotope	Description	Date	Activity (μCi)
C-14	Amersham Model 18820 (4 sets)	1970	0.1
C-14	Nuclear R-20	NA	NA
Na-22	Amersham Model 18820 (4 sets)	1970	10
Cl-36	Amersham Model 18820 (4 sets)	1970	0.4
Co-60	Picker Model 658-135	1970	NA
Cs-137	Nuclear	NA	NA
Cs-137	Picker Model 251-194	1970	1
Cs-137	Picker Model 658-194	1970	1
Cs-137	Nuclear RT-2	1960	0.49

1995 {Reference: October 1995 RCC meeting minutes dated January 3, 1996.}

In May/June 1995, Cs-137 and Gd-153 sources were misplaced. These items were accidentally sent to Fitzsimons' warehouse on Norm Street instead of to Building No. 511W. The sources were recovered and delivered to their proper location.

1995 {Reference: Memo dated October 17, 1995.}

The Radiation Therapy Department (Building No. 500) requested permission to transfer their Cs-137 sealed sources (total activity of 967.65 mCi) to the RPO.

1995 {Reference: RPO Quarterly Report for 4Q95, dated January 3, 1996.}

A Co-57 sealed source thought to be lost on November 2, 1995 was located by Nuclear Medicine personnel on December 4, 1995. The sealed source was located in the "hot" lab (Building No. 511A, Room 145A) underneath a lead brick. A written report regarding the incident is on file with the RPO.

1996 {Reference: September 1996 Sealed Source Inventory Report}

As of September 1996, most of the sealed sources have been shipped offsite. The remaining 34 sealed sources are check sources that are actively being used in Building No. 600, Rooms 110 and 131/131A; and Building No. 602, Rooms W212, W213, and W215. One additional sealed source is being stored in Building No. 603, Room 151 awaiting offsite shipment.

3.3 RADIOISOTOPE USAGE AND DAUGHTER PRODUCTS

Information from inventory reports, Atomic Energy Commission/NRC licenses, and other records was used to compile a list of radioisotopes that may have been used at Fitzsimons. The sealed and unsealed radioisotopes and radioactive materials that are suspected to have been used within the facilities to be decommissioned are summarized in Table 3.3. In cases where the form of the radioisotope (e.g., sealed versus unsealed) could not be determined, it was assumed that the radioisotope was used in an unsealed form. This assumption is a conservative approach for developing the survey and decommissioning plans. Historical documents also indicate that food irradiated with spent fuel was used at Fitzsimons for research studies. Neither the licenses nor other historical records provide documented evidence that spent fuel was ever used onsite. As such, radioisotopes that are components of spent fuel are not included in Table 3.3. General survey and radiation dose measurements will be used to verify that spent fuel components are not present onsite.

As required in the NRC guide entitled, *Working Draft Regulatory Guide on Release Criteria for Decommissioning: NRC Staff's Draft for Comment (NUREG-1500)*, ingrowth of daughter products needs to be considered in determining the total effective dose equivalent for any residual radioactivity remaining onsite. This guide also states that, "Ingrowth of decay products ... need not be considered beyond 1000 years

TABLE 3.3
USAGE OF SUSPECTED RADIOISOTOPES AND RADIOACTIVE MATERIALS
HISTORICAL SURVEY REPORT
U.S. ARMY GARRISON, FITZSIMONS
AURORA, COLORADO

Radioisotope or Radioactive Material \a	Sealed Sources	Unsealed Sources
H-3	•	•
Be-7		•
B-12		•
C-14	•	•
Na-22	•	•
Na-24		•
Mg-28		•
P-32		•
S-35		•
Cl-36	•	
K-42 \b		•
Ca-45		•
Ca-47		•
Cr-51		•
Mn-54	•	
Fe-55		•
Fe-59		•
Co-57	•	•
Co-58		•
Co-60	•	•
Ni-63	•	•
Cu-64		•
Zn-65		•
Ga-66		•
Ga-67		•
Ga-68		•
Se-75		•
Br-82		•
Kr-85	•	
Rb-86		•

Radioisotope or Radioactive Material \a	Sealed Sources	Unsealed Sources
Sr-85		•
Sr-89		•
Sr-90	•	•
Mo-99		•
Tc-99m	•	•
Cd-109	•	
In-111		•
I-123		•
I-125	•	•
I-129	•	
I-131		•
Xe-133		•
Cs-137	•	
Ba-133	•	
Ce-141 \b		•
Gd-153	•	•
Yb-169 \b		•
Ir-192	•	
Au-198	•	•
Hg-197		•
Hg-203		•
Tl-201		•
Po-210	•	
Ra-226	•	•
Am-241	•	
Thorium \c		•
Uranium \d	•	•

\a Irradiated food was also present at Fitzsimons; however, no radioisotopes are associated with this material.

\b Radioisotopes were only authorized for use on Pikes Peak.

\c Thorium nitrate was used by DCI. Potential radioisotopes associated with this material includes Th-229, Th-230, and Th-232.

\d Depleted uranium was used as a shielding material for the Tc-99m generators. A sealed uranium source is also being stored in Building 603. Uranyl acetate and uranyl nitrate were used for electron microscope staining in Pathology (Buildings 500 and 601). Potential radioisotopes associated with these materials include U-234, U-235, and U-238.

because of the large uncertainties associated with predicting conditions that far into the future." To assess the potential for ingrowth, the daughter products for each suspected radioisotope used at Fitzsimons was compiled and presented in Table 3.4. The more complex decay chains associated with radium, thorium, uranium, and americium are presented graphically in Figures 3.1 to 3.4.

The entire list of parent and daughter radioisotopes that may have been present at Fitzsimons is given in Table 3.5. Six screening criterion were established to eliminate 1) parent radioisotopes that have short half-lives (e.g., less than 10 days), 2) parent radioisotopes or daughter products that would no longer be present at the site due to last documented usage and radioactive decay, 3) parent radioisotopes or daughter products that are in forms (e.g., inert gases or sealed sources) that would not have been deposited on surfaces as a radioactive contaminant, 4) parent radioisotopes that are present in limited quantities that would not significantly contribute to the overall residual dose, 5) daughter products that would not be present because of limited ingrowth over the 1000-year time period, and 6) daughter products that would not likely be detected because their decay chain yields (e.g., the amount of the daughter product generated per unit of parent radioisotope) are low. The application and results of the above screening criteria are presented in the following paragraphs.

- **Criterion 1:** Parent radioisotopes and associated decay chains with a combined half-life less than 10 days were eliminated from consideration. These radioisotopes decay into stable compounds in a short period of time (about 100 days). The basis for selecting the 10-day half-life period stems from License 05-00046-13, Amendment No. 57. The transmittal letter for this amendment indicates that radioactive material with half-lives of 10 days or less do not need to be considered in the decommissioning process. Given the amount of time that has past since deactivation of the site in July 1996, these radioisotopes are not expected to be present. The radioisotopes and associated daughter products eliminated from the application of this criterion includes: B-12, Na-24, Mg-28, Al-28, K-42, Ca-47, Sc-47, Cu-64, Ga-66, Ga-67, Ga-68, Br-82, Mo-99, Tc-99m, In-111, I-123, I-131, Xe-133, Au-198, Hg-197, and Tl-201.

- **Criterion 2:** This screening criterion was used to eliminate parent radioisotopes if inventory records indicated that at least 10 half-lives will pass prior to the expected license termination date of October 1998. Available quarterly inventory records were compiled and assessed. Prior to January 1992, the inventory records on file were incomplete and, therefore, inadequate for applying this criterion. Although some of the inventory records are incomplete for all quarters after January 1992, they are sufficiently complete for the suspected radioisotopes that were eliminated based on the application of this criterion. Based on the expected license termination date (October 1998), at least 2465 days will have passed. As such, the inventory records are adequate to screen radioisotopes and associated decay chains with a combined half-life less than 246 days. Table 3.6 summarizes the inventory and screening information for parent radioisotopes and associated decay chains with half-lives between 10 and 246 days. [Note: Radioisotopes with half-lives less than 10 days were not included since they were eliminated under Criterion 1.] The radioisotopes and associated

TABLE 3.4
DAUGHTER PRODUCTS FOR SUSPECTED RADIOISOTOPES
HISTORICAL SURVEY REPORT
U.S. ARMY GARRISON, FITZSIMONS
AURORA, COLORADO

Parent Radioisotope	Form [a]	Parent Half-life [b]	Daughter Radioisotope(s) [b]	Daughter Half-life [b]
H-3	S, U	12.35 y	He-3	stable
Be-7	U	53.6 d	Li-7	stable
B-12	U	0.0203 s	C-12	stable
C-14	S, U	5730 y	N-14	stable
Na-22	S, U	2.602 y	Ne-22	stable
Na-24	U	14.96 h	Mg-24	stable
Mg-28	U	21.2 h	Al-28 Si-28	2.31 m stable
P-32	U	14.29 d	S-32	stable
S-35	U	87.44 d	Cl-35	stable
Cl-36	S	3.01e5 y	a) S-36 (1.9 %) b) Ar-36 (98.1%)	stable stable
K-42	U	12.36 h	Ca-42	stable
Ca-45	U	163 d	Sc-45	stable
Ca-47	U	4.53 d	Sc-47 Ti-47	3.351 d stable
Cr-51	U	27.704 d	V-51	stable
Mn-54	S	312.5 d	Cr-54	stable
Fe-55	U	2.7 y	Mn-55	stable
Fe-59	U	44.529 d	Co-59	stable
Co-57	S, U	270.9 d	Fe-57	stable
Co-58	U	71.3 d	Fe-58	stable
Co-60	S, U	5.271 y	Ni-60	stable
Ni-63	S, U	96 y	Cu-63	stable
Cu-64	U	12.701 h	a) Ni-64 (62.8 %) b) Zn-64 (37.2 %)	stable stable
Zn-65	U	243.9 d	Cu-65	stable
Ga-66	U	9.45 h	Zn-66	stable
Ga-67	U	3.261 d	Zn-67	stable

TABLE 3.4 (Continued)
DAUGHTER PRODUCTS FOR SUSPECTED RADIOISOTOPES
HISTORICAL SURVEY REPORT
U.S. ARMY GARRISON, FITZSIMONS
AURORA, COLORADO

Parent Radioisotope	Form [a]	Parent Half-life [b]	Daughter Radioisotope(s) [b]	Daughter Half-life [b]
Ga-68	U	68.3 m	Zn-68	stable
Se-75	U	119.8 d	As-75	stable
Br-82	U	35.34 h	Kr-82	stable
Kr-85	S	10.72 y	Rb-85	stable
Rb-86	U	18.66 d	Sr-86	stable
Sr-85	U	64.84 d	Rb-85	stable
Sr-89	U	50.5 d	Y-89	stable
Sr-90	S, U	29.12 y	Y-90 Zr-90	64 h stable
Mo-99	U	66 h	a) Tc-99m (87.6 %) Tc-99 Ru-99 b) Tc-99 (12.4 %) Ru-99	6.02 h 2.13e5 y stable 2.13e5 y stable
Tc-99m	S, U	6.02 h	Tc-99 Ru-99	2.13e5 y stable
Cd-109	S	464 d	Ag-109	stable
In-111	U	2.83 d	Cd-110	stable
I-123	U	13.2 h	a) Te-123m (5e-3 %) Te-123 Sb-123 b) Te-123 (99.99 %) Sb-123	119.7 d 1e13 y stable 1e13 y stable
I-125	S, U	60.14 d	Te-125	stable
I-129	S	1.57e7 y	Xe-129	stable
I-131	U	8.04 d	a) Xe-131m (1.11 %) Xe-131 b) Xe-131 (98.89 %)	11.9 d stable stable
Xe-133	U	5.245 d	Cs-133	stable

TABLE 3.4 (Continued)
DAUGHTER PRODUCTS FOR SUSPECTED RADIOISOTOPES
HISTORICAL SURVEY REPORT
U.S. ARMY GARRISON, FITZSIMONS
AURORA, COLORADO

Parent Radioisotope	Form [a]	Parent Half-life [b]	Daughter Radioisotope(s) [b]	Daughter Half-life [b]
Cs-137	S	30 y	a) Ba-137m (94.6 %) Ba-137 b) Ba-137 (5.4 %)	2.552 m stable stable
Ba-133	S	10.74 y	Cs-133	stable
Ce-141	U	32.501 d	Pr-141	stable
Gd-153	S, U	242 d	Eu-153	stable
Yb-169	U	32.01 d	Tm-169	stable
Ir-192	S	74.02 d	a) Pt-192 (95.3 %) b) Os-192 (4.7 %)	stable stable
Au-198	S, U	2.696 d	Hg-198	stable
Hg-197	U	65 h	Au-197	stable
Hg-203	U	46.6 d	Tl-203	stable
Tl-201	U	3.044 d	Hg-201	stable
Po-210	S	138.38 d	Pb-206	stable
Ra-226	S, U	1600 y	See Figure 3.1	
Th-229	U	7340 y	See Figure 3.2	
Th-230	U	7.7e4 y	See Figure 3.1	
Th-232	U	1.405e10 y	See Figure 3.3	
U-234	S, U	2.445e5 y	See Figure 3.1	
U-235	S, U	7.038e8 y	See Figure 3.4	
U-238	S, U	4.468e9 y	See Figure 3.1	
Am-241	S	432.2 y	See Figure 3.2	

\a Radioisotope forms, S = sealed source, U = unsealed usage.

\b Half-Lives and decay schemes were taken from *Annals of the ICRP, Radionuclide Transformations, Energy and Intensity of Emissions, ICRP Publication 38* and the *Radiological Health Handbook*, 1970. (Half-lives: y = year, d = day, h = hour, m = minute, s = second, and μs = microsecond.) (Decay chains: Each indent indicates a daughter product of the previous radioisotope. Splits in the decay chain are identified by "a)" and "b)" with the associated yield of the radioisotope provided in parentheses.

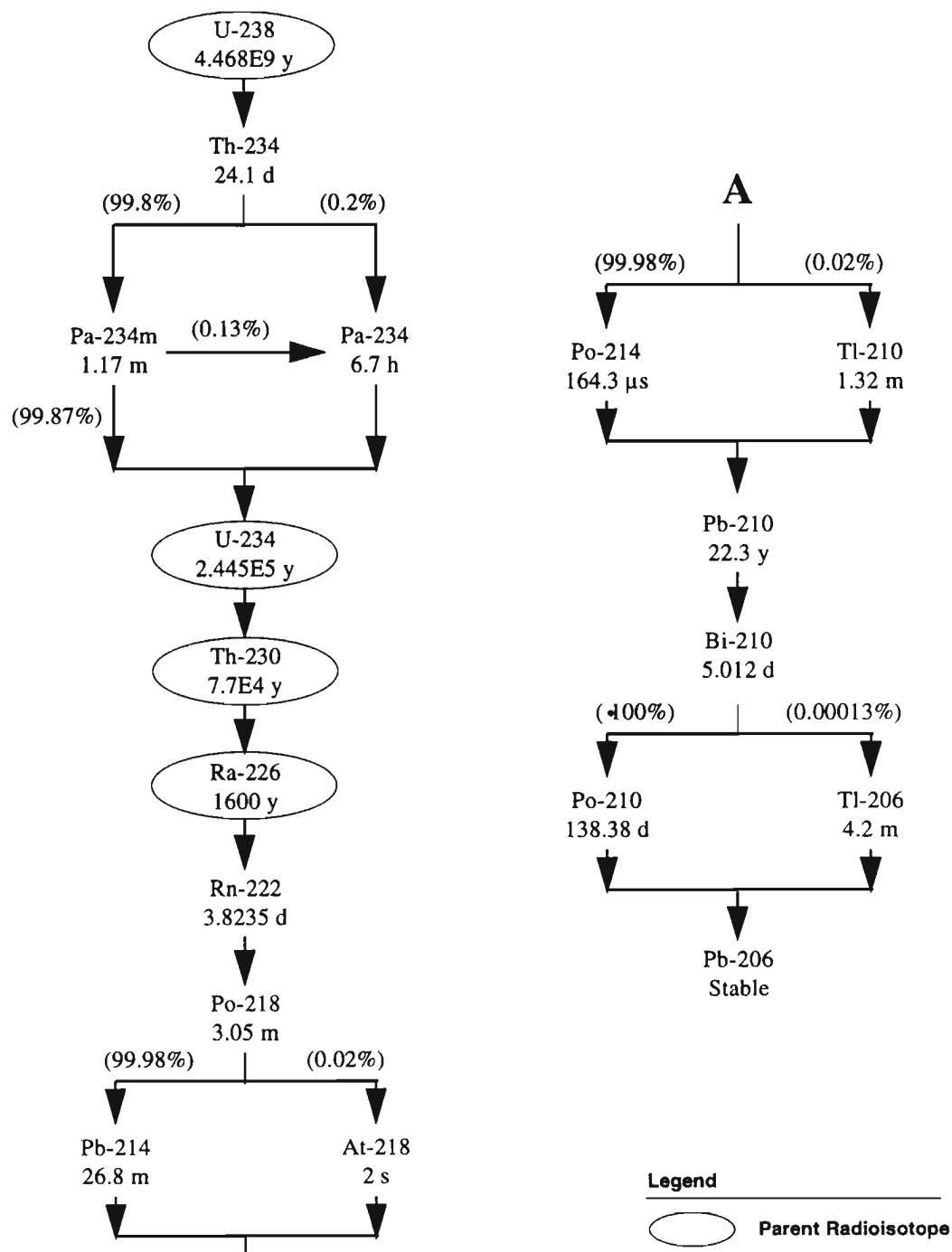

FIGURE 3.1

DECAY CHAINS FOR U-238, U-234, Th-230, AND Ra-226

U.S. Army Garrison, Fitzsimons
Aurora, Colorado

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

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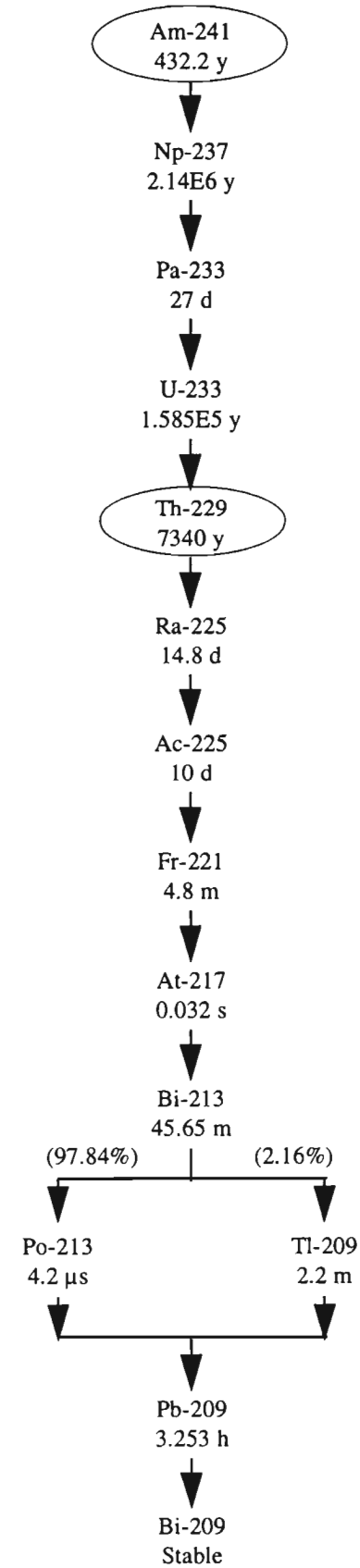

Legend

Parent Radioisotope

FIGURE 3.2

DECAY CHAINS FOR Am-241 AND Th-229

U.S. Army Garrison, Fitzsimons
Aurora, Colorado

PARSONS ENGINEERING SCIENCE, INC.

Denver, Colorado

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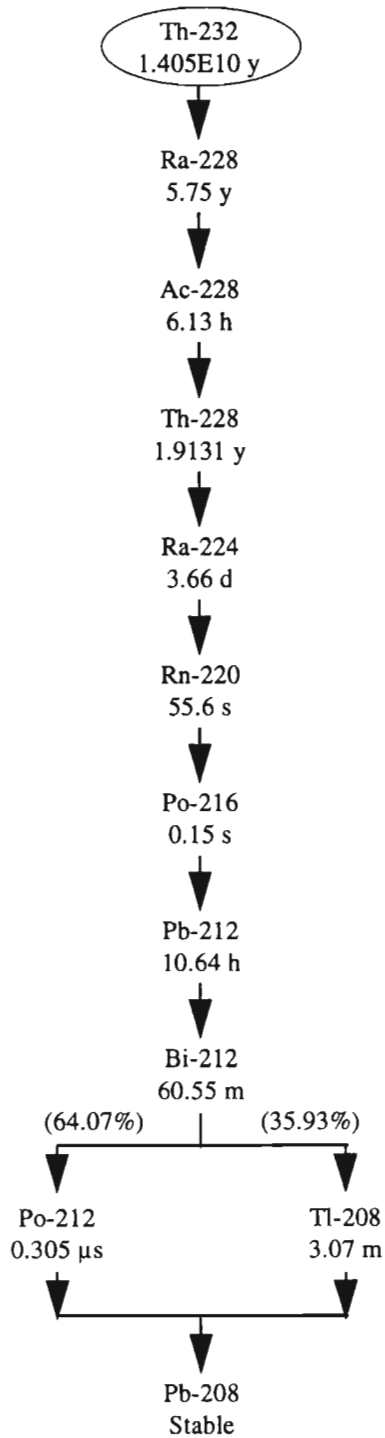

Legend

Parent Radioisotope

FIGURE 3.3

DECAY CHAINS FOR Th-232

U.S. Army Garrison, Fitzsimons
Aurora, Colorado

PARSONS ENGINEERING SCIENCE, INC.

Denver, Colorado

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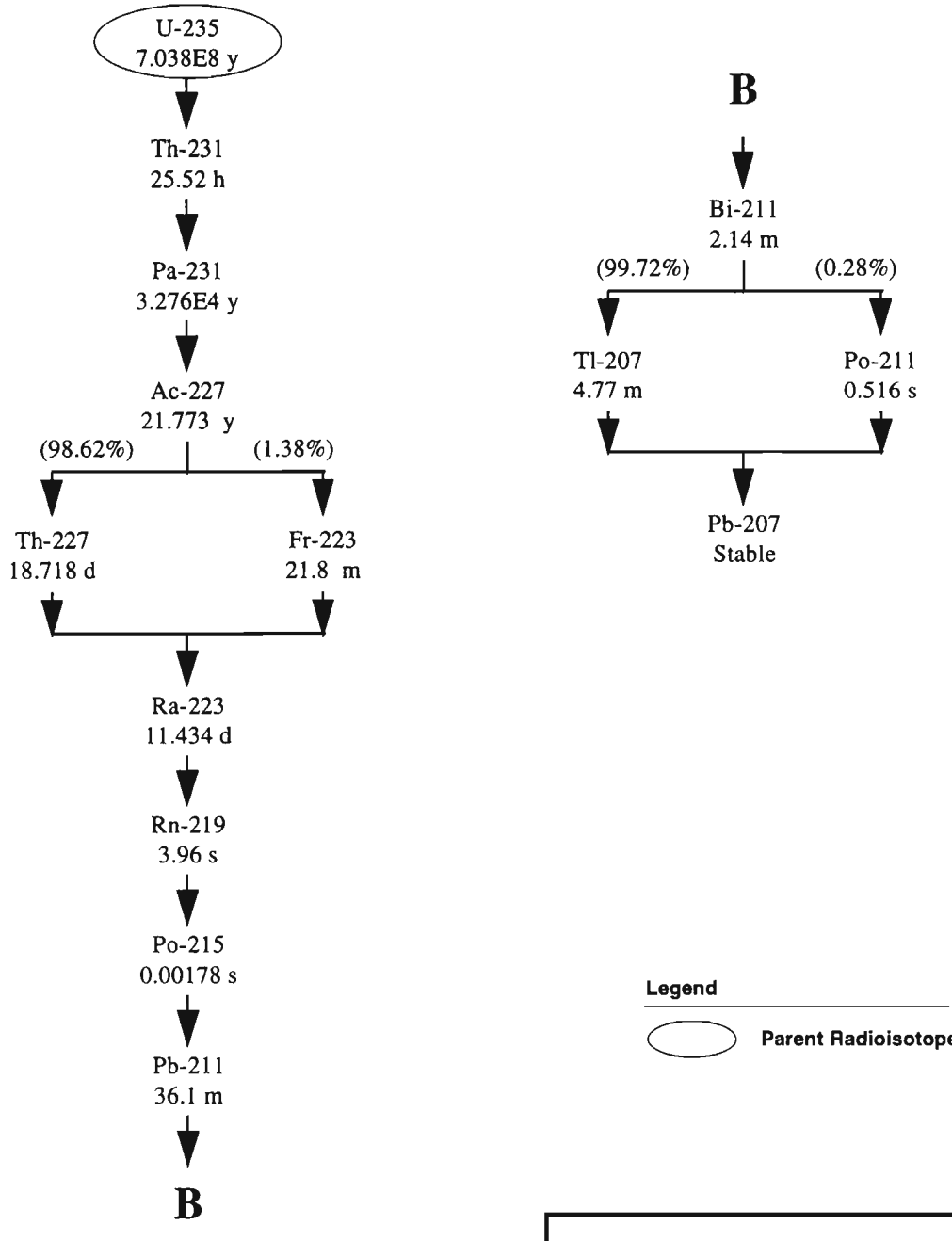

FIGURE 3.4

DECAY CHAINS FOR U-235

U.S. Army Garrison, Fitzsimons
Aurora, Colorado

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

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TABLE 3.5
SUSPECTED RADIOISOTOPES AND DAUGHTER PRODUCTS
HISTORICAL SURVEY REPORT
U.S. ARMY GARRISON, FITZSIMONS
AURORA, COLORADO

Parent Radioisotope	Half-Life[a]
H-3	12.35 y
Be-7	53.6 d
B-12	0.0203 s
C-14	5730 y
Na-22	2.602 y
Na-24	14.96 h
Mg-28	21.2 h
P-32	14.29 d
S-35	87.44 d
Cl-36	3.01e5 y
K-42	12.36 h
Ca-45	163 d
Ca-47	4.53 d
Cr-51	27.704 d
Mn-54	312.5 d
Fe-55	2.7 y
Fe-59	44.529 d
Co-57	270.9 d
Co-58	71.3 d
Co-60	5.271 y
Ni-63	96 y
Cu-64	12.701 h
Zn-65	243.9 d
Ga-66	9.45 h
Ga-67	3.261 d

Parent Radioisotope	Half-Life[a]
Ga-68	68.3 m
Se-75	119.8 d
Br-82	35.34 h
Kr-85	10.72 y
Rb-86	18.66 d
Sr-85	64.84 d
Sr-89	50.5 d
Sr-90	29.12 y
Mo-99	66 h
Tc-99m	6.02 h
Cd-109	464 d
In-111	2.83 d
I-123	13.2 h
I-125	60.14 d
I-129	1.57e7 y
I-131	8.04 d
Xe-133	5.245 d
Cs-137	30 y
Ba-133	10.74 y
Ce-141	32.501 d
Gd-153	242 d
Yb-169	32.01 d
Ir-192	74.02 d
Au-198	2.969 d
Hg-197	65 h

Parent Radioisotope	Half-Life[a]
Hg-203	46.6 d
Tl-201	3.044 d
Po-210	138.38 d
Ra-226	1600 y
Th-229	7340 y
Th-230	7.7e4 y
Th-232	1.405e10 y
U-234	2.445e5 y
U-235	7.038e8 y
U-238	4.468e9 y
Am-241	432.2 y

Daughter Radioisotope	Half-Life[a]
Al-28	2.31 m
Sc-47	3.351 d
Y-90	64 h
Tc-99m	6.02 h
Tc-99	2.13e5 y
Te-123	1e13 y
Te-123m	119.7 d
Xe-131m	11.9 d
Ba-137m	2.552 m
Tl-206	4.2 m

TABLE 3.5 (Continued)
SUSPECTED RADIOISOTOPES AND DAUGHTER PRODUCTS
HISTORICAL SURVEY REPORT
U.S. ARMY GARRISON, FITZSIMONS
AURORA, COLORADO

Daughter Radioisotope	Half-Life[a]
Tl-207	4.77 m
Tl-208	3.07 m
Tl-209	2.2 m
Tl-210	1.32 m
Pb-209	3.253 h
Pb-210	22.3 y
Pb-211	36.1 m
Pb-212	10.64 h
Pb-214	26.8 m
Bi-210	5.012 d
Bi-211	2.14 m
Bi-212	60.55 m
Bi-213	45.65 m
Bi-214	19.9 m
Po-210	138.38 d
Po-211	0.516 s
Po-212	0.305 μs

Daughter Radioisotope	Half-Life[a]
Po-213	4.2 μs
Po-214	164.3 μs
Po-215	0.00178 s
Po-216	0.15 s
Po-218	3.05 m
At-217	0.0323 s
At-218	2 s
Rn-219	3.96 s
Rn-220	55.6 s
Rn-222	3.8235 d
Fr-221	4.8 m
Fr-223	21.8 m
Ra-223	11.434 d
Ra-224	3.66 d
Ra-225	14.8 d
Ra-226	1600 y
Ra-228	5.75 y

Daughter Radioisotope	Half-Life[a]
Ac-225	10 d
Ac-227	21.773 y
Ac-228	6.13 h
Th-227	18.718 d
Th-228	1.9131 y
Th-229	7340 y
Th-230	7.7e4 y
Th-231	25.52 h
Th-234	24.10 d
Pa-231	3.276e4 y
Pa-233	27 d
Pa-234	6.7 h
Pa-234m	1.17 m
U-233	1.585e5 y
U-234	2.445e5 y
Np-237	2.14e6 y

\a Half-Lives from *Annals of the ICRP, Radionuclide Transformations, Energy and Intensity of Emissions, ICRP Publication 38* and the *Radiological Health Handbook*, 1970.
(y = year, d = day, h = hour, m = minute, s = second, μs = microsecond)

TABLE 3.6
RADIOISOTOPES SCREENED FOR CRITERION 2
HISTORICAL SURVEY REPORT
U.S. ARMY GARRISON, FITZSIMONS
AURORA, COLORADO

Radioisotope[a]	Half-Life[b] (days)	Date for 10 Half-Lives to Pass Prior to License Termination (Oct 1998)	Last Documented Inventory Since January 1992	Radioisotope Eliminated?
Be-7	53.6	Apr 1997	None	Yes
P-32	14.29	May 1998	4 Q 94	Yes
S-35	87.44	May 1996	None	Yes
Ca-45	163	Apr 1994	None	Yes
Cr-51	27.704	Dec 1997	3 Q 95	Yes
Fe-59	44.529	Jul 1997	3 Q 93	Yes
Co-58	71.3	Oct 1996	None	Yes
Zn-65	243.9	Jan 1992	None	Yes
Se-75	119.8	Jun 1995	None	Yes
Rb-86	18.66	Mar 1998	None	Yes
Sr-85	64.84	Dec 1996	None	Yes
Sr-89	50.5	May 1997	2 Q 95	Yes
I-125	60.14	Feb 1997	4 Q 95	Yes
I-123 + Te-123m	120.25	Jun 1995	4 Q 95	No
I-131 + Xe-131m	19.94	Mar 1998	3 Q 95	Yes
Ce-141	32.501	Nov 1997	None	Yes
Gd-153	242	Feb 1992	1 Q 93	No
Yb-169	32.01	Nov 1997	None	Yes
Ir-192	74.02	Sep 1996	None	Yes
Hg-203	46.6	Jun 1997	None	Yes
Po-210	138.38	Dec 1994	None	Yes

\a Criterion 2 only includes radioisotopes and associated decay chains with half-lives between 10 and 246 days.

\b Half-lives from *Annals of the ICRP, Radionuclide Transformations, Energy and Intensity of Emissions, ICRP Publication 38* and the *Radiological Health Handbook*, 1970.

daughter products eliminated from the application of this criterion include: Be-7, P-32, S-35, Ca-45, Cr-51, Fe-59, Co-58, Zn-65, Se-75, Rb-86, Sr-85, Sr-89, I-125, Xe-131m, Ce-141, Yb-169, Ir-192, Hg-203, and Po-210.

- **Criterion 3A:** The daughter products are assumed to be co-located with the parent radioisotope, except for inert gases which will migrate to other locations unless encapsulated in a sealed source or trapped within the structure. The inert radioactive gases that may be present at Fitzsimons include krypton, xenon, and radon. These gases were eliminated from consideration unless they could be continuously generated by a parent radioisotope. Kr-85 was eliminated from further consideration since this radioisotope was only present onsite as a sealed source, would be rapidly dispersed if the sealed source leaked, and decays into a stable isotope. Although Xe-131m and Xe-133 were eliminated by Criterion 1 and 2, these radioisotopes would also be eliminated based on this criteria since they would be rapidly dispersed, and decay into a stable isotopes. Although Rn-219, Rn-220, and Rn-222 are inert gases, they were not eliminated since they are daughter products associated with the uranium and thorium decay chains and decay into other radioisotopes that can accumulate and contaminate surfaces.

- **Criterion 3B:** The form of the radioisotope (i.e., sealed versus unsealed) was considered in developing the survey approach and assessing if a particular area should be decommissioned. An inventory control program was implemented to account for sealed sources. Historical records do not indicate that any of the sealed sources used at Fitzsimons leaked. Therefore, dispersion of sealed source material is extremely unlikely and the radioisotopes that were present only as sealed sources were eliminated from further consideration. Although radiochemical analysis for radioisotopes that were present at Fitzsimons only as a sealed source will not be included in the scope of the Survey Plan, field personnel will visually inspect for sealed sources. If uninventoried sealed sources are found, they will be surveyed and tested for leakage to determine the potential for radioactive contamination. The parent radioisotopes and associated daughter products eliminated from the application of this criterion include: Cl-36, Mn-54, Kr-85, Cd-109, I-129, Cs-137, Ba-133, Ba-137m, Ir-192, Po-210, Pa-233, U-233, Np-237, and Am-241.

- **Criterion 4:** Radioisotopes that exist in limited quantities that would not be a significant component of the residual dose, and decay into a daughter product with an extremely long half-life (i.e., extremely small specific activity) were eliminated from consideration. Te-123, a daughter product of I-125, was eliminated from consideration based on this criterion. Since the half-life of Te-123 is about 1×10^{13} years, the calculated activity for one gram of pure Te-123 is less than 300 picoCuries (pCi). Because Te-123 decays into a stable daughter product and has a low specific activity, it will not contribute significantly to the dose from any residual contamination.

- **Criterion 5:** As provided in NUREG-1500, the ingrowth of daughter products beyond 1,000 years does not need to be considered. Based on the suspected parent radioisotopes present, this criterion is applicable only to the radium,

thorium, uranium, and americium decay chains. Because radium, thorium, and uranium were used at Fitzsimons in their natural state, it is assumed that all of their daughter products would also be present in secular equilibrium. As such, these parent radioisotopes and associated daughter products can not be eliminated from consideration. Only Am-241 can be screened under this criteria since it was present as a separated radioisotope. Although Am-241 was previously eliminated under Criterion 3B as a sealed source, its daughter products (Pa-233 and U-233) would not be expected to be present within the 1,000-year time period. However, these radioisotopes would be eliminated because they could not significantly contribute to the overall dose. [Note: Per NUREG/CR-5849, radioisotopes remaining at the time of license termination and that would contribute less than 10 percent of the total radiation dose from all contaminants or that are present at concentrations less than 10 percent of their respective guideline value, are not considered to be significant contaminants.]

- **Criterion 6:** When identifying a parent radioisotope and its daughter products, surveying and sampling for the parent radioisotope will be the preferred method of detection. If appropriate, specific daughter product(s) may be used to determine whether the parent radioisotope and associated decay chain is present. Daughter products that have a yield (e.g., quantity of daughter product generated per quantity of the decayed radioisotope) less than 0.1 percent were considered to be inappropriate for monitoring and were, therefore, eliminated from consideration. The daughter products eliminated from the application of this criterion includes: Tl-206, Tl-210, and At-218.

The radioisotopes and associated daughter products that remain after the application of the above screening criterion are presented in Table 3.7. These radioisotopes will form the basis for future surveying and decommissioning activities.

TABLE 3.7
RETAINED RADIOISOTOPES AND DAUGHTER PRODUCTS
HISTORICAL SURVEY REPORT
U.S. ARMY GARRISON, FITZSIMONS
AURORA, COLORADO

Parent Radioisotope	Half-Life[a]
H-3	12.35 y
C-14	5730 y
Na-22	2.602 y
Ca-47	4.53 d
Fe-55	2.7 y
Co-57	270.9 d
Co-60	5.271 y
Ni-63	96 y
Sr-90	29.12 y
I-125	60.14 d
Gd-153	242 d
Ra-226	1600 y
Th-229	7340 y
Th-230	7.7e4 y
Th-232	1.405e10 y
U-234	2.445e5 y
U-235	7.038e8 y
U-238	4.468e9 y

Daughter Radioisotope	Half-Life[a]
Y-90	64 h
Tc-99	2.13e5 y
Te-123m	119.7 d
Tl-207	4.77 m

Daughter Radioisotope	Half-Life[a]
Tl-208	3.07 m
Tl-209	2.2 m
Pb-209	3.253 h
Pb-210	22.3 y
Pb-211	36.1 m
Pb-212	10.64 h
Pb-214	26.8 m
Bi-210	5.012 d
Bi-211	2.14 m
Bi-212	60.55 m
Bi-213	45.65 m
Bi-214	19.9 m
Po-210	138.38 d
Po-211	0.516 s
Po-212	0.305 μs
Po-213	4.2 μs
Po-214	164.3 μs
Po-215	0.00178 s
Po-216	0.15 s
Po-218	3.05 m
At-217	0.0323 s
Rn-219	3.96 s
Rn-220	55.6 s
Rn-222	3.8235 d
Fr-221	4.8 m

Daughter Radioisotope	Half-Life[a]
Fr-223	21.8 m
Ra-223	11.434 d
Ra-224	3.66 d
Ra-225	14.8 d
Ra-226	1600 y
Ra-228	5.75 y
Ac-225	10 d
Ac-227	21.773 y
Ac-228	6.13 h
Th-227	18.718 d
Th-228	1.9131 y
Th-229	7340 y
Th-230	7.7e4 y
Th-231	25.52 h
Th-234	24.10 d
Pa-231	3.276e4 y
Pa-233	27 d
Pa-234	6.7 h
Pa-234m	1.17 m
U-233	1.585e5 y
U-234	2.445e5 y
Np-237	2.14e6 y

\a Half-Lives from *Annals of the ICRP, Radionuclide Transformations, Energy and Intensity of Emissions, ICRP Publication 38* and the *Radiological Health Handbook*, 1970.
(y = year, d = day, h = hour, m = minute, s = second, μs = microsecond)

SECTION 4

IDENTIFICATION AND HISTORICAL INFORMATION FOR AREAS REQUIRING RADIOLOGICAL SURVEYS

Information pertaining to the specific buildings and areas where radioisotopes were used, stored, or disposed of is provided in the following sections. The specific radioisotopes and locations are based on interviews and the historical records review. Table 4.1 summarizes the building usage and radioisotopes used for each room or area. A floor plan for most of these buildings is presented in Appendix B indicating the floor, wing, and room (as provided) where radioisotopes were used, stored, or disposed of.

Buildings that lacked specific information on the rooms in which radioisotopes may have been used or stored were evaluated based on previous radiological surveys and on room descriptions. Information regarding the type and source (sealed or unsealed) of radioactive material or waste used or stored at Fitzsimons was included when available. Information regarding quantities of radioisotopes received, used, and disposed of was limited prior to 1989.

The criterion for selecting survey and sample locations for buildings/rooms is based on whether the building or room is designated as a potentially contaminated area (e.g., "affected"), an area that is expected to be uncontaminated (e.g., "unaffected"), but is immediately adjacent to an affected area, or an area whose contamination status is not known (e.g., "indeterminate"). NUREG/CR-5849 defines an "affected area" as "Areas that have potential radioactive contamination (based on plant operating history) or known radioactive contamination (based on past or preliminary radiological surveillance)." By this definition, affected areas normally include areas where radioactive materials were used and stored, where records indicate spills or other unusual occurrences that could have resulted in the spread of contamination, and where radioactive materials were buried. NUREG/CR-5849 defines an "unaffected area" as "all areas not classified as affected." Parsons ES will consider the rooms immediately adjacent to the "affected" rooms as "unaffected" rooms because they are not expected to be radioactively contaminated, but may have become radioactively contaminated if radionuclides migrated into these areas from the adjacent "affected" areas. These areas are not expected to contain residual radioactivity based on a knowledge of site history and previous survey information. Parsons ES has identified "indeterminate areas" for areas where there is not enough historical data available to assess whether the area is affected or unaffected. As an Army base, in addition to having a hospital onsite, most of the building areas were completely outside of the NRC license activities. Parsons ES considers these areas and buildings to be "clean", and they will be outside of the

TABLE 4.1
SUSPECTED RADIOISOTOPE STORAGE AND USE LOCATIONS
HISTORICAL SURVEY REPORT
U.S. ARMY GARRISON, FITZSIMONS
AURORA, COLORADO

Building	Room	Uses	Radiation Designation	Suspected Radioisotopes	
				Unsealed Sources	Sealed Sources
265 [a]	All Rooms	Wastewater Treatment	Indeterminate	H-3, C-14, Na-22, P-32, S-35, Ca-45, Ca-47, Cr-51, Fe-55, Fe-59, Co-57, Ni-63, Cu-64, Zn-65, Se-75, Rb-86, Sr-85, Sr-89, Sr-90, Mo-99, I-125, I-131, Ce-141, Yb-169, Au-198, Hg-203	None Identified
404	Second Floor - West (All Rooms)	RPO Count Laboratory	Indeterminate	None Identified	Tc-99m, I-125, Cs-137
500	1013	Unknown	Indeterminate	None Identified	None Identified
500	1024, 1024A, 1024B	Patient Room - Biachytherapy (Radiation Therapy)	Indeterminate	None Identified	Cs-137, Ir-192
500	1034A, 1034B, 1034C	Unknown	Indeterminate	None Identified	None Identified
500	1074	Nuclear Cardiology	Affected	H-3, Ga-67, Tc-99m, In-111, Tl-201	None Identified
500	1023A, 1026, 1071	Rooms Adjacent to an Affected Area	Unaffected	None Identified	None Identified
500	1142	Unknown	Indeterminate	None Identified	None Identified
500	2030, 2031	Patient Room - Radiation Therapy	Affected	P-32, I-131	Co-60, Sr-90, Cs-137, Ir-192, Au-198, Ra-226

TABLE 4.1 (Continued)
SUSPECTED RADIOISOTOPE STORAGE AND USE LOCATIONS
HISTORICAL SURVEY REPORT
U.S. ARMY GARRISON, FITZSIMONS
AURORA, COLORADO

Building	Room	Uses	Radiation Designation	Suspected Radioisotopes	
				Unsealed Sources	Sealed Sources
500	2055	Patient Room - Radiation Therapy	Affected	P-32, I-131	Co-60, Sr-90, Cs-137, Ir-192, Au-198, Ra-226
500	2058, 2059	Patient Room - Radiation Therapy	Affected	P-32, I-131	Co-60, Sr-90, Cs-137, Ir-192, Au-198, Ra-226
500	2173	Unknown	Indeterminate	Ga-67, Tc-99m, Tl-201	None Identified
500	2202W	Nuclear Cardiology	Affected	In-111, Tc-99m	None Identified
500	2029, 2032, 2052, 2053, 2056A, 2057, 2060, 2201W, 2203W, 2205	Rooms Adjacent to an Affected Area	Unaffected	None Identified	None Identified
500	3113, 3113A, 3113B, 3116, 3117, 3118, 3118B	Radiology	Affected	P-32, Cr-51, Fe-59, Co-60, I-131, Au-198	None Identified
500	3118A	Radiology, Radiation Therapy Sealed Source Safe Storage	Affected	P-32, Cr-51, Fe-59, Co-60, I-131, Au-198	Co-60, Sr-90, Cs-137, Ir-192, Au-198, Ra-226
500	3183	Unknown	Affected	I-131	None Identified
500	3184, 3185	Rooms Adjacent to an Affected Area	Unaffected	None Identified	None Identified

TABLE 4.1 (Continued)
SUSPECTED RADIOISOTOPE STORAGE AND USE LOCATIONS
HISTORICAL SURVEY REPORT
U.S. ARMY GARRISON, FITZSIMONS
AURORA, COLORADO

Building	Room	Uses	Radiation Designation	Suspected Radioisotopes	
				Unsealed Sources	Sealed Sources
500	3110, 3114, 3123, 3123A, 3130, 3130A	Rooms Adjacent to an Affected Area	Unaffected	None Identified	None Identified
500	4176, 4176A	Bronchosopy	Indeterminate	None Identified	Cs-137
500	6021	Patient Room - Radiation Therapy	Indeterminate	None Identified	Cs-137, Ir-192
500	7046	Latrine	Indeterminate	None Identified	None Identified
505	226	Previous RPO Count Laboratory	Affected	Any	H-3, C-14, Na-22, Cl-36, Mn-54, Co-57, Co-60, Tc-99m, Cd-109, I-125, I-129, Cs-137, Ba-133, Gd-153, Ra-226, Am-241
505	W19, 225	Rooms Adjacent to an Affected Area	Unaffected	None Identified	None Identified
511W	126, 128, 130, 132, 136, 137, 138, 139, 140A, 141, 141A, 143, 143A, 145A, 147, 155	Nuclear Medicine	Affected	H-3, Na-24, P-32, Cr-51, Fe-59, Co-57, Co-58, Co-60, Ga-67, Se-75, Sr-85, Sr-89, Mo-99, Tc-99m, In-111, I-123, I-125, I-131, Xe-133, Gd-153, Au-198, Hg-197, Hg-203, Tl-201, U-234, U-235, U-238	Na-22, Mn-54, Co-57, Co-60, Cd-109, I-125, I-129, Cs-137, Ba-133, Gd-153
511W	127, 127A, 135A	RIA Laboratory	Affected	Fe-59, Co-57, I-125	None Identified

TABLE 4.1 (Continued)
SUSPECTED RADIOISOTOPE STORAGE AND USE LOCATIONS
HISTORICAL SURVEY REPORT
U.S. ARMY GARRISON, FITZSIMONS
AURORA, COLORADO

Building	Room	Uses	Radiation Designation	Suspected Radioisotopes	
				Unsealed Sources	Sealed Sources
511W	122, 124, 127A, 129A, 131A, 131B, 133, 134, 135, 138, 140, 144A, 146, 149, 149A	Rooms Adjacent to an Affected Area	Unaffected	None Identified	None Identified
511W	22, 250, 250A, 250B, 251	Nuclear Cardiology	Affected	Fe-59, Co-57, Ga-67, Tc-99m, In-111, I-123, I-125, I-131, Xe-133, Tl-201	None Identified
511W	13, 14, 248, 251A	Rooms Adjacent to an Affected Area	Unaffected	None Identified	None Identified
511W	140B	Service Elevator	Indeterminate	None Identified	None Identified
511A	B1	Radium Storage and Needle Filling	Affected	Radium	None Identified
600	100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 111	RIA Pathology	Affected	H-3, C-14, P-32, Co-57, Ni-63, I-125, I-131,	None Identified
600	110	DCI Count Lab, DCI Waste Storage	Affected	H-3, C-14, P-32, Co-57, Ni-63, I-125, I-131,	H-3, C-14, Co-57, Ni-63, I-129, Cs-137, Ba-133, Po-210, Ra-226
600	117	Former Meter Storage	Indeterminate	None Identified	Cs-137
600	124	Former Meter Storage	Indeterminate	None Identified	Cs-137

TABLE 4.1 (Continued)
SUSPECTED RADIOISOTOPE STORAGE AND USE LOCATIONS
HISTORICAL SURVEY REPORT
U.S. ARMY GARRISON, FITZSIMONS
AURORA, COLORADO

Building	Room	Uses	Radiation Designation	Suspected Radioisotopes	
				Unsealed Sources	Sealed Sources
600	131/131A	DCI Count Lab, DCI Waste Storage, RPO Count Lab	Affected	Any	H-3, C-14, Na-22, Mn-54, Co-57, Co-60, Tc-99m, Cd-109, I-125, I-129, Cs-137, Ba-133, Gd-153, Ra-226, Am-241
600	112, 113, 114, 115, 116, 118, 119, 120, 121, 122, 123, 125, 126, 127, 128, 129, 130, 132, 133, 134	Chemistry Division	Indeterminate	None Identified	None Identified
600	200, 202, 203, 204, 205, 206, 207, 208	DCI Laboratories	Affected	H-3, C-14, P-32, I-125, I-131	None Identified
600	201	DCI Laboratory	Affected	H-3, C-14, P-32, I-125, I-131	Ni-63
600	210, 211, 212, 213, 215	RIA Pathology	Affected	H-3, C-14, P-32, Co-57, I-125, I-131	None Identified
600	214	RIA Pathology	Affected	H-3, C-14, P-32, Co-57, I-125, I-131	Ni-63
600	209, 218, 219, 220, 221, 222, 223, 224, 225, 226, 227, 228, 229, 230, 231, 232, 233	DCI Laboratories	Indeterminate	None Identified	None Identified
601	002, 003, 004, 005		Indeterminate	None Identified	None Identified

TABLE 4.1 (Continued)
SUSPECTED RADIOISOTOPE STORAGE AND USE LOCATIONS
HISTORICAL SURVEY REPORT
U.S. ARMY GARRISON, FITZSIMONS
AURORA, COLORADO

Building	Room	Uses	Radiation Designation	Suspected Radioisotopes	
				Unsealed Sources	Sealed Sources
601	W104, W105, W106, W107, W108, W109, W110, W112, W114, W115	DCI Laboratories, Microbiology, Physiology	Affected	H-3, C-14, Mg-28, P-32, S-35, K-42, Ca-45, Ca-47, Cr-51, Fe-55, Fe-59, Co-60, Zn-65, Se-75, Br-82, Sr-85, Sr-89, Sr-90, I-125, I-131, Ce-141, Yb-169, Au-198	None Identified
601	W102, W103, W113, W116	Rooms Adjacent to an Affected Area	Unaffected	None Identified	None Identified
601	229	DCI Microbiology Laboratory	Affected	H-3, C-14, P-32, I-125	None Identified
601	230	DCI Microbiology Laboratory, Count Room	Affected	Any	H-3, C-14, Po-210, Ra-226
601	200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 221, 222, 223, 224, 225, 226, 227, 228, 231, 233, 235, 237, 239, 241	DCI Laboratories	Indeterminate	None Identified	None Identified
601	210, 211, 212, 213, 214, 215	RIA Pathology	Indeterminate	None Identified	None Identified
602	W100, W101, W102, W103, W104, W105, W106, W108, W110,	Animal Research	Affected	H-3, C-14, P-32, S-35, Ca-45, Sr-89, Sr-90, I-125, I-131	None Identified

TABLE 4.1 (Continued)
SUSPECTED RADIOISOTOPE STORAGE AND USE LOCATIONS
HISTORICAL SURVEY REPORT
U.S. ARMY GARRISON, FITZSIMONS
AURORA, COLORADO

Building	Room	Uses	Radiation Designation	Suspected Radioisotopes	
				Unsealed Sources	Sealed Sources
602	W100, W101, W102, W103, W104, W105, W106, W108, W110, W112, W116	Animal Research	Affected	H-3, C-14, P-32, S-35, Ca-45, Sr-89, Sr-90, I-125, I-131	None Identified
602	W114	Rooms Adjacent to an Affected Area	Unaffected	None Identified	None Identified
602	W212, W213, W215	CHPPM Laboratory (Sealed Sources Only)	Indeterminate	None Identified	H-3, Ni-63
602	Second Floor - East and West Wings (All Rooms)	Chemistry Division	Indeterminate	None Identified	None Identified
603	115C, 116, 118, 119, 120, 122, 123, 151, 152, 153	Radioisotope Laboratory, RPO Waste Storage	Affected	H-3, C-14, Na-22, Na-24, Mg-28, P-32, Ca-45, Ca-47, Cr-51, Fe-55, Fe-59, Co-57, Co-58, Zn-65, Ga-67, Se-75, Br-82, Sr-85, Sr-89, Sr-90, Tc-99m, In-111, I-125, I-131, Xe-133, Tl-201, U-234, U-235, U-238	C-14, Na-22, Cl-36, Mn-54,Co-57, Co-60, Kr-85, Tc-99m, Cd-109, I-125, I-129, Cs-137, Ba-133, Gd-153,
603	124	Rooms Adjacent to an Affected Area	Unaffected	None Identified	None Identified
603	21	Unknown	Indeterminate	None Identified	None Identified

TABLE 4.1 (Continued)
SUSPECTED RADIOISOTOPE STORAGE AND USE LOCATIONS
HISTORICAL SURVEY REPORT
U.S. ARMY GARRISON, FITZSIMONS
AURORA, COLORADO

Building	Room	Uses	Radiation Designation	Suspected Radioisotopes	
				Unsealed Sources	Sealed Sources
610	All Rooms	Animal Research	Indeterminate	Tc-99m	None Identified
616	1, 2, 3, 4	Waste Storage	Indeterminate	None Identified	None Identified

\a Also includes Lagoons 270 and 271 and the golf course.

scope for license termination activities. Table 4.1 identifies the designation assigned to each room for those buildings that are included within the scope of the license termination activities. As additional information is obtained from the future surveys, room designations may be revised.

Historical building information that was specifically targeted for review also included disposal "hot" sinks, refrigerators, ductwork, and laboratory fume hoods.

4.1 BUILDING NO. 260

Building No. 260 is currently operated under a State of Colorado license which is held by the University of Colorado. The building is now owned by the University of Colorado and is not included in the NRC license termination activities for Fitzsimons.

4.2 BUILDING NO. 265/LAGOON NOS. 271 AND 272

Building No. 265 is the control building for the wastewater treatment plant (WWTP) that has been in operation since the 1940s. The treatment plant only handles sewage from Fitzsimons and has a design capacity of one-million gallons per day. The average throughput prior to the closure of Fitzsimons was 300,000 to 400,000 gallons per day.

The WWTP currently holds an National Pollution Discharge Elimination System (NPDES) permit to discharge effluent into Tollgate Creek. During the warmer months, treated effluent from the WWTP is used as irrigation water for the Fitzsimons golf course. Radioisotopes that may have been discharged by the WWTP include those listed in Table 4.2. This table was reproduced from the actual disposal records and only includes data from 1961 to 1974, but is representative of the possible types of radioisotopes historically disposed of through the WWTP.

Lagoon No. 271 is adjacent to the WWTP and was constructed in 1941 as a collection point for treated wastewater effluent prior to discharge. Lagoon No. 272 was constructed as an overflow lagoon to handle excess treated effluent during peak periods. These lagoons cover a surface area of approximately 2.4 acres. The potential radioisotopes in the lagoons would be consistent with those associated with the WWTP in Table 4.2.

Building No. 265 and Lagoon Nos. 271 and 272 are considered indeterminate by definition.

4.3 BUILDING NO. 404

Building No. 404 is the Opthamology Clinic which was constructed in 1942. This building, originally Building No. 206, functioned as a hospital infirmary ward. Building No. 404 has been used for patient rooms for radiation treatment and also was used by the Radiation Protection Office. Hence, both sealed and unsealed sources are suspected of being used within the building. Documentation of the exact room numbers and storage locations used during radiological activities could not be confirmed during the historical record search, as indicated by Table 4.1. A close-out survey was performed in the Counting Laboratory on 01 December 1988 by the

TABLE 4.2
HISTORICAL DISPOSAL OF RADIOISOTOPES INTO THE WASTE WATER TREATMENT PLANT
HISTORICAL SURVEY REPORT
U.S. ARMY GARRISON, FITZSIMONS
AURORA, COLORADO

LIQUID/SEWAGE DISPOSAL (31 December 1961 through 06 December 1974)	
Radioisotope	**Dates**
H-3	63, 64, 65, 66, 68, 69, 70, 71, 72, 73, 74
C-14	61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74
Na-22	72, 73
P-32	65, 66, 67, 68, 69, 70, 71, 72, 73
S-35	63, 64, 65, 66, 69, 70, 71, 72, 73, 74
Ca-45	63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74
Ca-47	70, 71, 73
Cr-51	65, 66, 67, 68, 69, 70, 71
Fe-55	65, 72
Fe-59	64, 65, 71, 72
Co-57	74
Ni-63	69, 70
Cu-64	68
Zn-65	63, 64, 65, 66, 69, 71
Se-75	71, 72, 73, 74
Rb-86	64, 65
Sr-85	71, 72
Sr-89	63, 65, 66
Sr-90	63, 69
Mo-99	64, 65
I-125	65, 66, 67, 68, 69, 71, 72, 73, 74
I-131	61, 62, 63, 65, 66, 67, 70
Ce-141	71
Yb-169	71
Au-198	63
Hg-203	73, 74

Radiation Protection Office. No levels above the minimum detection activity (MDA) were detected.

4.4 BUILDING NO. 500

Building No. 500 is the main hospital, and was completed in 1941. This building consists of 11 floors with a total of 290,000 square feet of floor space. Radiation usage was primarily for patient radiation therapy. Radioisotopes were used on the 1st, 2nd, 3rd, 4th, 6th, and 7th floors of the building. Table 4.1 lists the suspected radioisotopes and rooms in which radioisotopes may have been stored or used. The relevant departments that have operated in the hospital include Nuclear Cardiology and Radiation Therapy.

A Co-60 teletherapy unit was located in the basement prior to being dismantled and removed on 20 January 1993. The NRC terminated the teletherapy license on 12 January 1994 under NRC license 05-00046-15, Amendment No. 28. The shipping papers to document the transfer of the Co-60 source to Neutron Products Inc. and results of a radiation survey conducted for the room where the sealed source was located (Radiation Therapy Vault, Building No. 500 Basement) were submitted to the NRC as part of NRC Form 314 (Certificate of Disposition of Material) to terminate the license. Since no contamination was detected, this area is not included in the scope for this project. Sealed sources, Cs-137, Ir-192, Sr-90, and Ra-226, that were originally stored in the basement were then moved to the north storage room on the third floor (Room 3118A) within the building (see Appendix B).

Disposal methods in Building No. 500 have included release of liquid wastes into the sanitary sewer system, incineration, and collection of wastes for offsite disposal. Incineration, at Building No. 616 or at the incinerator within Building No. 500, of radioactively contaminated wastes would have been limited to linen and consumables used by patients in radiation therapy. Although the incinerator in Building No. 500 was removed in 1977, the stack remains in-place. Historical records also indicate that an autoclave (used to sterilize pathological wastes prior to disposal in the sanitary sewer system) was operated in the building until 1985. The flue ducting still remains and can be seen in the basement. Sanitary sewer system releases would have included contaminated wash water, patient urine, and spill cleanup liquids. Concentration limits in the sanitary sewer were established as early as 1958 at a limit of 0.1 microcurie per milliliter of radioisotopes, such as P-32 or I-131 for short period contamination. Disposal of urine containing I-131 into the sanitary sewer system was allowed in the 1990s following the collection and storage of waste products after 10 half-lives of the radioisotope had passed, as discussed in Section 3.3.

The tunnel between Buildings No. 500 and No. 511 experienced a spill of patient urine containing I-131 on 09 January 1980. The spill was immediately cleaned up by Nuclear Medicine Services and Health Physics personnel.

4.5 BUILDING NO. 505

Building No. 505 has been most recently used as the ENT Clinic. The building was constructed in 1918 and was originally Building No. 743. The facility was a tuberculosis ward until the 1940s. The Radiation Protection Office moved to this building on 01 December 1988 following the close-out survey of the Counting Laboratory in Building No. 404. Based on Table 4.1, which also lists room numbers, the radioisotopes would have been used for patient radiation therapy. Further information about radioisotope usage and department activities was limited for this building.

4.6 BUILDING NO. 511

Building No. 511 is the Medical Clinic Administration and Nuclear Medicine Services Building. The building was constructed in 1918 and was originally Building No. 30, when it was a tuberculosis ward/infirmary. This building contained two "hot" sinks where radiologically contaminated wastewater was discharged to the sanitary sewer system.

Historical documents indicate that the building has experienced extensive use of radioisotopes over the last decade. The Nuclear Medicine Services and RadioImmunoAssay (RIA) Lab were the primary users in this building. The Nuclear Medicine Department provided uptake, dilution, excretion, and function imaging as well as heart stress and rest tests. Supporting data for any previous activities within the building were not available. The RIA laboratory was reported as closed in the RPOs quarterly report (third quarter) of 1995. Table 4.1 lists the suspected radioisotopes and room numbers that may have formerly stored or used radioisotopes.

Only one spill is documented for Building No. 511. The spill occurred on 04 December 1989 in the Nuclear Medicine Services. According to RPO records, 2 mCi of I-131 was spilled during dose preparation under the fume hood in the "hot" laboratory. Clean-up was immediately performed.

4.7 BUILDING NO. 600

Building No. 600 is the Department of Clinical Investigation (DCI) Laboratory and Audiology building. RIA-Pathology also used this building. This facility was constructed in 1918 and was a tuberculosis ward until the 1940s. This building was originally Building No. 744. The Clinical Investigation Service used this facility for radioisotope analysis of I-125, C-14, and H-3. The laboratory areas were surveyed in 1976 and were found to be free of radioactive contamination, and exposure rates were within acceptable limits. The most recent usage for the building was by the DCI Counting laboratory and for waste storage. This facility contained a "hot" sink where contaminated liquids were discharged to the sanitary sewer system. Table 4.1 lists the suspected radioisotopes and room numbers that may have formerly stored or used radioisotopes.

4.8 BUILDING NO. 601

Building No. 601 was primarily used for laboratory operations and support. The facility was originally constructed in 1942 as a hospital ward. The original building number was No. 402, having changed sometime prior to 1968. The Clinical Investigation Service used this facility for radioisotope analysis of I-125, C-14, and H-3. The building was also used by the DCI, RIA-Pathology, and the Microbiology Service. The laboratory areas were surveyed in 1976 and were found to be free of radioactive contamination, and exposure rates were within acceptable limits. The RIA-Pathology also used this building. Table 4.1 lists the suspected radioisotopes and room numbers that may have formerly stored or used radioisotopes.

4.9 BUILDING NO. 602

Building No. 602 was also primarily used for laboratory operations and support by Chemistry Services. The structure was built in 1942 as a hospital ward. The original building number was No. 403, which was changed sometime prior to 1968. Building No. 602 is also referenced as Building No. 602-A in some of the historical documents. Building No. 602-A will be referred to as Building No. 602 throughout this document. Table 4.1 lists the suspected radioisotopes and room numbers that may have formerly stored or used these radioisotopes.

4.10 BUILDING NO. 603

Building No. 603 is the CHPPM/Radiation Protection waste storage building that was built in 1918. This building was originally No. 745 and then No. 405, and functioned as a tuberculosis ward. Building No. 603 contained a licensed Gammacell (Model 220) which contained approximately 6,925 curies of Co-60. The Gammacell was installed in 1967 under License 05-00046-14. The area where the Gammacell was previously located was a concrete porch that was extended to accommodate the installation of a irradiation cell for in-vitro research. License 05-00046-14 expired in September 1975. The exact date that these activities were terminated and the disposition of the sealed sources are not known. However, a Radiation Protection Survey Report from 1976 indicated that this sealed source was regularly leak tested with no evidence of leaks. This building also contained a "hot" sink where contaminated wastewater was discharged to the sewer system. It is important to note that solid low-level radioactive wastes are still stored in the Radioactive Waste Laboratory. Table 4.1 lists the suspected radioisotopes and room numbers that may have formerly stored or used radioisotopes.

A spill of H-3 was documented on 31 July 1986 in room 218. It was immediately cleaned up.

4.11 BUILDING NO. 610

Building No. 610 was identified in the EBS as having used and stored radioisotopes for animal studies. Tc-99m was the only identified radioisotope. No historical

information was found in this search to support the use of further radioisotopes within Building No. 610. In fact, this building was not listed in the NRC license.

4.12 BUILDING NO. 616

Building No. 616 is the incinerator and hazardous waste staging area. The building was constructed in 1935 and was originally Building No. 424. Operations at this facility included low-level waste and drum waste storage. Details of the radioisotopes stored at this facility were not available. Records indicate that only waste containing C-14 was incinerated.

A close-out survey was performed on 16 July 1986 by the Radiation Protection Office. "No radiation or contamination was detected and the building was turned over to the Directorate of Engineering and Housing (DEH), currently Directorate of Public Works (DPW) for conversion into a (non-radioactive)/hazardous material storage facility."

4.13 LANDFILL NO. 5

Landfill No. 5 is located east of Building No. 642, and was used for the burial of low-level radioactive waste in 1961 and 1962. The waste consisted of biological materials primarily contaminated with short-half-life radioisotopes. Total radioactivity present at the time of burial was 8.291 mCi (TechLaw, 1994). Table 4.3 presents the radioisotopes that were buried at the landfill.

A formal sampling and analysis program at Landfill No. 5 was undertaken in September 1996, and will be incorporated into Appendix C of the final Historical Survey Report when it is received from the Contractor. The intrusive activities at Landfill No. 5 were performed to confirm that no residual activity remains at this site after removal of the landfill material. No residual activity was discovered.

4.14 GOLF COURSE

The golf course was first developed in 1921. Treated effluent from the WWTP has been used to irrigate the golf course since the 1940s. The existence of radioisotopes in the sanitary sewer system and potentially in the WWTP effluent has potentially led to the release of radioisotopes on the golf course. The extent of possible soil contamination will be evaluated during future surveys. Radioisotopes potentially released onto the golf course include those listed in Table 4.2. The golf course is also considered indeterminate by definition.

4.15 SANITARY SEWER SYSTEM

The sanitary sewer system has been in full operation since the construction of the WWTP in the 1940s. Suspect locations within the sanitary sewer system would include entry points such as the sinks within buildings, traps, clean-outs, and access points. Suspect radioisotopes within the sanitary sewer system include those listed in Table 4.2 and those specified for each building utilizing disposal sinks. Since these check sources are of minimal activity, no additional surveys are required.

TABLE 4.3
HISTORICAL DISPOSAL OF RADIOISOTOPES
AT LANDFILL 5
HISTORICAL SURVEY REPORT
U.S. ARMY GARRISON, FITZSIMONS
AURORA, COLORADO

BURIAL DISPOSAL (22 November 1961 through 24 October 1962)	
Radioisotope	**Dates**
H-3	62
C-14	61, 62
S-35	62
Zn-65	62
I-131	61, 62
Au-198	62
Food irradiated with spent fuel rods	62
Gamma emitters	62

4.16 OTHER AREAS

The RPO currently occupies Building No. 403. Storage of sealed sources within the building is in accordance with the NRC license. Since these check sources are of minimal activity, no additional surveys are required.

Historical documentation indicates that some buildings and departments may have been approved by the Radiation Control Committee to use certain radioisotopes in various locations. However, further documentation supporting the use of these radioisotopes at these locations was not available. Based on the lack of radiation surveys and receipt reports, it is unlikely that these areas actually used radioisotopes. The following is a summary of the few areas, given by building number, most recent building use, and radioisotopes, that were approved for radioisotope usage but lack any documentation to support their use.

- Building No. 228, Entomology Division, H-3, C-14, and Na-22; and
- The Health Physics section of Building No. 514, was designated to be used as a radioactive use and storage area in 1980.

Some of the radioisotopes are not documented prior to certain dates. The NRC established criteria allowing for the disposal of the sealed source records following NRC inspections. It is believed that some of the supporting radiological survey, receipt, and disposal records may have been disposed of or archived offsite following these inspections.

4.17 SUMMARY OF RADIOACTIVE WASTE MANAGEMENT

Fitzsimons has generated and disposed of solid and liquid radioactive wastes including biological wastes. Reports from 1954 indicate that liquid wastes were slowly dispositioned to the sanitary sewer system by constant drip discharge bottle techniques so that the activity concentrations in the sewer were within discharge limitations. In addition, high activity concentration liquid wastes were stored to allow the radioactive decay process to reduce the waste's activity concentration prior to being slowly released to the sewer system. By 1966, the license stipulated that a maximum of one curie per year could be discharged to the sewer system. At that time, liquid wastes continued to be discharged to the sewer system in compliance with the license, associated amendments, and state discharge limitations.

Reports from 1954 also indicate that solid, radioactively-contaminated wastes that were combustible were dispositioned to the incinerator, while non-combustible solid wastes were buried in Landfill No. 5. Animal carcasses from carbon-14 research projects were incinerated in 1957 (incinerator site not given). Biological solid wastes were dispositioned to Landfill No. 5 in the early 1960s. Other radiological wastes were handled and disposed of by the Health Physics Office. These wastes were boxed, drummed, stored, and inventoried prior to shipment. Animal remains from the Animal Resources Building were collected separately for disposal in a commercial radioactive landfill during the 1980s (ES&E, 1984).

4.18 PREVIOUS SURVEYS AND INSPECTIONS

The Fitzsimons Health Physics Organization, Hygiene Organization, and Radiation Protection Office have performed regular "Radiation Protection Surveys" and "Radiological Hygiene Surveys" to maintain a safe work environment. These surveys included swipe tests and/or the use of survey meters. In addition, leak testing was performed on sealed sources in accordance with NRC regulations. Documentation of the actual leak test results is incomplete for the years prior to 1989. However, reference to leak tests can be found in many documents that indicate no leaks were found.

In October of 1968, the Atomic Energy Commission performed an inspection of Fitzsimons and conducted surveys in the areas where radioisotopes were used, stored, and disposed of. All areas surveyed were found to be free of radioactive contamination, and stored materials were found to be properly shielded. Detailed records associated with this survey were not available. The NRC inspections, as filed, under License 05-00046-13 are summarized in Table 4.4.

Historically, contamination was found in the radium storage room (Room 3125, Building No. 500). A radiological survey of the radium storage safe in 1966 noted that the inside areas had been successfully decontaminated. However, contamination remained on top of the safe and required further decontamination. After further use, the radium safe was swipe tested in 1969, and no significant contamination was detected. Between 1969 and 1972, the radium storage safe was moved to a location in the tunnel between Building Nos. 500 and 511 (see Appendix B). A survey of the new radium storage room in 1972 led to a finding of no radioactive contamination. This new radium storage room also stored a Monel metal radium plaque containing approximately 9.8 milligrams (radium equivalent), and a night vision adaptometer containing 1.6 millicuries of carbon-14. Leak tests were conducted on these units every 6 months, and no records were identified indicating that these sealed sources had failed a leak test.

A radiation protection survey was performed at the Radioisotope Clinic (Building No. 603) in 1976. All areas were found to be free from radioactive contamination, and exposure rates were within acceptable limits. Internal inspections were also performed by Fitzsimons. For example, on 10 March 1995, a senior management review of Nuclear Medicine was conducted. The findings of this audit were:

- Although the door to the waste room was shut, it was not locked.
- Sources and unit dose were stored in an unsecured area.
- Waste was outside the "hot" lab in the treatment room but was in a waste receptacle (not end of day yet).
- Large source in hallway; not in secure area such as the "hot" lab.

TABLE 4.4
NRC INSPECTION FINDINGS
HISTORICAL SURVEY REPORT
U.S. ARMY GARRISON, FITZSIMONS
AURORA, COLORADO

Date	License	Findings	Response
7/96	05-00046-13	No violations were observed and violations from previous inspections have been corrected.	None.
7/95	05-00046-13	Contrary to 10 CFR 20.1302(a), the licensee had not made surveys of radioactive materials in gaseous effluents released to unrestricted areas to demonstrate compliance with the dose limits in 10 CFR 20.1301.	Not available.
3/94	05-00046-13	Failure to have a representative from management present at two of the 1993 quarterly Radiation Safety Committee meetings, which is a violation of 10 CFR 35.22. Also a delay in obtaining dosimetry results and fully implementing revised 10 CFR 20.	Not available.
8/90	05-00046-13	Within the areas inspected, no violations were identified.	None.
10/89	05-00046-13	Within the areas inspected, no violations were identified.	None.
8/86	05-00046-13	Within the scope of the inspection, no violations were observed.	None.
4/81	05-00046-13	No items of noncompliance or unsafe conditions were found.	None.

TABLE 4.4 (Continued)
NRC INSPECTION FINDINGS
HISTORICAL SURVEY REPORT
U.S. ARMY GARRISON, FITZSIMONS
AURORA, COLORADO

Date	License	Findings	Response
11/76	05-00046-13	Contrary to 10 CFR 20.207, licensed byproduct material was not secured against unauthorized removal from the Nuclear Medicine Hot Laboratory during a period on November 11, 1976, when the area was unrestricted due to lack of license control.	Enclosure #1, directive has been published and posted. The Chief of Nuclear Medicine Service or his representative will conduct appropriate checks during duty hours to insure that the Hot Laboratory is under surveillance of an authorized employee or that the door to the Hot Laboratory is locked. Prior to departure from the Nuclear Medicine Clinic at the close of duty hours, the Chief of Service or his designated representative will personally insure that the door to the Hot Laboratory is locked and properly secured.

4.19 NON-CONCLUSIVE INFORMATION

During the historical survey, some of the radiological use areas or radioisotopes identified lacked the necessary information to reach a conclusion on the location or use of radioisotope usage. The following are some areas that may require more research:

- Accurate records on the exact dates of building number changes were not available. Estimates on the building number changes were based on radioisotope inventory records, receipt reports, and radiation surveys.

- Discrepancies in the old room numbers versus the current room numbers exist. Some room numbers changed during remodeling efforts, while others were simply mislabeled on reports.

- Radium delivery tickets and receipt reports were available from the 1940s and 1950s. However, no accurate accounting of the use or location of the radium was available. Storage locations (e.g., 3-north in Building No. 500) were only found for the 1980s and 1990s.

- Inventory reports appear to be for individual departments and not for all of Fitzsimons for a given quarter. Hence, it is uncertain if the entire radioisotope inventory was included for any particular quarter.

- Based on inspection report reviews, hallways and adjacent rooms to waste storage and treatment rooms were not consistently surveyed during radiation surveys.

- An undated appendix for the Nutrition Laboratory at Building No. 602 discusses the use of a locked and posted outside walk-in freezer next to the building for storage of solid radioactive waste. The document appears to be pre-1980.

- Historical records did not indicate the performance of radiological surveys in any of the piping systems at Fitzsimons. Interviews with Fitzsimons maintenance personnel indicate that the sanitary sewer may have leaked in certain locations. No specific locations were given.

Each of these areas was researched for all available information. If additional information is found, it will be incorporated into the survey plan and updates.

4.20 SUMMARY OF RADIOISOTOPE USAGE AREAS

The historical records search revealed many of the buildings and rooms that used, stored, or disposed of radioisotopes. The buildings that were identified, through the records search and Atomic Energy Commission/NRC licenses, were Building Nos. 265, 404, 500, 505, 511, 600, 601, 602, 610, and 616. Appendix B contains figures for most of these buildings and the associated rooms. Other areas suspected of having been exposed to radioisotopes include Landfill No. 5, Lagoon Nos. No. 271 and 272, and the golf course. Historical data was not found indicating any previous surveys that may have been performed within building piping systems. Data was also not found

supporting any other areas of potential soil contamination other than those already discussed in previous sections.

APPENDIX A

FITZSIMONS LICENSE SUMMARIES

LICENSE 5-46-1

The original AEC application is dated (information not on file). The AEC license was issued to the Fitzsimons Army Hospital Medical Nutrition Laboratory on March 19, 1956. The license expired on March 31, 1958.

Item	Isotope	Chemical/ Physical Form	Authorized Uses	Maximum Limit (mCi)
A	C-14	Any	Chemical and biological laboratory studies in lower animals.	1

Conditions:

1) Byproduct material to be used by, or under the supervision of Dr. J. M. Iacono.

2) Licensee was required to comply with the proposed 10 CFR 20 standards for protection against radiation as published in the Federal Register dated July 16, 1955.

Amendment No. 1

Application dated June 25, 1956 was approved by AEC on September 21, 1956 to add the following Isotope and use.

Item	Isotope	Chemical/ Physical Form	Authorized Uses	Maximum Limit (mCi)
B	S-35	Any	None specified.	1

Amendment No. 2

The possession limits for C-14 was increased from 1 to 5 mCi on February 26, 1957.

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LICENSE 5-46-3

The original AEC application is dated (information not on file). The AEC license was issued to the Fitzsimons Army Hospital Biochemistry Branch, Chemistry Division, Medical Nutrition Laboratory on January 31, 1957. The license expired on January 31, 1959.

Item	Isotope	Chemical/ Physical Form	Authorized Uses	Maximum Limit (mCi)
A	C-14	Any	Laboratory research and development.	50

Conditions:

1) Byproduct material to be used by, or under the supervision of, Zigmund Z. Ziporin, Ph.D.

2) Licensee was required to comply with the proposed 10 CFR 20 standards for protection against radiation as published in the Federal Register dated July 16, 1955.

3) Byproduct material shall not be used in or on humans.

Amendment No. 1

Application dated April 28, 1958 was approved by AEC on June 13, 1958 to add the following Isotope and use. This amendment use issued to the Chemistry and Physiology Division, Medical Nutrition Laboratory.

Item	Isotope	Chemical/ Physical Form	Authorized Uses	Maximum Limit (mCi)
B	Ca-45	Any	Laboratory studies of the intermediary metabolism of compounds in microorganisms and lower animals.	5
C	P-32	Any	Laboratory studies of the intermediary metabolism of compounds in microorganisms and lower animals.	5
D	Sr-89/ Sr-90	Any	Laboratory studies of the intermediary metabolism of compounds in microorganisms and lower animals.	5
E	S-35	Any	Laboratory studies of the intermediary metabolism of compounds in microorganisms and lower animals.	5

Amendment No. 2

Letter dated June 16, 1958 was approved by AEC on June 20, 1958 to add the following Isotope and use. This amendment use issued to the Chemistry and Physiology Division, Medical Nutrition Laboratory.

Item	Isotope	Chemical/ Physical Form	Authorized Uses	Maximum Limit (mCi)
F	H-3	Any	Laboratory studies of the intermediary metabolism of compounds in microorganisms and lower animals.	5,000 (Total amount for license)

LICENSE 5-46-6

The original AEC application is dated (information not on file). The AEC license was issued to the Fitzsimons Army Hospital Metabolic Research Division, Medical Nutrition Laboratory on December 17, 1957. The license expired on December 31, 1959.

Item	Isotope	Chemical/ Physical Form	Authorized Uses	Maximum Limit (mCi)
A	I-131	Iodinated Human Serum Albumin	Measurement of turnover rate of albumin of 10 normal young men in various nutritional states.	1

Conditions:

1) Byproduct material to be used by, or under the supervision of, Irvin C. Plough, M.D.

[A hand written note on the license indicates that the license was canceled on September 2, 1960 via a letter from the AEC.]

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LICENSE 5-46-8

The original AEC application is dated (information not on file). The AEC license was issued to the Fitzsimons Army Hospital, Medical Research and Nutrition Laboratory on February 18, 1959. The license expired on February 29, 1964.

Item	Isotope	Chemical/ Physical Form	Authorized Uses	Maximum Limit (mCi)
A	C-14	Any	Laboratory studies of the intermediary metabolism of compounds in microorganisms and lower animals.	50
B	H-3	Any	Laboratory studies of the intermediary metabolism of compounds in microorganisms and lower animals.	5,000 (Total amount for license)
C	Ca-45	Any	Laboratory studies of the intermediary metabolism of compounds in microorganisms and lower animals.	5
D	P-32	Any	Laboratory studies of the intermediary metabolism of compounds in microorganisms and lower animals.	5
E	Sr-89	Any	Laboratory studies of the intermediary metabolism of compounds in microorganisms and lower animals.	5
F	Sr-90	Any	Laboratory studies of the intermediary metabolism of compounds in microorganisms and lower animals.	5
G	S-35	Any	Laboratory studies of the intermediary metabolism of compounds in microorganisms and lower animals.	5

Conditions:

1) Byproduct material to be used by, or under the supervision of, Zigmund Z. Ziporin, Ph.D.

2) Byproduct material shall not be used in or on humans.

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LICENSE 5-46-9

Amendment No. 4

Only Amendment 4 of this license was on file. The license was amended in its entirety in accordance with the application dated March 10, 1961. The amendment was issued to the Fitzsimons Army Hospital, Radiology Department, Radioisotope Section on April 7, 1961. The license expired on April 23, 1963.

Item	Isotope	Chemical/ Physical Form	Authorized Uses	Maximum Limit (mCi)
A	I-131	Iodide	Diagnosis of thyroid function and thyroid scanning. Treatment of hyperthyroidism, cardiac conditions and thyroid carcinoma.	150
B	I-131	Iodinated Human Serum Albumin	Determination of blood and plasma volumes.	1
C	I-131	Rose Bengal	Determination of liver function and liver scans.	1
D	I-131	Labeled Fats and/or Fatty Acids	Determination of fat absorption.	1
E	I-131	Labeled Renal Function Compounds	Determination of renal functions.	2
F	I-131	Triiodothyronine	In vitro determination of thyroid function.	1
G	P-32	Soluble Phosphate	Treatment of polycythemia vera, leukemia, and bone metastases.	50
H	P-32	Colloidal Chromic Phosphate	Intracavitary treatment of fluid accumulation due to malignancies.	15
I	Au-198	Colloidal	Intracavitary treatment of fluid accumulation due to malignancies.	300
J	Cr-51	Sodium Chromate	Determination of red cell volume and red cell survival time.	5
K	Co-60	Vitamin B12	Diagnosis of pernicious anemia.	1
L	Fe-59	Ferric Chloride and/or Ferrous Citrate	Iron metabolism studies.	2

Conditions:

1) Byproduct material to be used by, or under the supervision of, Captain J. A. Nagle, MC, or Captain Richard C. Powell, MC.

2) Byproduct material for use in humans shall be acquired from a supplier, other than an AEC facility, who certifies the pharmaceutical quality and assay of such material.

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LICENSE 5-46-11

The original application is dated May 12, 1959. The AEC license was issued to the Department of Army, U.S. Army Medical Research and Nutrition Laboratory, Fitzsimons Army Hospital on September 23, 1959. The license expired on September 30, 1961.

Item	Isotope	Chemical/ Physical Form	Authorized Uses	Maximum Limit (mCi)
A	Ca-45	Any	Research and development in chemistry, biochemistry, and related fields.	5
B	C-14	Any	Research and development in chemistry, biochemistry, and related fields.	200
C	Cr-51	Any	Research and development in chemistry, biochemistry, and related fields.	25
D	Co-60	Any	Research and development in chemistry, biochemistry, and related fields.	5
E	H-3	Any	Research and development in chemistry, biochemistry, and related fields.	5,000
F	I-131	Any	Research and development in chemistry, biochemistry, and related fields.	200
G	Fe-55	Any	Research and development in chemistry, biochemistry, and related fields.	5
H	Fe-59	Any	Research and development in chemistry, biochemistry, and related fields.	5
I	P-32	Any	Research and development in chemistry, biochemistry, and related fields.	100
J	Sr-89	Any	Research and development in chemistry, biochemistry, and related fields.	5
K	Sr-90	Any	Research and development in chemistry, biochemistry, and related fields.	5
L	S-35	Any	Research and development in chemistry, biochemistry, and related fields.	200
M	Zn-65	Any	Research and development in chemistry, biochemistry, and related fields.	5

Conditions:

1) Byproduct material to be used by, or under the direct supervision of individuals approved by the Radioisotope Committee, Captain Edward E. Dean, Chairman.

2) Byproduct material shall not be used in or on humans.

3) Byproduct material shall not be used in field applications where activity is released.

4) Licensee shall possess and use byproduct material in accordance with the statements, representations, and procedures contained in the application and administrative instructions entitled *General Protection Rules - Radioisotopes* submitted with letter dated September 3, 1959 from Lt. Colonel Charles W. Krual.

5) Waste material containing C-14 may be incinerated. The concentration of radioactive effluent shall not exceed the limits specified in 10 CFR 20, Appendix B, Table II.

6) for use in humans shall be acquired from a supplier, other than an AEC facility, who certifies the pharmaceutical quality and assay of such material.

Amendment No. 1

Application dated March 3, 1961 was approved by AEC on April 7, 1961 to increase the possession limit for Item C (Cr-51) from 25 to 100 mCi and to add the following Isotopes and use.

Item	Isotope	Chemical/ Physical Form	Authorized Uses	Maximum Limit (mCi)
N	Se-75	Any	Research and development in chemistry, biochemistry, and related fields.	100
O	Br-82	Any	Research and development in chemistry, biochemistry, and related fields.	200

Amendment No. 2

The license was amended in its entirety in accordance with an application dated July 14, 1961. This amendment was approved by AEC on August 10, 1961. Expiration date was changed to August 31, 1963. There were no changes to the list of isotopes, chemical/physical forms, authorized uses, or possession limits. The following conditions were modified.

1) Byproduct material to be used by, or under the direct supervision of individuals approved by the Radioisotope Committee~~, Captain Edward E. Dean, Chairman.~~

2) Licensee shall possess and use byproduct material in accordance with the statements, representations, and procedures contained in the application~~ and administrative instructions entitled General Protection Rules - Radioisotopes submitted with letter~~ dated May 12, 1959 as amended by letter dated September 3, 1959, application dated March 3, 1961, and application dated July 14, 1961. ~~from Lt. Colonel Charles W. Krual.~~

Amendment No. 3

Application dated January 8, 1962 was approved by AEC on March 2, 1962 add the following isotope and use.

Item	Isotope	Chemical/ Physical Form	Authorized Uses	Maximum Limit (mCi)
P	Sr-85	Any	Research and development in chemistry, biochemistry, and related fields.	5

Amendment No. 4

Application dated October 1, 1962 was approved by AEC on November 7, 1962 add the following isotope and use.

Item	Isotope	Chemical/ Physical Form	Authorized Uses	Maximum Limit (mCi)
Q	Au-198	Any	Research and development in chemistry, biochemistry, and related fields.	50

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LICENSE 5-46-12

The original application is dated July 28, 1960. The AEC license was issued to the Department of Army, U.S. Army Medical Research and Nutrition Laboratory, Fitzsimons Army Hospital on December 11, 1959. The license expired on December 31, 1961.

Item	Isotope	Chemical/ Physical Form	Authorized Uses	Maximum Limit (mCi)
A	C-14	Glucose, Glucoronic Acid, Glucuronolactone, Ascorbic Acid	Measurement of pool size and turnover rate of body ascorbic in normal and investigation of the possibility that humans may be able to synthesize small amounts of ascorbic acid.	2

Conditions:

1) Byproduct material to be used by, or under the direct personal supervision of, Lt. Colonel Irvin C. Plough, M.D.

2) Byproduct material acquired from an AEC facility shall not be used in humans until its pharmaceutical quality and assay have been independently established.

Amendment No. 1

Application dated July 28, 1960 was approved by AEC on September 9, 1960 to change Lt. Colonel Irvin C. Plough, M.D to Captain William T. Nunes, MC.

Amendment No. 2

The license was amended in its entirety in accordance with an application dated October 5, 1961. This amendment was approved by AEC on December 31, 1961.

Item	Isotope	Chemical/ Physical Form	Authorized Uses	Maximum Limit (mCi)
A	C-14	Glucose	Metabolism and physiological tracer studies in humans.	1
B	C-14	Glucoronic Acid	Metabolism and physiological tracer studies in humans.	1
C	C-14	Glucuronolactone	Metabolism and physiological tracer studies in humans.	1
D	C-14	Ascorbic Acid	Metabolism and physiological tracer studies in humans.	1
E	C-14	Glycine	Metabolism and physiological tracer studies in humans.	2
F	C-14	Mevalonic Acid	Metabolism and physiological tracer studies in humans.	1
G	C-14	Acetate	Metabolism and physiological tracer studies in humans.	4
H	C-14	Carbon Monoxide	Metabolism and physiological tracer studies in humans.	5

Amendment No. 3

Application dated October 5, 1961 was approved by AEC on November 14, 1961 to extend the expiration date from December 31, 1961 to December 31, 1963 and to add the following isotope and use.

Item	Isotope	Chemical/ Physical Form	Authorized Uses	Maximum Limit (mCi)
I	C-14	Cholesterol	Metabolism and physiological tracer studies in humans.	2

Amendment No. 4

Application submitted January 24, 1963 was approved by AEC on January 28, 1963 to change the following condition:

1) Byproduct material to be used by, or under the direct personal supervision of, Captain William T. Nunes, MC <u>or Captain Gerald L. DeNardo, MC</u>.

Amendment No. 5

Application submitted March 19, 1963 was approved by AEC on April 1, 1963 to change the following condition:

1) Byproduct material to be used by, or under the direct personal supervision of, Captain William T. Nunes, MC, Captain Gerald L. DeNardo, MC, or <u>Captain John R. Handy, MC</u>.

Amendment No. 6

Application dated February 21, 1963 was approved by AEC on (information not on file) to add the following isotope and use.

Item	Isotope	Chemical/ Physical Form	Authorized Uses	Maximum Limit (mCi)
J	H-3	Water	Determination of total body water.	150

Condition:

1) Byproduct material specified in Item J may also be used at Ft. Carson for determination of total body water in 112 volunteers.

LICENSE 05-00046-13

The original AEC application is dated December 6, 1963. The original AEC license was issued to the Department of the Army, Fitzsimons General Hospital and U.S. Army Medical Research and Nutrition Laboratory in February 1964. License expired on January 31, 1966.

Item	Isotope	Chemical/ Physical Form	Authorized Uses	Maximum Limit (mCi)
A	I-131	Iodide	Diagnosis of thyroid function and thyroid scanning. Treatment of hyperthyroidism, cardiac conditions and thyroid carcinoma.	250
B	I-131	Iodinated Human Serum Albumin	Determination of plasma volumes and cardiac output. Cardiac scanning. Localization of brain tumors. Performance of placentograms.	5
C	I-131	Hippuran	Determination of renal functions.	2
D	I-131	Rose Bengal	Determination of liver function. Liver scanning.	2
E	I-131	Triolein and/or Oleic Acid	Determination of fat absorption.	2
F	I-131	Cholografin	Determination of liver and gallbladder function.	2
G	I-131	p-Toluidine Polyvinylpyrrolidone	Determination of protein loss. Brain scanning.	2
H	I-131	Thyroxine	Determination of thyroxine turnover.	2
I	I-125	Iodide	Diagnosis of thyroid function and thyroid scanning.	1
J	I-125	Iodinated Human Serum Albumin	Determination of plasma volume.	1
K	I-125	Hippuran	Determination of renal functions.	1
L	I-125	Rose Bengal	Determination of liver function. Liver scanning.	1
M	I-125	Triolein and/or Oleic Acid	Determination of fat absorption.	1
N	I-125	Cholografin	Determination of liver and gallbladder function.	1
O	I-125	Thyroxine	Determination of thyroxine turnover.	1
P	P-32	Soluble Phosphate	Treatment of polycythemia vera, leukemia, and bone metastases.	25
Q	P-32	Colloidal Chromic Phosphate	Intracavitary treatment of malignant effusions.	25
R	Au-198	Colloidal	Intracavitary treatment of malignant effusions. Interstitial treatment of prostate carcinoma. Liver scanning.	250

Item	Isotope	Chemical/ Physical Form	Authorized Uses	Maximum Limit (mCi)
S	Cr-51	Sodium Chromate and/or Chromic Chloride	Determination of red cell mass, red cell survival time, and gastrointestinal bleeding. Spleen scanning.	4
T	Co-58	Vitamin B12	Diagnosis of pernicious anemia.	10
U	Co-60	Vitamin B12	Diagnosis of pernicious anemia.	10
V	Fe-59	Ferric Chloride and/or Ferrous Citrate	Determination of iron turnover.	1
W	Hg-197	Chlormerodrin	Kidney and brain scanning.	10
X	Hg-203	Chlormerodrin	Kidney and brain scanning.	10
Y	H-3	Water	Determination of total body water.	25
Z	Na-24	Sodium Chloride	Determination of total exchangeable sodium.	1
AA	Se-75	Selenomethionine	Pancreatic scanning.	10
BB	Xe-133	Gas	Determination of pulmonary function.	2
CC	Sr-85	Strontium Nitrate	Bone scanning.	1
DD	Sr-90	Tacerlab Model RA-1 Sealed Medical Applicator	Treatment of superficial eye conditions.	25
EE	Atomic Nos. 1-83	Any	Laboratory research in vitro and in lower animals.	500 each except H-3 (5 Ci). Total not to exceed 10 Ci

Licenses conditions include:

14A) Each sealed source containing byproduct material, other than H-3, with a half-life greater than 30 days and in any form other than gas shall be tested for leakage and/or contamination at intervals not to exceed 6 months. Sealed sources are not to transferred or placed into use without a current test.

14C) If the test reveals the presence of 0.005 microcurie or more of removable contamination, the licensee shall immediately withdraw the sealed source from use for decontamination, repair, or disposal. A report is to be filed with the AEC.

15) Item EE shall not be used in humans.

In a letter dated February 10, 1964 from Col. Glenn J. Collins, MC (Office of the Surgeon General, Department of the Army) indicates that authority to use Co-57 as requested in the December 6, 1963 application is granted provided that the Co-57 is procured, utilized, and disposed of in a manner that is consistent with the Radiation Program at Fitzsimons General Hospital, the U.S. Army Medical Research and Nutritional Laboratory (AR 40-37) and the application. Because Co-57 is an accelerator produced isotope, it is not required to be licensed by AEC as a byproduct material.

Amendment No. 1

Application dated March 12, 1964. Amendment approved July 31, 1964. Added the following isotopes and authorized uses.

Item	Isotope	Chemical/ Physical Form	Authorized Uses	Maximum Limit (mCi)
FF	C-14	Vitamins	Nutrition and metabolism tracer studies.	10
GG	C-14	Amino Acids	Nutrition and metabolism tracer studies.	10
HH	C-14	Lipids	Nutrition and metabolism tracer studies.	10
II	C-14	Acetate	Nutrition and metabolism tracer studies.	10
JJ	C-14	Carbohydrates	Nutrition and metabolism tracer studies.	10
KK	C-14	Mevalonic Acid	Nutrition and metabolism tracer studies.	10
LL	C-14	Bicarbonate or Carbon Dioxide	Nutrition and metabolism tracer studies.	10
MM	H-3	Vitamins	Nutrition and metabolism tracer studies.	50
NN	Mg-28	Magnesium Oxide, Magnesium Chloride, Magnesium Citrate	Nutrition and metabolism tracer studies.	10
OO	Ca-47	Calcium Chloride	Nutrition and metabolism tracer studies.	10
PP	Ca-45	Calcium Chloride	Nutrition and metabolism tracer studies.	10

Amendment No. 2

An undated application received by AEC on September 2, 1964 was approved by AEC on September 9, 1964. Added the following condition.

17) C-14 as ascorbic acid may be used ... on the summit of Pikes Peak, Colorado for nutrition and metabolism studies ...[on rats].

Amendment No. 3

Application dated August 12, 1964 was approved by AEC in late 1964. Added the following condition.

18) 0.5 mCi of I-131 as iodide and 0.5 mCi of I-125 as iodide may be used on the summit of Pikes Peak, Colorado for studies in lower animals.

Amendment No. 4

An undated application received by AEC on June 4, 1965 was approved by AEC on June 14, 1965. Added the following condition.

19) 1 mCi of C-14 in any form, 1 mCi of I-131 in any form, and 1 mCi of I-125 in any form may be used on the summit of Pikes Peak, Colorado for metabolic studies in lower animals.

Amendment No. 5

On May 11, 1966, the AEC extended the expiration date of license 05-00046-13 to July 31, 1966.

Amendment No. 6

Application and license renewed in total. Application dated June 21, 1966 was approved by the AEC on August 4, 1966. License expires July 31, 1968.

Item	Isotope	Chemical/ Physical Form	Authorized Uses	Maximum Limit (mCi)
A	I-131	Iodide	Diagnosis of thyroid function and thyroid scanning. Treatment of hyperthyroidism, cardiac conditions and thyroid carcinoma.	250
B	I-131	Iodinated Human Serum Albumin	Determination of plasma volumes and cardiac output. Cardiac scanning. Localization of brain tumors. Placenta localization.	5
C	I-131	Labeled Renal Function Compounds	Determination of renal functions.	2
D	I-131	Rose Bengal	Determination of liver function. Liver scanning.	2
E	I-131	Labeled Fats and Fatty Acids	Determination of fat absorption.	2
F	I-131	Cholografin	Determination of liver and gallbladder function.	2
G	I-131	Thyroxine	Determination of thyroxine turnover.	2
H	I-125	Iodide	Diagnosis of thyroid function and thyroid scanning.	1
I	I-125	Iodinated Human Serum Albumin	Determination of plasma volume.	1
J	I-125	Labeled Renal Function Compounds	Determination of renal functions.	1
K	I-125	Rose Bengal	Determination of liver function.	1

Item	Isotope	Chemical/ Physical Form	Authorized Uses	Maximum Limit (mCi)
L	I-125	Labeled Fats and Fatty Acids	Determination of fat absorption.	1
M	I-125	Cholografin	Determination of liver and gallbladder function.	1
N	I-125	Thyroxine	Determination of thyroxine turnover.	1
O	P-32	Soluble Phosphate	Treatment of polycythemia vera, leukemia, and bone metastases.	25
P	P-32	Colloidal Chromic Phosphate	Intracavitary treatment of malignant effusions.	25
Q	Au-198	Colloidal	Intracavitary treatment of malignant effusions. Interstitial treatment of prostate carcinoma. Liver scanning.	250
R	Cr-51	Sodium Chromate and/or Chromic Chloride	Determination of red cell mass, red cell survival time, and gastrointestinal bleeding. Spleen scanning.	4
S	Co-58 Co-60	Vitamin B12	Diagnosis of pernicious anemia.	10
T	Fe-59	Ferric Chloride and/or Ferrous Citrate	Determination of iron turnover.	1
U	Hg-197 Hg-203	Chlormerodrin	Kidney and brain scanning.	10
V	H-3	Water	Determination of total body water.	25
W	Na-24	Sodium Chloride	Determination of total exchangeable sodium.	1
X	Xe-133	Gas	Determination of pulmonary function.	2
Y	Sr-85	Nitrate and Chloride	Bone scans in patients with diagnosed cancer.	1
Z	Sr-90	Tacerlab Model RA-1 Sealed Medical Applicator	Treatment of superficial eye conditions.	25
AA	Atomic Nos. 1-83	Any	Laboratory research in vitro and in lower animals.	500 each except H-3 (5 Ci). Total not to exceed 10 Ci

Conditions:

11) 1 mCi of C-14, 1 mCi of I-131, 1 mCi of I-125, 1 mCi of Cr-51, 5 mCi of H-3, 5 mCi of S-35, and 5 mCi of Br-82 may be used on the summit of Pikes Peak, Colorado for metabolic studies in lower animals.

15A) Each sealed source containing byproduct material, other than H-3, with a half-life greater than 30 days and in any form other than gas shall be tested for leakage and/or contamination at intervals not to exceed 6 months. Sealed sources are not to transferred or placed into use without a current test.

15C) If the test reveals the presence of 0.005 microcurie or more of removable contamination, the licensee shall immediately withdraw the sealed source from use for decontamination, repair, or disposal. A report is to be filed with the AEC.

17) Patients containing I-131 or Au-198 shall remain hospitalized until the residual activity is 30 mCi or less.

Amendment No. 7

Application dated August 2, 1966 was approved by AEC on August 22, 1966 to add the following Isotope and use.

Item	Isotope	Chemical/ Physical Form	Authorized Uses	Maximum Limit (mCi)
BB	I-131	Macroaggregated Human Serum Albumin	Lung scanning for diagnosis of massive pulmonary embolism.	3

Amendment No. 8

Application dated November 22, 1966 and an undated application submitted November 23, 1966 were approved by AEC on January 9, 1967 to add the following Isotope and use.

Item	Isotope	Chemical/ Physical Form	Authorized Uses	Maximum Limit (mCi)
CC	Sr-90	U.S. Radium Corporation Model LAB-369-1	For use in Glowall Corporation Model AD-10 Ionization detector in a Glowall Corporation gas chromatograph.	1 source of 13 mCi
DD	Mo-99	E.R. Squibb Model 08871 Generator	Source of Tc-99m pertechnetate.	600
EE	Tc-99m	Pertechnetate	Brain scanning.	300

Amendment No. 9

Application dated November 18, 1966 was approved by AEC on March 24, 1967 to add the following Isotope and use.

Item	Isotope	Chemical/ Physical Form	Authorized Uses	Maximum Limit (mCi)
CC	C-14	Vitamins, carbohydrates, amino acids, lipids, and acetate.	Metabolic and physiological tracer studies in volunteers.	10 each
DD	H-3	Vitamins, water	Metabolic and physiological tracer studies in volunteers.	50 each
EE	Mg-28	Oxide, Chloride, Citrate	Metabolic and physiological tracer studies in volunteers.	10 each
FF	Ca-45	Chloride	Metabolic and physiological tracer studies in volunteers.	10
GG	Ca-47	Chloride	Metabolic and physiological tracer studies in volunteers.	10

Amendment No. 10

Application submitted on April 13, 1967 was approved by AEC on May 11, 1967 to add the following Isotope and use.

Item	Isotope	Chemical/ Physical Form	Authorized Uses	Maximum Limit (mCi)
HH	Xe-133	Gas dissolved in saline	Measurement of myocardial blood flow.	50

Amendment No. 11

Application dated July 13, 1967 was approved by AEC on September 15, 1967 to add the following Isotope and use.

Item	Isotope	Chemical/ Physical Form	Authorized Uses	Maximum Limit (mCi)
II	C-14	4-Cl4-cortisol	For use in 10 volunteers to study effects of high altitude on man.	0.1
JJ	H-3	1,2-H3-aldosterone	For use in 10 volunteers to study effects of high altitude on man.	0.1

Conditions:

Above isotopes may be used at Fort Lewis, Washington and Pikes Peak, Colorado under the supervision of Captain A. H. Janoski, MC or Captain Richard P. Carson, MC.

Amendment No. 12

Application dated October 12, 1967 was approved by AEC on November 6, 1967 to increase the limit of Item R (Cr-51) from 4 mCi to 10 mCi.

Amendment No. 13

Application dated October 12, 1967 was approved by AEC on March 14, 1968 to increase the limit of Item C (I-131) from 2 mCi to 6 mCi and Item BB (I-131) from 3 mCi to 20 mCi. Amendment also added the following Isotopes and uses.

Item	Isotope	Chemical/ Physical Form	Authorized Uses	Maximum Limit (mCi)
FF	Ca-45	Chloride	Metabolic and physiological tracer studies in volunteers in accordance with application dated November 18, 1966.	10
GG	Ca-47	Chloride	Metabolic and physiological tracer studies in volunteers in accordance with application dated November 18, 1966.	10
KK	C-14	Vitamins, carbohydrates, amino acids, lipids, and acetate.	Metabolic and physiological tracer studies in volunteers in accordance with application dated November 18, 1966.	10 each

Item	Isotope	Chemical/ Physical Form	Authorized Uses	Maximum Limit (mCi)
LL	H-3	Vitamins, water	Metabolic and physiological tracer studies in volunteers in accordance with application dated November 18, 1966.	50 each
MM	Mg-28	Oxide, Chloride, Citrate	Metabolic and physiological tracer studies in volunteers in accordance with application dated November 18, 1966.	10 each

Amendment No. 14

Application dated April 1, 1968 was approved by AEC on May 23, 1968 to increase the limit of Item Y (Sr-90) from 1 mCi to 3 mCi. The use of Item U was changed to read, "Brain scanning with Hg-203. Brain scanning and kidney scanning with Hg-197." Amendment also added the following Isotopes and uses.

Item	Isotope	Chemical/ Physical Form	Authorized Uses	Maximum Limit (mCi)
NN	Cr-51	Labeled Human Serum Albumin	Determination of gastrointestinal protein loss	4
OO	Cs-137	Any	Standard for assay of molybdenum content of eluate of molybdenum generator.	1

Amendment No. 15

Application and license renewed in total. Application dated June 25, 1968 was approved by the AEC on April 28, 1969. License expires April 30, 1974.

Item	Isotope	Chemical/ Physical Form	Authorized Uses	Maximum Limit (mCi)
A	Any byproduct material listed in Groups I and II of 10 CFR 35.100 Schedule A.	Any radiopharmaceutical listed in Groups I and II of 10 CFR 35.100 Schedule A.	Any diagnostic procedure listed in Groups I and II of 10 CFR 35.100 Schedule A.	As necessary for authorized uses
B	I-131	Iodide	Treatment of hyperthyroidism, cardiac dysfunction, and thyroid carcinoma.	250
C	I-131	Iodinated Human Serum Albumin	Placenta localization.	5
D	I-131	Thyroxine	Determination of thyroxine turnover.	2
E	I-125	Iodide	Thyroid scanning.	1
F	I-125	Thyroxine	Determination of thyroxine turnover.	1
G	P-32	Soluble Phosphate	Treatment of polycythemia vera, leukemia, and bone metastases.	25
H	P-32	Colloidal Chromic Phosphate	Intracavitary treatment of malignant effusions.	25
I	Au-198	Colloidal	Intracavitary treatment of malignant	250

Item	Isotope	Chemical/ Physical Form	Authorized Uses	Maximum Limit (mCi)
			effusions. Interstitial treatment of prostate carcinoma.	
J	Cr-51	Sodium Chromate and/or Chromic Chloride	Determination of gastrointestinal bleeding. Spleen scanning.	10
K	H-3	Water	Determination of total body water.	25
L	Na-24	Sodium Chloride	Determination of total exchangeable sodium.	1
M	Xe-133	Gas	Determination of pulmonary function.	2
N	Xe-133	Gas dissolved in saline	Measurement of myocardial blood flow.	50
O	Mo-99	E.R. Squibb Model 08871 Generator	Source of Tc-99m pertechnetate.	600
P	Sr-90	Tacerlab Model RA-1 Sealed Medical Applicator	Treatment of superficial eye conditions.	25
Q	Ca-45	Calcium Chloride	Metabolic and physiological tracer studies in volunteers.	10
R	Ca-47	Calcium Chloride	Metabolic and physiological tracer studies in volunteers.	10
S	C-14	Vitamins, carbohydrates, amino acids, lipids, and acetate.	Metabolic and physiological tracer studies in volunteers.	10 each
T	H-3	Vitamins, water	Metabolic and physiological tracer studies in volunteers.	50 each
U	Mg-28	Oxide, Chloride, Citrate	Metabolic and physiological tracer studies in volunteers.	10 each
V	Atomic Nos. 1-83	Any	Laboratory research in vitro and in lower animals.	500 each except H-3 (5 Ci). Total not to exceed 10 Ci
W	Sr-90	U.S. Radium Corporation Model LAB-369-1	For use in Glowall Corporation Model AD-10 Ionization detector in a Glowall Corporation gas chromatograph.	1 source of 13 mCi
X	Cs-137	Any	Standard for assay of molybdenum content of eluate of molybdenum generator.	1

Conditions:

11) 1 mCi of C-14, 1 mCi of I-131, 1 mCi of I-125, 1 mCi of Cr-51, 5 mCi of H-3, 5 mCi of S-35, and 5 mCi of Br-82 may be used on the summit of Pikes Peak, Colorado for metabolic studies in lower animals.

15A) Each sealed source containing byproduct material, other than H-3, with a half-life greater than 30 days and in any form other than gas shall be tested for leakage and/or contamination at intervals not to exceed 6 months. Sealed sources are not to transferred or placed into use without a current test. The periodic leak test does not apply to sealed sources that are in storage.

15C) If the test reveals the presence of 0.005 microcurie or more of removable contamination, the licensee shall immediately withdraw the sealed source from use for decontamination, repair, or disposal. A report is to be filed with the AEC.

18) Patients containing I-131 or Au-198 shall remain hospitalized until the residual activity is 30 mCi or less.

NOTE: 10 CFR 35.100, Schedule A Group I includes the following isotopes for uptake, dilution, and excretion studies (does not include scans or tumor localizations):

- I-131 or 125 as sodium iodide for thyroid function studies
- I-131 or 125 as iodinated human serum albumin for determinations of blood and blood plasma volume
- I-131 or 125 as labeled rose bengal for liver function studies
- I-131 or 125 as labeled fats or fatty acids for fat adsorption studies
- I-131 or 125 as labeled iodopyracet, sodium iodhippurate, sodiun diatrizoate, diatrizoate methylglucamine, sodium diprotrizoate, sodium acetrizoate, or sodium iothalamate for kidney function studies
- Cr-51 as labeled human serum albumin for gastrointestinal protein loss studies
- Cr-51 as sodium chromate for determination of red blood cell volume and studies of red blood cell survival time
- Fe-59 as chloride, citrate, or sulfate for iron turnover studies
- Co-58 or 60 as labeled vitamin B-12 for intestinal absorption studies
- K-42 as chloride for potassium space determinations

NOTE: 10 CFR 35.100, Schedule A Group II includes the following isotopes for scans and tumor localizations:

- I-131 as sodium iodide for thyroid scans
- I-131 as iodinated human serum albumin for brain tumor localizations and cardiac scans

- I-131 as macroaggregated iodinated human serum albumin for lung scans
- I-131 as colloidal (macroaggregated) iodinated human serum albumin for liver scans
- I-131 as labeled rose bengal for liver scans
- I-131 as iodopyracet, sodium iodhippurate, sodiun diatrizoate, diatrizoate methylglucamine, sodium diprotrizoate, sodium acetrizoate, or sodium iothalamate for kidney scans
- I-131 as sodium iodipamide for cardiac scans
- Cr-51 as sodium chromate for spleen scans
- Au-198 in colloidal form for liver scans
- Hg-197 as chloromerdrin for kidney and brain scans
- Hg-203 as chloromerdrin for brain scans
- Sr-85 as nitrate or chloride for bone scans in patients with diagnosed cancer
- Tc-99m as pertechnetate for brain scans

Amendment No. 16

Application dated April 25, 1969 was approved by AEC on May 15, 1969 to add the following Isotope and use.

Item	Isotope	Chemical/ Physical Form	Authorized Uses	Maximum Limit (mCi)
Y	C-14	Glucose	Study of glucose metabolism in 8 normal male volunteers at summit of Pikes Peak, Colorado and in 8 normal male volunteers at Fort Sam Houston, Texas. Study shall be conducted by, or under the supervision of Captain Shafeek S. Sanbar, MC.	1

Amendment No. 17

Application dated October 17, 1969 was approved by AEC on November 3, 1969 to add the following Isotope and use.

Item	Isotope	Chemical/ Physical Form	Authorized Uses	Maximum Limit (mCi)
Z	Tc-99m	Technetium Sulfur Colloid	Liver scanning and spleen scanning.	100

Amendment No. 18

Application dated January 16, 1970 was approved by AEC on January 26, 1970 to amend Condition 11 to read as follows; "1 mCi of C-14, 1 mCi of I-131, 1 mCi of I-125, 1 mCi of Cr-51, 5 mCi of H-3, 5 mCi of S-35, 5 mCi of Br-82, 10 mCi of K-42, and 10 mCi of Na-24 may be used on the summit of Pikes Peak, Colorado for metabolic studies in lower animals.

Amendment No. 19

Application dated April 11, 1970 was approved by AEC on May 11, 1970 to amend Condition 11 to read as follows; "1 mCi of C-14, 1 mCi of I-131, 3 mCi of I-125, 3 mCi of Cr-51, 5 mCi of H-3, 5 mCi of S-35, 5 mCi of Br-82, 10 mCi of K-42, 10 mCi of Na-24, 2 mCi of Sr-85, 2 mCi of Ce-141, and 2 mCi of Yb-169 may be used on the summit of Pikes Peak, Colorado for metabolic studies in lower animals.

Amendment No. 20

Application dated July 2, 1970 was approved by AEC on September 11, 1970 to add the following Isotope and use.

Item	Isotope	Chemical/ Physical Form	Authorized Uses	Maximum Limit (mCi)
AA	Tc-99m	Pertechnetate	Joint scans in accordance with protocol dated April 20, 1970.	100

The authorized use for Item B was amended to read, "Treatment of hyperthyroidism, cardiac dysfunction, and thyroid carcinoma. Diagnosis of functioning metastases from thyroid carcinoma."

The authorized use for Item C was amended to read, "Placenta localization. Cisternography and ventriculography in accordance with protocol dated April 20, 1970."

Amendment No. 21

Application dated November 12, 1970 was approved by AEC on December 18, 1970 to increase the limit of Item O (Mo-99) from 600 mCi to 1 Ci and Item P (Sr-90) from 25 mCi to 50 mCi.

Amendment No. 22

Application dated January 5, 1971 was approved by AEC on April 26, 1971 to amend the following Isotope and use.

Item	Isotope	Chemical/ Physical Form	Authorized Uses	Maximum Limit (mCi)
Y	C-14	Glucose	Study of glucose metabolism in 8 normal male volunteers at summit of Pikes Peak, Colorado and in 24 normal male volunteers at Fort Sam Houston, Texas. Study shall be conducted by, or under the supervision of Captain Raymond F. Burk, MC.	1

Amendment No. 23

Application dated January 5, 1971 was approved by AEC on May 28, 1971 to add the following Isotope and use.

Item	Isotope	Chemical/ Physical Form	Authorized Uses	Maximum Limit (mCi)
BB	Se-75	Selenite	Determine site and nature of selenium protein bond in 25 cancer patients plasma to evaluate nutritional liver disease. Within 6 weeks after the completion of the study, the licensee shall furnish a report to the Commission which briefly summarizes the results obtain.	2

Amendment No. 24

Letter dated May 18, 1971 was approved by AEC on August 11, 1971 to delete Item N and to amend the following isotope and use.

Item	Isotope	Chemical/ Physical Form	Authorized Uses	Maximum Limit (mCi)
M	Xe-133	Free gas or in saline	Pulmonary function studies. Blood flow studies.	2,000

Amendment No. 25

Application dated June 22, 1972 was approved by AEC on November 22, 1972 to add the following Isotope and use.

Item	Isotope	Chemical/ Physical Form	Authorized Uses	Maximum Limit (mCi)
N	Tc-99m	Labeled albumin microspheres (human) prepared by the licensee using the 3M kit.	Lung imaging.	100

Amendment No. 26

Letter dated November 16, 1972 was approved by AEC on December 29, 1972 to add the following Isotope and use.

Item	Isotope	Chemical/ Physical Form	Authorized Uses	Maximum Limit (mCi)
O	Tc-99m	Labeled polyphosphates prepared by the licensee using the NEN kit.	Bone imaging in 25 patients in accordance with letter dated November 16, 1972 signed by Dr. Thomas A. Verdon. Within 6 weeks after the completion of the study, the licensee shall furnish a report to the Commission which briefly summarizes the results obtain.	100

Amendment No. 27

Letter dated March 9, 1973 was approved by AEC on April 3, 1973 to amend the following authorized use.

Item	Isotope	Chemical/ Physical Form	Authorized Uses	Maximum Limit (mCi)
O	Tc-99m	Labeled polyphosphates prepared by the licensee using the NEN kit.	Bone imaging in 25 patients in accordance with letter dated November 16, 1972 and March 9, 1973. Within 6 weeks after the completion of the study, the licensee shall furnish a report to the Commission which briefly summarizes the results obtain.	100

Amendment No. 28

Application and license renewed in total. Application dated March 12, 1973 was approved by the AEC on April 24, 1973. License expires April 30, 1974.

Item	Isotope	Chemical/ Physical Form	Authorized Uses	Maximum Limit (mCi)
A	Any byproduct material listed in Groups I and II of 10 CFR 35.100 Schedule A.	Any radiopharmaceutical listed in Groups I and II of 10 CFR 35.100 Schedule A.	Any diagnostic procedure listed in Groups I and II of 10 CFR 35.100 Schedule A.	As necessary for authorized uses
B	I-131	Iodide	Treatment of hyperthyroidism, cardiac dysfunction, and thyroid carcinoma. Diagnosis of functioning metastases from thyroid carcinoma.	250
C	I-131	Iodinated Human Serum Albumin	Placenta localization. Cisternography and ventriculography in accordance with protocol dated April 20, 1970.	5
D	I-131	Thyroxine	Determination of thyroxine turnover.	2
E	I-125	Iodide	Thyroid imaging.	1
F	I-125	Thyroxine	Determination of thyroxine turnover.	1
G	P-32	Soluble Phosphate	Treatment of polycythemia vera, leukemia, and bone metastases.	25
H	P-32	Colloidal Chromic Phosphate	Intracavitary treatment of malignant effusions.	25
I	Au-198	Colloidal	Intracavitary treatment of malignant effusions. Interstitial treatment of prostate carcinoma.	250
J	Cr-51	Sodium Chromate and/or Chromic Chloride	Determination of gastrointestinal bleeding. Spleen imaging.	10
K	H-3	Water	Determination of total body water.	25

Item	Isotope	Chemical/ Physical Form	Authorized Uses	Maximum Limit (mCi)
L	Na-24	Sodium Chloride	Determination of total exchangeable sodium.	1
M	Xe-133	Free gas or in saline	Pulmonary function studies. Blood flow studies.	2,000
N	Tc-99m	Labeled albumin microspheres (human) prepared by the licensee using the 3M kit.	Lung imaging.	100
O	Mo-99	E.R. Squibb Model 08871 Generator	Production of Tc-99m pertechnetate.	1,000
P	Sr-90	Tacerlab Model RA-1 Sealed Medical Applicator	Treatment of superficial eye conditions.	50
Q	Ca-45	Calcium Chloride	Metabolic and physiological tracer studies in volunteers.	10
R	Ca-47	Calcium Chloride	Metabolic and physiological tracer studies in volunteers.	10
S	C-14	Vitamins, carbohydrates, amino acids, lipids, and acetate.	Metabolic and physiological tracer studies in volunteers.	10 each
T	H-3	Vitamins, water	Metabolic and physiological tracer studies in volunteers.	50 each
U	Mg-28	Oxide, Chloride, Citrate	Metabolic and physiological tracer studies in volunteers.	10 each
V	Atomic Nos. 1-83	Any	Laboratory research in vitro and in lower animals.	500 each except H-3 (5 Ci). Total not to exceed 10 Ci
W	Sr-90	U.S. Radium Corporation Model LAB-369-1 (Sealed Source)	For use in Glowall Corporation Model AD-10 Ionization detector in a Glowall Corporation gas chromatograph.	1 source of 13 mCi
X	Cs-137	Any	Standard for assay of molybdenum content of eluate of molybdenum generator.	1
Y	C-14	Glucose	Study of glucose metabolism in 24 normal male volunteers at summit of Pikes Peak, Colorado and in 24 normal male volunteers at Fort Sam Houston, Texas. Study shall be conducted by, or under the supervision of Captain Raymond F. Burk, MC in accordance with application dated 1/5/71.	1

Item	Isotope	Chemical/ Physical Form	Authorized Uses	Maximum Limit (mCi)
Z	Tc-99m	Technetium Sulfur Colloid	Liver and spleen imaging.	100
AA	Tc-99m	Pertechnetate	Joint imaging in accordance with protocol dated April 20, 1970.	100
BB	Se-75	Selenite	Determine site and nature of selenium protein bond in 25 cancer patients plasma to evaluate nutritional liver disease. Within 6 weeks after the completion of the study, the licensee shall furnish a report to the Commission which briefly summarizes the results obtain.	2
CC	Tc-99m	Labeled polyphosphates prepared by the licensee using the NEN kit.	Bone imaging in 100 additional patients in accordance with letter dated November 16, 1972 and March 9, 1973. Within 6 weeks after the completion of the study, the licensee shall furnish a report to the Commission which briefly summarizes the results obtain.	100
DD	Cs-137	Sealed Source (Amersham/Searle)	Interstitial treatment of carcinoma. For use in medical applicators for the intrecavitary treatment of carcinoma.	626

Conditions:

10) 1 mCi of C-14, 1 mCi of I-131, 3 mCi of I-125, 3 mCi of Cr-51, 5 mCi of H-3, 5 mCi of S-35, 5 mCi of Br-82, 10 mCi of K-42, 10 mCi of Na-24, 2 mCi of Sr-85, 2 mCi of Ce-141, and 2 mCi of Yb-169 may be used on the summit of Pikes Peak, Colorado for metabolic studies in lower animals.

17A) Each sealed source containing byproduct material, other than H-3, with a half-life greater than 30 days and in any form other than gas shall be tested for leakage and/or contamination at intervals not to exceed 6 months. Sealed sources are not to transferred or placed into use without a current test. The periodic leak test does not apply to sealed sources that are in storage.

17C) If the test reveals the presence of 0.005 microcurie or more of removable contamination, the licensee shall immediately withdraw the sealed source from use for decontamination, repair, or disposal. A report is to be filed with the AEC.

18) Activities to be conducted in accordance with the applications dated June 25, 1968 and March 12, 1973.

Amendment No. 29

Application dated April 12, 1973 was approved by AEC on May 23, 1973 to add the following Isotope and use.

Item	Isotope	Chemical/ Physical Form	Authorized Uses	Maximum Limit (mCi)
EE	I-125 and I-131	Any	In vitro studies.	5

Amendment No. 30

Condition 18 was amended by AEC on July 31, 1973 to add reference to the April 12, 1973 application. This application request the use of byproduct material for in-vitro testing at locations other than those specified in the June 25, 1973 application after a safety survey is conducted by the RPO and approval is granted by the FAMC Isotope Committee.

Amendment No. 31

Application dated July 23, 1973 was approved by AEC on September 13, 1973 to delete Item BB and to amend Item CC as follows:

Item	Isotope	Chemical/ Physical Form	Authorized Uses	Maximum Limit (mCi)
CC	Tc-99m	Labeled polyphosphates prepared by the licensee using the NEN or Diagnostic Isotopes kits.	Bone imaging. [NOTE: Condition 19 added and requires that the statements, representations, and procedures contained in the July 23, 1973 application are to be followed.]	100

Amendment No. 32

Application dated October 30, 1973 was approved by AEC on December 15, 1973 to add the following Isotope and use.

Item	Isotope	Chemical/ Physical Form	Authorized Uses	Maximum Limit (mCi)
FF	Tc-99m	Iron-ascorbate diethylenetriamine pentaacetic acid complex (prepared by the licensee using the Squibb Kit)	Kidney imaging	50

Amendment No. 33

Not on file.

Amendment No. 34

Application and license renewed in total. Application dated February 22, 1974 was approved by the AEC on June 17, 1974. License expires April 30, 1979.

Item	Isotope	Chemical/ Physical Form	Authorized Uses	Maximum Limit (mCi)
A	Any byproduct material listed in Groups I and II of 10 CFR 35.100 Schedule A.	Any radiopharmaceutical listed in Groups I and II of 10 CFR 35.100 Schedule A.	Any diagnostic procedure listed in Groups I and II of 10 CFR 35.100 Schedule A.	As necessary for authorized uses
B	I-131	Iodide	Treatment of hyperthyroidism, cardiac dysfunction, and thyroid carcinoma. Diagnosis of functioning metastases from thyroid carcinoma.	250
C	I-131	Iodinated Human Serum Albumin	Placenta localization.	5
D	I-131	Thyroxine	Determination of thyroxine turnover.	2
E	I-125	Iodide	Thyroid imaging.	1
F	I-125	Thyroxine	Determination of thyroxine turnover.	1
G	I-125 and I-131	Any	In vitro studies, tests.	5
H	P-32	Soluble Phosphate	Treatment of polycythemia vera, leukemia, and bone metastases.	50
I	P-32	Colloidal Chromic Phosphate	Intracavitary treatment of malignant effusions.	50
J	Au-198	Colloidal	Intracavitary treatment of malignant effusions. Interstitial treatment of prostate carcinoma.	250
K	Cr-51	Sodium Chromate and/or Chromic Chloride	Determination of gastrointestinal bleeding. Spleen imaging.	10
L	H-3	Water	Determination of total body water.	25
M	Na-24	Sodium Chloride	Determination of total exchangeable sodium.	1
N	Xe-133	Free gas or in saline	Pulmonary function studies. Blood flow studies.	2,000
O	Tc-99m	Labeled albumin microspheres (human) prepared by the licensee using the 3M kit.	Lung imaging.	150
P	Tc-99m	Technetium Sulfur Colloid	Liver and spleen imaging.	150

Item	Isotope	Chemical/ Physical Form	Authorized Uses	Maximum Limit (mCi)
Q	Tc-99m	Pertechnetate	Joint imaging in accordance with protocol dated April 20, 1970.	500
R	Tc-99m	Labeled polyphosphates prepared by the licensee using the NEN kit.	Bone imaging.	150
S	Tc-99m	Labeled disodium etidronate prepared by licensee using the Procter & Gamble kit.	Bone imaging.	150
T	Mo-99	Mo-99/Tc-99m generators (E.R. Squibb Model Nos. 08871 and 09650; Abbott Labs. Model Nos. 7721 and 6724: NEN Pharmaceuticals Model No. NRP-196; Mallinckrodt Chemical Works Model Nos. 006 through 012 and 100 through 106; Cambridge Nuclear Corp. Model No. CN-4291; and Amersham/Searle Corp. Model Nos. GTC-50, GTC-100, GTC-200, GTC-300, and GTC-400)	Production of Tc-99m pertechnetate.	2,000
U	Sr-90	Tacerlab Model RA-1 Sealed Medical Applicator	Treatment of superficial eye conditions.	50
V	Atomic Nos. 1-83	Any	Laboratory research in vitro and in lower animals and in vitro testing.	500 each except H-3 (5 Ci). Total not to exceed 10 Ci
W	Cs-137	Any	Standard for assay of molybdenum content of eluate of molybdenum generator.	1
X	Cs-137	Sealed Source (Amersham/Searle)	Interstitial treatment of carcinoma. For use in medical applicators for the intrecavitary treatment of carcinoma.	626

Item	Isotope	Chemical/ Physical Form	Authorized Uses	Maximum Limit (mCi)
Y	Tc-99m	Iron-ascorbate diethylenetriamine pentaacetic acid complex (prepared by the licensee using the Squibb Kit)	Kidney imaging	50

Conditions:

16A) Each sealed source containing byproduct material, other than H-3, with a half-life greater than 30 days and in any form other than gas shall be tested for leakage and/or contamination at intervals not to exceed 6 months. Sealed sources are not to transferred or placed into use without a current test. The periodic leak test does not apply to sealed sources that contain 100 mCi or less of beta and/or gamma emitting material or 10 mCi of alpha emitting material.

16C) If the test reveals the presence of 0.005 microcurie or more of removable contamination, the licensee shall immediately withdraw the sealed source from use for decontamination, repair, or disposal. A report is to be filed with the AEC.

17) Activities to be conducted in accordance with the applications dated February 22, 1974 and April 15, 1974.

Amendment No. 35

Telegram received on January 24, 1975 was approved by NRC on January 24, 1975 to add the following Isotope and use. Also changed from AEC to NRC.

Item	Isotope	Chemical/ Physical Form	Authorized Uses	Maximum Limit (mCi)
Z	Au-198	Seeds	Interstitial treatment of carcinoma in one patient.	100

Amendment No. 36

Application and license renewed in total. Application dated March 15, 1975 was approved by the NRC on August 25, 1975. License expires April 30, 1979.

Item	Isotope	Chemical/ Physical Form	Authorized Uses	Maximum Limit (mCi)
A	Any byproduct material listed in 10 CFR 35.100 Sch A, Groups I/II.	Any radiopharmaceutical listed in Groups I/II of 10 CFR 35.100 Schedule A.	Any diagnostic procedure listed in Groups I and II of 10 CFR 35.100 Schedule A.	As necessary for authorized uses

Item	Isotope	Chemical/ Physical Form	Authorized Uses	Maximum Limit (mCi)
B	Any byproduct material listed in 10 CFR 35.100 Sch A, Group III	Any form listed in Group III of 10 CFR 35.100 Schedule A.	Preparation and use of radio-pharmaceutical for any diagnostic procedure listed in Group III of 10 CFR 35.100 Schedule A.	2,000 each
C	Any byproduct material listed in 10 CFR 35.100 Sch A, Group IV.	Any radiophar-maceutical listed in Group IV of 10 CFR 35.100 Schedule A.	Any therapeutic procedure listed in Group IV of 10 CFR 35.100 Schedule A.	As necessary for authorized uses
D	Any byproduct material listed in 10 CFR 35.100 Sch A, Group V.	Any radiophar-maceutical listed in Group V of 10 CFR 35.100 Schedule A.	Any therapeutic procedure listed in Group V of 10 CFR 35.100 Schedule A.	As necessary for authorized uses
E	Any byproduct material listed in 10 CFR 35.100 Sch A, Group VI.	Any sealed sources listed in Group IV of 10 CFR 35.100 Schedule A.	Any procedure listed in Group VI of 10 CFR 35.100 Schedule A.	1,000 total for all sources
F	I-131	Thyroxine	Determination of thyroxine turnover.	2
G	I-125	Thyroxine	Determination of thyroxine turnover.	1
H	Cs-137	Any	Standard for assay of Mo content of elute of Mo generator.	1
I	Atomic Nos. 1-83	Any	Laboratory research in vitro and in lower animals and in vitro testing.	500 each; H-3 (5 Ci). Total not to exceed 10 Ci
J	Xe-133	Free gas or in saline	Pulmonary function and blood flow study	2,000
K	H-3	Water	Determine total body water.	25
L	Na-24	Sodium Chloride	Determine total exchangeable sodium.	1

Conditions:

13) Activities to be conducted in accordance with the applications dated February 22, 1974 and letters dated April 15, 1974 and July 30, 1975.

NOTE: 10 CFR 35.100, Schedule A Group I includes the following isotopes for uptake, dilution, and excretion studies (does not include scans or tumor localizations):

- I-131 or 125 as sodium iodide for thyroid function studies
- I-131 or 125 as iodinated human serum albumin for determinations of blood and blood plasma volume
- I-131 or 125 as labeled rose bengal for liver function studies
- I-131 or 125 as labeled fats or fatty acids for fat adsorption studies

- I-131 or 125 as labeled iodopyracet, sodium iodhippurate, sodiun diatrizoate, diatrizoate methylglucamine, sodium diprotrizoate, sodium acetrizoate, or sodium iothalamate for kidney function studies
- Cr-51 as labeled human serum albumin for gastrointestinal protein loss studies
- Cr-51 as sodium chromate for determination of red blood cell volume and studies of red blood cell survival time
- Fe-59 as chloride, citrate, or sulfate for iron turnover studies
- Co-58 or 60 as labeled vitamin B-12 for intestinal absorption studies
- K-42 as chloride for potassium space determinations
- Na-24 as chloride for sodium space determinations
- Tc-99m as pertechnetate for blood flow studies
- Mercury as chlormerodin for kidney function studies
- Any byproduct material in a radiopharamaceutical and for a diagnostic use involving measurements of uptake, dilution, or excretion for which a "Notice of Claimed Investigation Exemption for a New Drug" has been accepted by the Food and Drug Administration.

NOTE: 10 CFR 35.100, Schedule A Group II includes the following isotopes for imaging and tumor localizations:

- I-125 or I-131 as sodium iodide for thyroid imaging
- I-131 as iodinated human serum albumin for brain tumor localizations and cardiac imaging
- I-131 as macroaggregated iodinated human serum albumin for lung imaging
- I-131 as colloidal (macroaggregated) iodinated human serum albumin for liver imaging
- I-131 as labeled rose bengal for liver imaging
- I-131 as iodopyracet, sodium iodhippurate, sodiun diatrizoate, diatrizoate methylglucamine, sodium diprotrizoate, sodium acetrizoate, or sodium iothalamate for kidney imaging
- I-131 as sodium iodipamide for cardiac imaging
- I-131 as iodinated human serum albumin for placenta localization
- Cr-51 as sodium chromate for spleen imaging
- Cr-51 as labeled human serum albumin for placenta localization
- Au-198 in colloidal form for liver imaging
- Hg-197 as chloromerdrin for kidney and brain imaging
- Hg-203 as chloromerdrin for brain imaging

- Se-75 as labeled selenomethionine for pancreas imaging
- Sr-85 as nitrate or chloride for bone imaging in patients with diagnosed cancer
- Tc-99m as pertechnetate for brain, thyroid, and salivary gland imaging; and blood pool imaging (including placenta localization)
- Tc-99m as labeled sulfur colloid for liver, spleen, and bone marrow imaging
- Any byproduct material in a radiopharamaceutical prepared from a reagent kit listed in 10 CFR 100(c)(3) for a listed use.
- Any byproduct material in a radiopharamaceutical and for a diagnostic use involving imaging for which a "Notice of Claimed Investigation Exemption for a New Drug" has been accepted by the Food and Drug Administration.

NOTE: 10 CFR 35.100, Schedule A Group III includes the use of generators and reagent kits for preparing and using radiopharamaceuticals containing byproduct material for the following diagnostic uses:

- Mo-99/Tc-99m generators for the elution of Tc-99m as pertechnetate for brain, thyroid, and salivary gland imaging; blood pool imaging (including placenta localization); blood flow studies; and use with reagent kits as provided in 10 CFR 100(c)(3) and (4).
- Reagent kits for preparing Tc-99m labeled sulfur colloid for liver and spleen imaging; iron-acsorbate-diethylenetriamine pentaacetic acid complex for kidney imaging; diethylenetriamine pentaacetic acid for kidney function studies and brain imaging; human serum albumin microspheres for lung imaging; ployphosphates for bone imaging; macroaggregated human serum albumin for lung imaging; distannous etidronate complex for bone imaging; and stannous pyrophosphate for bone imaging.
- Any generator or reagent kit for preparation and diagnostic use of a radiopharamaceutical containing byproduct material for which generator or reagent kit a "Notice of Claimed Investigation Exemption for a New Drug" has been accepted by the Food and Drug Administration.

NOTE: 10 CFR 35.100, Schedule A Group IV includes the use of prepared radiopharamaceuticals for the following therapeutic uses that do not normally require hospitalization for purposes of radiation safety:

- I-131 as iodide for treating hyperthyroidism and cardiac dysfunction
- P-32 as soluble phosphate for treating polycythemia vera, leukemia, and bone metastases
- P-32 as colloidal chromic phosphate for intracavitary treatment of malignant effusions
- Any byproduct material in a radiopharamaceutical and for therapeutic uses that do not normally require hospitalization for purposes of radiation safety for which a "Notice of Claimed Investigation Exemption for a New Drug" has been accepted by the Food and Drug Administration.

NOTE: 10 CFR 35.100, Schedule A Group V includes the use of prepared radiopharamaceuticals for the following therapeutic uses that do not normally require hospitalization for purposes of radiation safety:

- Au-198 as colloid for intracavitary treatment of malignant effusions
- I-131 as iodide for treating thyroid carcinoma
- Any byproduct material in a radiopharamaceutical and for therapeutic uses that do not normally require hospitalization for purposes of radiation safety for which a "Notice of Claimed Investigation Exemption for a New Drug" has been accepted by the Food and Drug Administration.

NOTE: 10 CFR 35.100, Schedule A Group VI includes the use of the following sources containing byproduct material for certain medical uses:

- I-125 or Am-241 as a sealed source in a device for bone mineral analysis
- Cs-137 or Co-60 encased in needles and applicator cells for topical, interstitial, and intracavitary treatment of cancer
- I-125 or Au-198 as seeds for interstitial treatment of cancer
- Ir-192 as seeds encased in nylon ribon for interstitial treatment of cancer
- Sr-90 sealed in an applicator for treating superficial eye conditions

Amendment No. 37

Application and license renewed in total. Application dated March 6, 1979 was approved by the NRC on July 14, 1980. License expires July 31, 1985.

Item	Isotope	Chemical/ Physical Form	Authorized Uses	Maximum Limit (mCi)
A	Any byproduct material listed in 10 CFR 35.100 Sch A, Groups I/II.	Any radiophar-maceutical listed in Groups I/II of 10 CFR 35.100 Schedule A.	Any diagnostic procedure listed in Groups I and II of 10 CFR 35.100 Schedule A.	As necessary for authorized uses
B	Any byproduct material listed in 10 CFR 35.100 Sch A, Group III	Any form listed in Group III of 10 CFR 35.100 Schedule A.	Preparation and use of radio-pharmaceuticals for any diagnostic procedure listed in Group III of 10 CFR 35.100 Schedule A.	5,000 each
C	Any byproduct material listed in 10 CFR 35.100 Sch A, Group IV.	Any radiophar-maceutical listed in Group IV of 10 CFR 35.100 Schedule A.	Any therapeutic procedure listed in Group IV of 10 CFR 35.100 Schedule A.	As necessary for authorized uses
D	Any byproduct material listed in 10 CFR 35.100 Sch A, Group V.	Any radiophar-maceutical listed in Group V of 10 CFR 35.100 Schedule A.	Any therapeutic procedure listed in Group V of 10 CFR 35.100 Schedule A.	As necessary for authorized uses
E	Any byproduct material listed in 10 CFR 35.100 Sch A, Group VI.	Any sealed sources listed in Group IV of 10 CFR 35.100 Schedule A.	Any procedure listed in Group VI of 10 CFR 35.100 Schedule A.	2,000 total for all sources

Item	Isotope	Chemical/ Physical Form	Authorized Uses	Maximum Limit (mCi)
F	Xe-133	Gas or gas in solution that is the subject of an active *New Drug Application* approved by FDA or an active *Notice of Claimed Investigational Exemption for a New Drug* accepted by FDA	Pulmonary function and blood flow study	2,000
G	Any byproduct materials with Atomic Nos. 1-83	Any	Research and development as defined in 10 CFR 30.4(q).	500 each
H	H-3	Any	Research and development as defined in 10 CFR 30.4(q).	5,000
I	Cs-137	Any	Research and development as defined in 10 CFR 30.4(q).	1
J	I-131	Thyroxine	Determination of thyroxine turnover.	2
K	I-125	Thyroxine	Determination of thyroxine turnover.	1
L	H-3	Water	Determine total body water.	25
M	Na-24	Sodium Chloride	Determine total exchangeable sodium.	1

Conditions:

22) Activities to be conducted in accordance with the application dated March 6, 1979 and letter dated June 3, 1980.

Amendment No. 38

Letter dated February 23, 1983 incorporated into Condition 22 by NRC on March 23, 1983 to specify that activities are to be conducted in accordance with the application dated March 6, 1979; letter dated June 3, 1980; and attachment dated February 24, 1983. [NOTE: Attachment and letter not on file.]

Amendment No. 39

Letter dated February 4, 1983 was approved by NRC on August 10, 1983 to add the following isotope and use.

Item	Isotope	Chemical/ Physical Form	Authorized Uses	Maximum Limit (mCi)
N	I-131	I-6B-Iodomethynor-cholesterol (NP 59)	For adrenal imaging in accordance with IND No. 12,605.	As needed.

Condition 22 was also amended:

22) Activities are to be conducted in accordance with the application dated March 6, 1979; letter dated June 3, 1980; letter and attachment dated February 23, 1983; letter and attachment dated February 24, 1983; and letters and attachments dated February 4, 1983 and June 13, 1983.

Amendment No. 40

Letter dated September 13, 1983 was approved by NRC on November 2, 1983 to add Condition 24 for conducting linearity tests of the dose calibrator following the procedures in the Atomic Products Operation Lineator Instructions Manual dated June 20, 1983.

Amendment No. 41

Letter dated January 28, 1985 was approved by NRC on May 22, 1985 to add the following isotope and use.

Item	Isotope	Chemical/ Physical Form	Authorized Uses	Maximum Limit (mCi)
O	Gd-153	Sealed sources (Gulf Nuclear Model GD-1)	For use in Lunar Radiation Corporation Model DP3 spine scanner for use in bone mineral analysis.	Not to exceed 1.5 Ci per source.

Amendment No. 42

Application and license amended in total. Letter dated February 6, 1984 was approved by the NRC on December 9, 1985. License expires December 31, 1990.

Item	Isotope	Chemical/ Physical Form	Authorized Uses	Maximum Limit (mCi)
A	Any byproduct materials with Atomic Nos. 1-83	Any	Medical research, diagnosis, and therapy. In vitro studies. Studies in laboratory animals.	Not to exceed 500 mCi per radionuclide; expect for: H-3: 5 Ci Mo-99: 5 Ci Tc-99m 5 Ci I-125 1 Ci I-131 2 Ci Xe-133 2 Ci
B	Any byproduct materials with Atomic Nos. 4-84	Sealed sources	Medical research, diagnosis, and therapy. In vitro studies. Studies in laboratory animals.	Not to exceed 2 Ci per source

The following Conditions were changed:

20) The licensee is authorized to hold radioactive material with a half-life of less than 65 days for decay in storage before disposal with ordinary trash provide that: (A) radioactive waste is held for decay a minimum of 10 half-lives; (B) monitoring of the

waste is conducted to ensure that it cannot be distinguished from background; and (C) generator column are to be segregated and monitored separately.

22) Activities to be conducted in accordance with the application dated February 6, 1984 and letter dated October 29, 1985.

Amendment No. 43

Letter dated December 4, 1985 was approved by NRC on February 20, 1985 to change the RPO; Condition 21 added reference to the December 4, 1985 letter.

Amendment No. 44

Letter dated February 27, 1986 was approved by NRC on April 22, 1985 to change the RPO; Condition 21 added reference to the February 27, 1986 letter.

Amendment No. 45

Application and license amended in total. Letter dated May 21, 1986 was approved by the NRC on August 13, 1986. License expires December 31, 1990. There were no changes to the approved, uses, and possession limits. The amendment primarily revises the text of the Conditions but not their content. Some administrative conditions were eliminated. Condition 12 was revised to allow the licensee to dispose of sealed source leak test records following Commission inspection.

Amendment No. 46

Application and license amended in total. Letter dated August 18, 1986 was approved by the NRC on December 8, 1986. License expires December 31, 1990. Other than adding reference to the letter dated August 18, 1986 to Condition 18, there are no apparent changes to the approved, uses, possession limits, and other previously approved conditions. [NOTE: The August 18, 1986 letter was not reviewed.]

Amendment No. 47

Application and license amended in total. Letter dated April 29, 1987 was approved by the NRC on July 10, 1987. License expires December 31, 1990. There are no apparent changes to the approved, uses, possession limits, and other previously approved conditions. [NOTE: The April 29, 1987 letter was not reviewed.]

Amendment No. 48

Application and license amended in total. Letter dated July 7, 1987 was approved by the NRC on August 27, 1987. License expires December 31, 1990. Other than adding reference to the letter dated July 7, 1987 to Condition 18, there are no apparent changes to the approved, uses, possession limits, and other previously approved conditions. [NOTE: The July 7, 1987 letter was not reviewed.]

Amendment No. 49

Application and license amended in total. Letter dated November 4, 1987 was approved by the NRC on December 23, 1987. License expires December 31, 1990.

Item	Isotope	Chemical/ Physical Form	Authorized Uses	Maximum Limit (mCi)
A	Any byproduct materials with Atomic Nos. 1-83	Any	Medical research, diagnosis, and therapy. In vitro studies. Studies in laboratory animals.	Not to exceed 500 mCi per radionuclide; expect for: H-3: 5 Ci Mo-99: **10 Ci** Tc-99m **10 Ci** I-125 1 Ci I-131 2 Ci Xe-133 2 Ci
B	Any byproduct materials with Atomic Nos. 4-84	Sealed sources	Medical research, diagnosis, and therapy. In vitro studies. Studies in laboratory animals.	Not to exceed 2 Ci per source
C	Uranium, Natural or Deplete	Shielding material	Shielding in Mo-99/Tc-99 generators.	Not to exceed 999 kg

Reference to the letter dated November 4, 1987 was added to Condition. [NOTE: The November 4, 1987 letter was not reviewed.]

Amendment No. 50

Application and license amended in total. Letter dated October 11, 1988 was approved by the NRC on February 22, 1989. License expires December 31, 1990. Other than adding reference to the letter dated October 11, 1988 to Condition 18, there are no apparent changes to the approved, uses, possession limits, and other previously approved conditions. [NOTE: October 11, 1988 letter was not reviewed.]

Amendment No. 51

Application and license amended in total. Letter dated May 10, 1989 was approved by the NRC on June 26, 1989. License expires December 31, 1990. Other than adding reference to the letter dated May 10, 1989 to Condition 18, there are no apparent changes to the approved, uses, possession limits, and other previously approved conditions. [NOTE: May 10, 1989 letter was not reviewed.]

Amendment No. 52

Application and license amended in total. Letter dated April 5, 1990 was approved by the NRC on June 4, 1990. License expires December 31, 1990. Reference to the letter dated April 5, 1990 was added to the license conditions. 2LT Christopher J. Clayton was specified as the Radiation Safety Office in the license conditions. This amendment also included a condition that requires the licensee to maintain records that are important to the safe and

effective decommissioning in accordance with the provisions of 10 CFR 30.35(g). [NOTE: April 5, 1990 letter was not reviewed. It appears that the enhanced decommissioning record keeping requirements when promulgated in 53 FR 24044, June 27, 1988. Per the NRC transmittal letter, these requirements include: 1) identification of areas or locations where contamination remains after cleanup procedures have been implemented or at locations in which there is a likelihood that contamination may have spread to inaccessible sites. These documents must identify spills or other unusual occurrences involving the spread of contamination in and around equipment, facilities, or sites; include as-built drawings and outline modifications of structures and equipment in restricted areas where radioactive materials are used and/or stored; identify specific locations of possible inaccessible contamination such as buried pipes, concrete in existing physical plant structures (floor, walls, ceilings, etc.), and storage vaults; and provide information relative to the identification, quantity, chemical or physical form, and concentration of nuclides involved in contaminating incidents.]

Amendment No. 53

Application and license amended in total. Letter dated February 28, 1992 was approved by the NRC on March 10, 1992. License expired December 31, 1990. Other than adding reference to the letter dated May 10, 1989 to Condition 18, there are no apparent changes to the approved, uses, possession limits, and other previously approved conditions. However, the February 28th letter is an emergency request to possess a sealed Am-241 source (not to exceed 2 mCi) to service equipment.

Amendment No. 54

Application and license amended in total. Letter dated October 9, 1992 was approved by the NRC on December 8, 1992. License expired December 31, 1990. Reference to the letter dated October 9, 1992 was added to the license conditions. Captain Regina L. Russell was specified as the Radiation Safety Office in the license conditions. [NOTE: October 9, 1992 letter was not reviewed.]

Amendment No. 55

Application and license amended in total. Letter dated May 10, 1995 was approved by the NRC on May 18, 1995. License expired December 31, 1990. Reference to the letter dated May 10, 1995 was added to the license conditions. Major Albert T. Lambert was specified as the Radiation Safety Office in the license conditions. [NOTE: May 10, 1995 letter was not reviewed.]

Amendment No. 56

Application and license amended in total. Letter dated April 25, 1995 was approved by the NRC on July 24, 1995. License expired December 31, 1990. Reference to the letters dated April 25, 1995 and July 5, 1995 were added to the license conditions. Captain Annette Boatwright was specified as the Radiation Safety Office in the license conditions. The frequency for leak testing sealed sources that emit alpha particles was changed from every six months to every three months. A new condition was added to require the licensee to conduct a physical inventory every 3 months to account for all sources and/or devices received and

possessed pursuant to 10 CFR 35.59, 35.400 and 35.500; and every 6 months for all other sources and/or devices. [NOTE: The April 25, 1995 and July 5, 1995 letters were reviewed.]

Amendment No. 57

Application and license amended in total. Letter dated August 8, 1995 was approved by the NRC on March 26, 1996. License expires December 31, 1999. Although the license expiration date was extended to December 1999, Condition 23 only authorizes activities that are related to the decommissioning of the facilities for unrestricted use be conducted after July 1, 1996. [NOTE: August 8, 1995 letter was not reviewed. The NRC transmittal letter requires that the following items be maintained in a single document decommissioning records that have been certified for completeness and accuracy:

- Onsite areas designated or formerly designated as restricted areas as defined in 10 CFR 20.3(a)(14) or 20.1003.]

- Onsite areas, other than restricted areas, where radioactive materials in quantities greater than the amounts listed in Appendix C to 10 CFR 20.1001-20.2401 have been used, possessed, or stored.

- Onsite areas, other than restricted areas, where spills or other unusual occurrences involving the spread of contamination in and around the facility, equipment, or site have occurred that required reporting pursuant to 10 CFR 30.50(b)(1) or (b)(4), including areas where subsequent cleanup procedures have removed the contamination.

- Specific locations and radionuclide contents of previous and current burial areas within the site, excluding radioactive material with half-lives of 10 days or less, depleted uranium used only for shielding or as penetrators in unused munitions, or sealed sources authorized for use at temporary job sites.

- Location and description of all contaminated equipment involved in the licensed operations that is to remain onsite after license termination.

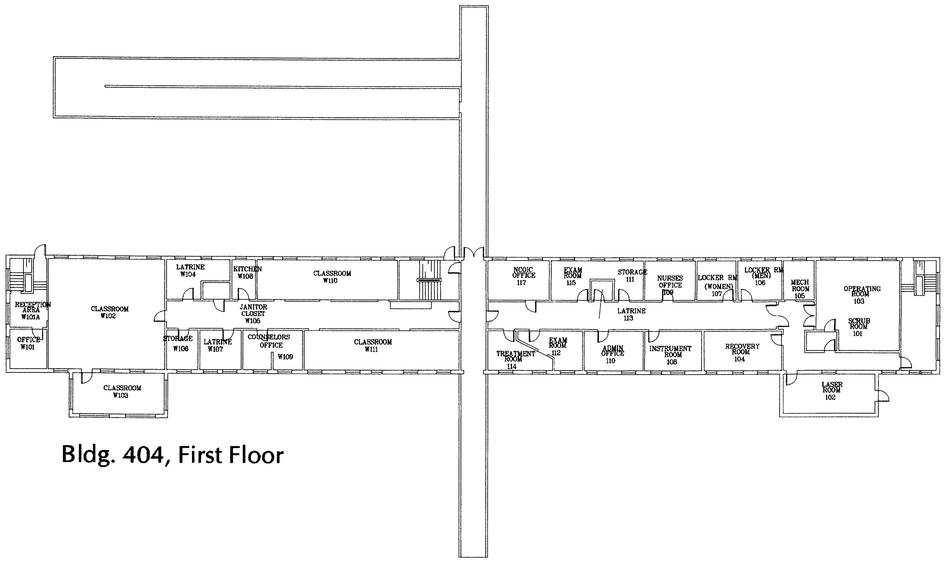
Amendment No. 58

In accordance with a letter dated June 14, 1996, the license was amended to reflect changing of Fitzsimons Army Medical Center to the U.S. Army Garrison, Fitzsimons.

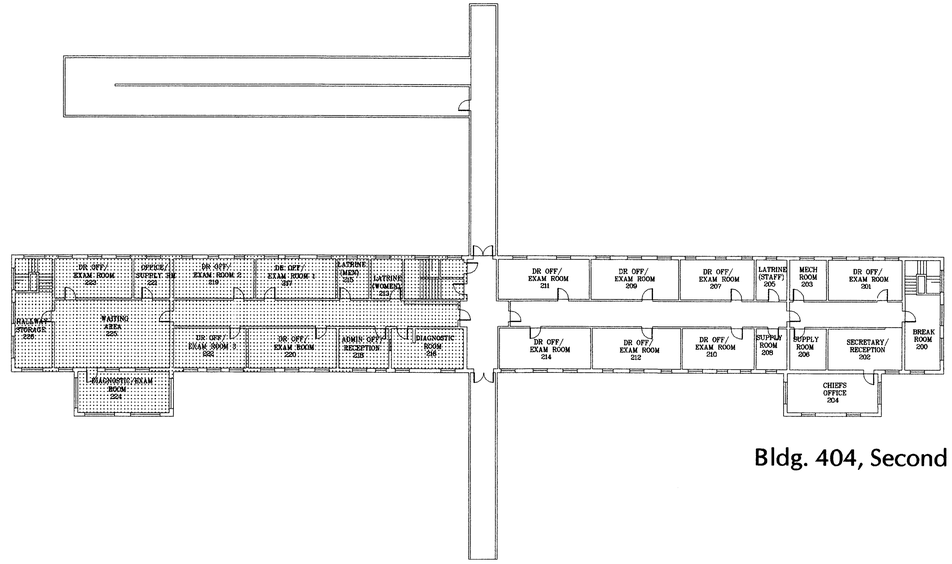
APPENDIX B

APPENDIX B

BUILDING MAPS



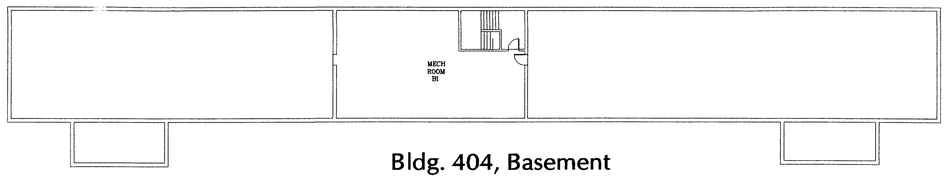
Bldg. 404, First Floor



Bldg. 404, Second Floor

Legend

- Suspected Affected Area
- Indeterminate Area
- Unaffected Area

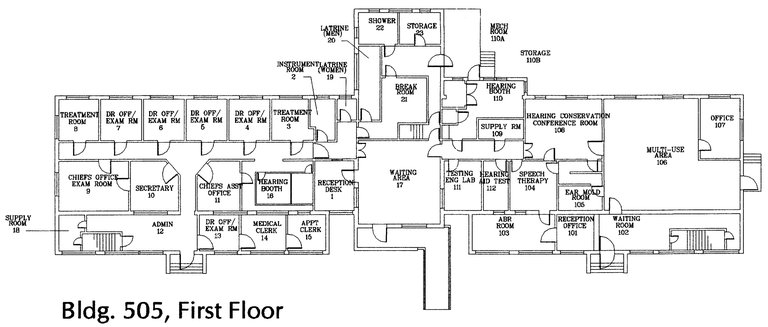


Bldg. 404, Basement

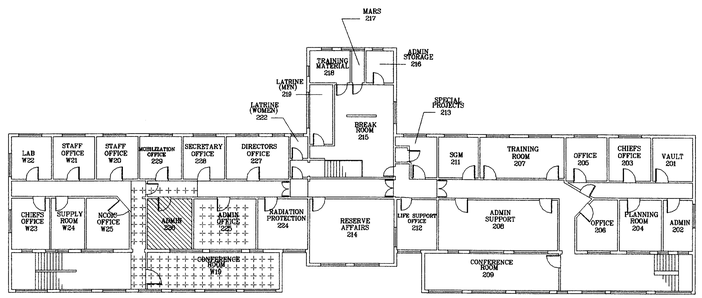
N

0 20 40
FEET

1 inch = 20 feet



Bldg. 505, First Floor



Bldg. 505, Second Floor

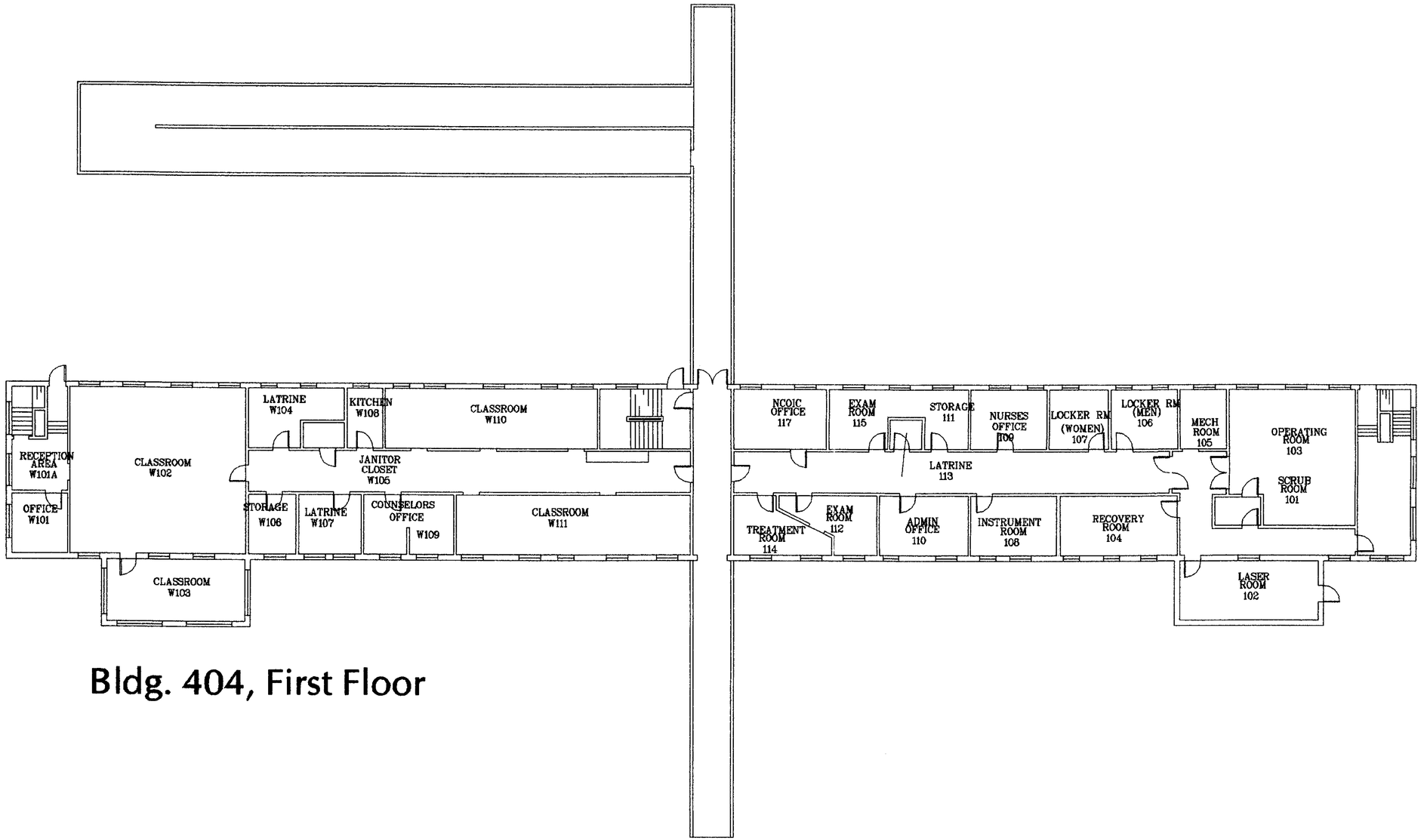
REVISION	DATE	DESCRIPTION	BY
A	10/96	Draft Historical Survey Report	JS
B	11/96	Final Historical Survey Report	JS

HISTORICAL SURVEY
U.S. ARMY GARRISON, FITZSIMONS

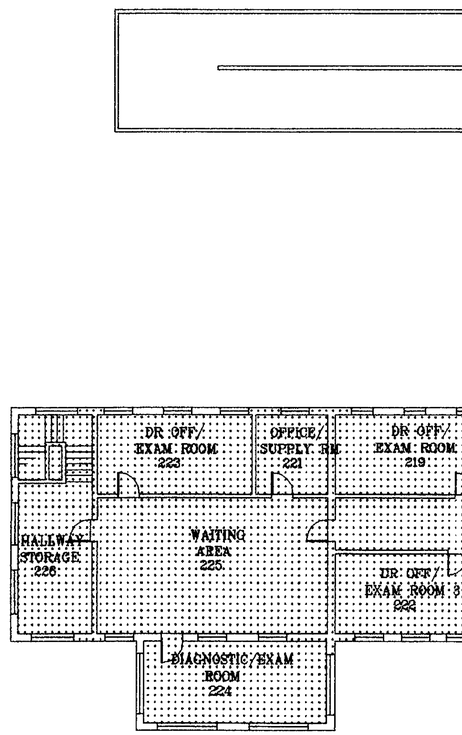
SOURCE:
U.S. Army Garrison, Fitzsimons

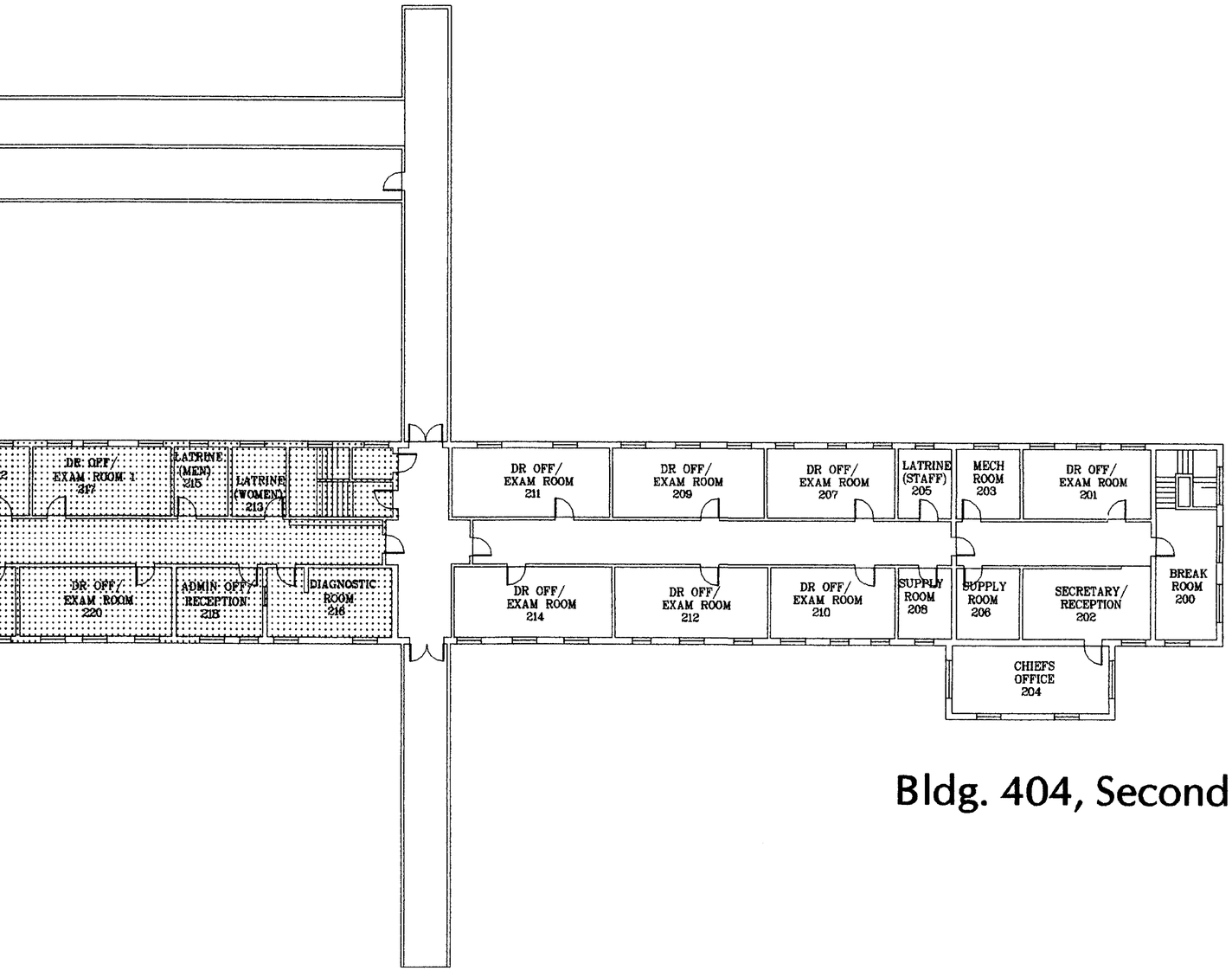
Location of Historical Radioisotope Use, Storage or Disposal Buildings 404 and 505

Projection: None (units feet)



Bldg. 404, First Floor





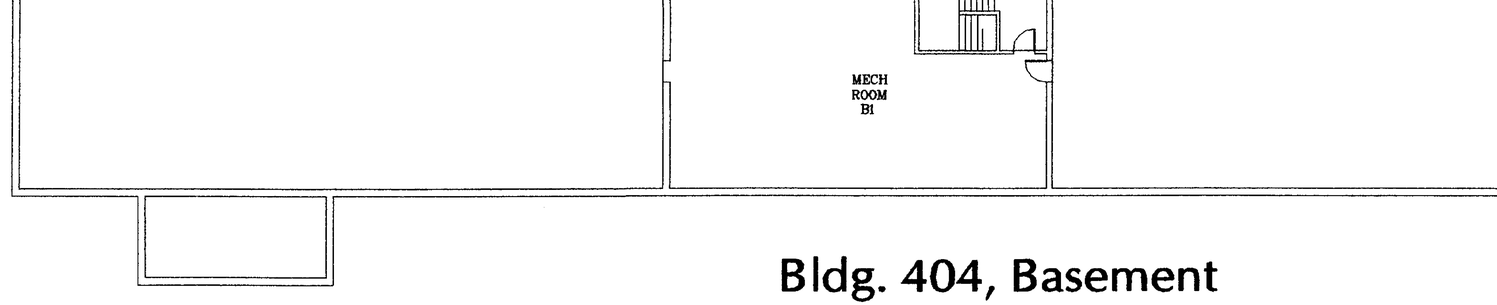
Bldg. 404, Second Floor

Legend

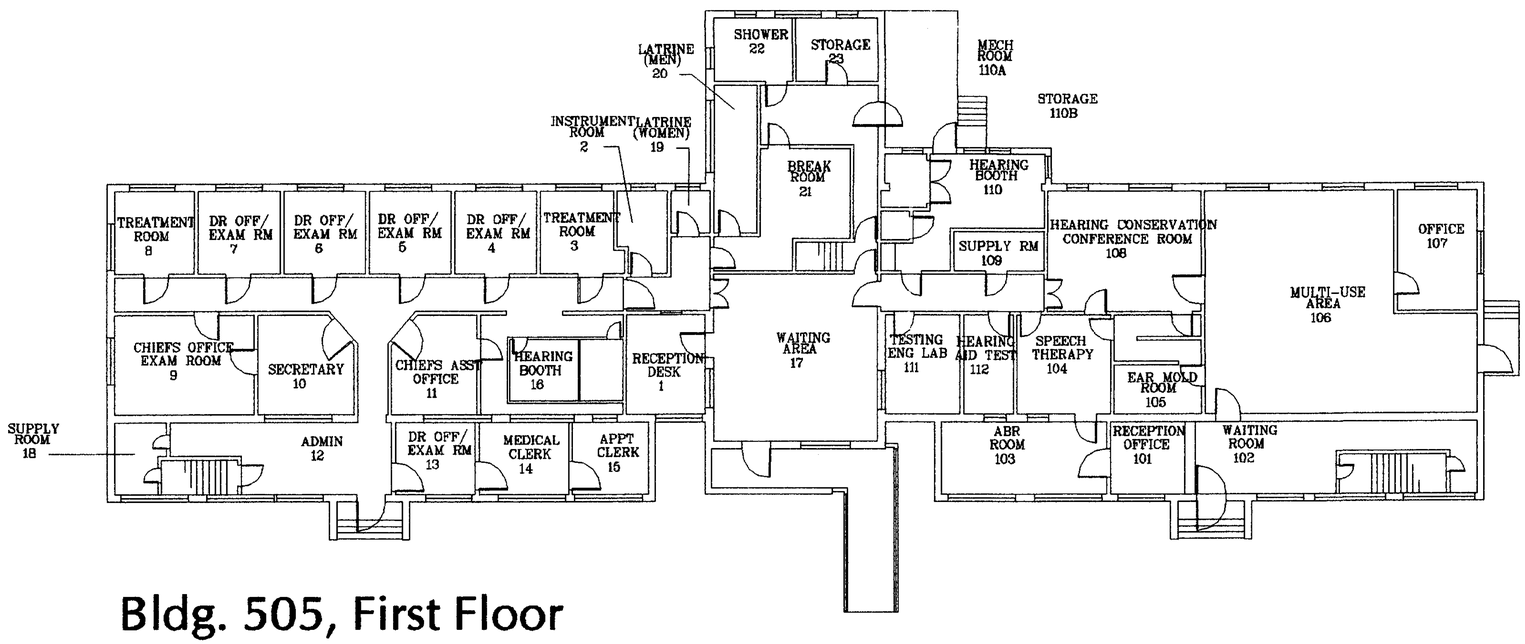
Suspected Affected Area

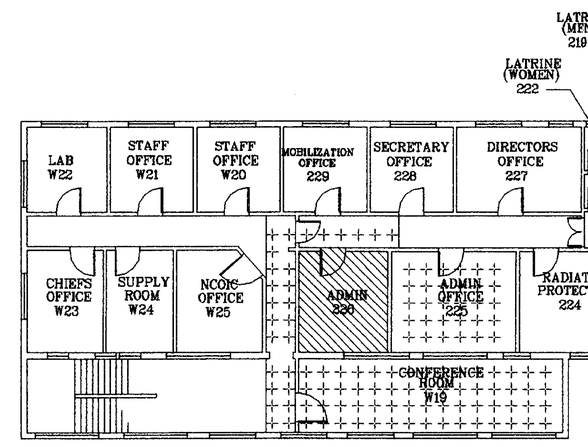
Indeterminate Area

Unaffected Area

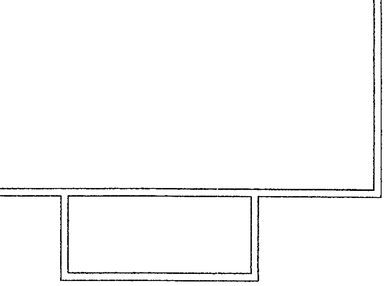


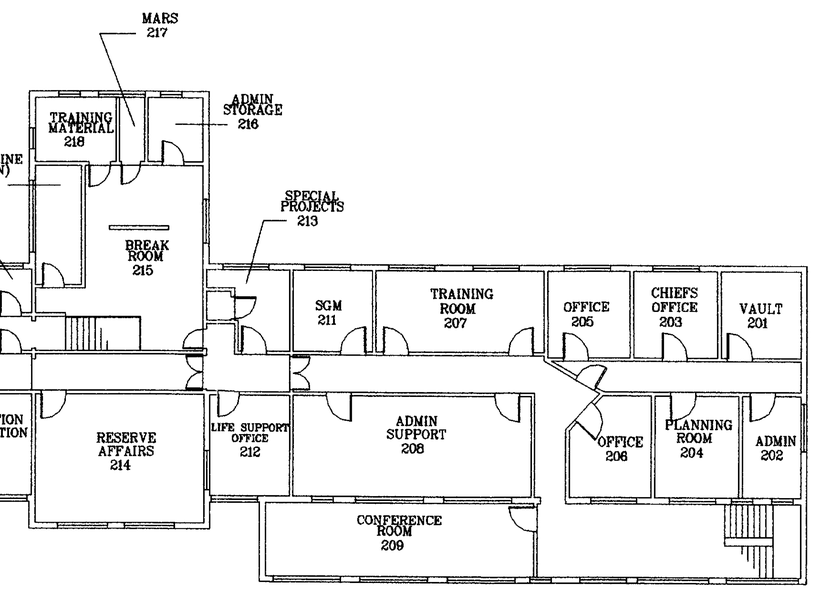
Bldg. 404, Basement



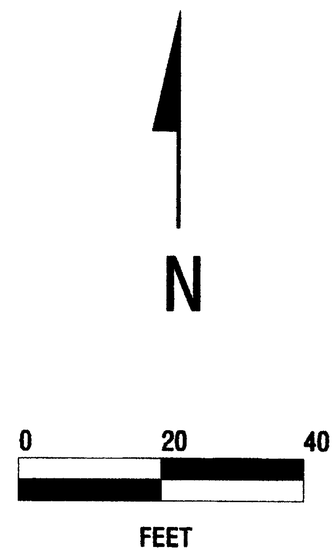


Bldg. 505, First Floor





Bldg. 505, Second Floor



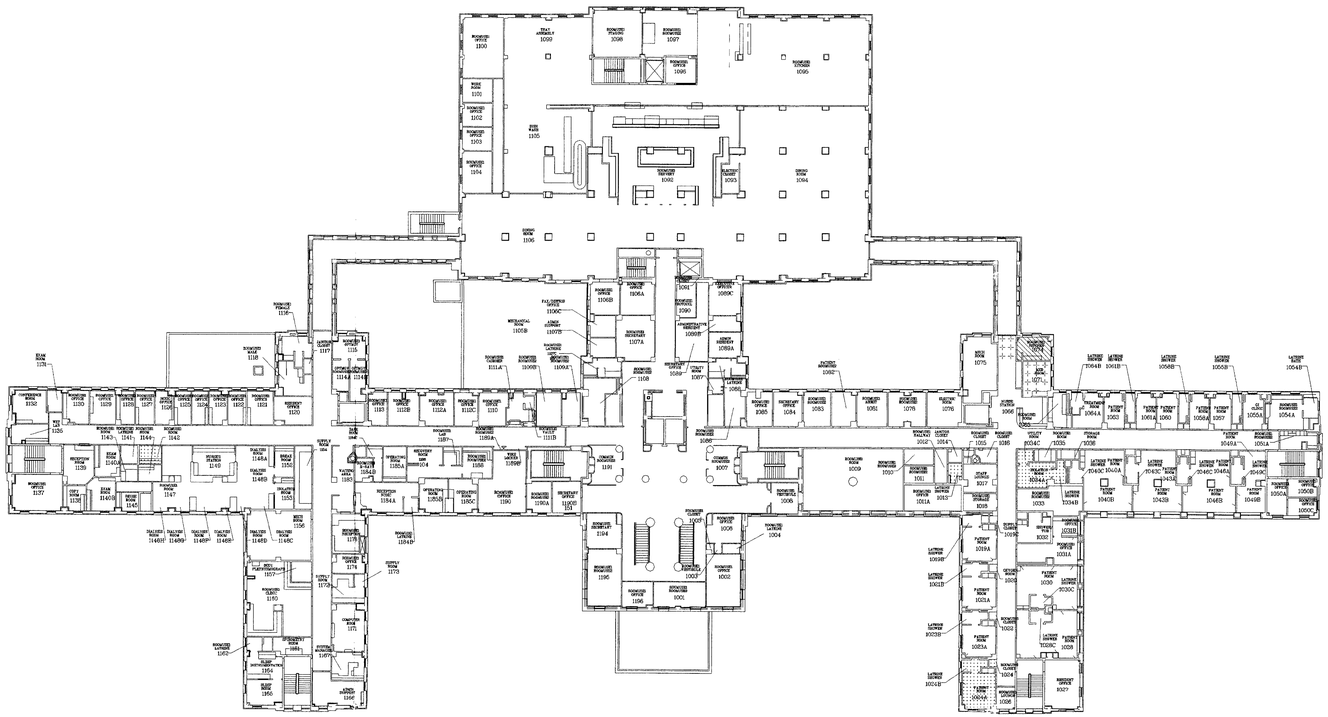
REVISION	DATE	DESCRIPTION	BY
A	10/96	Draft Historical Survey Report	JS
B	11/96	Final Historical Survey Report	JS

HISTORICAL SURVEY
U.S. ARMY GARRISON, FITZSIMONS

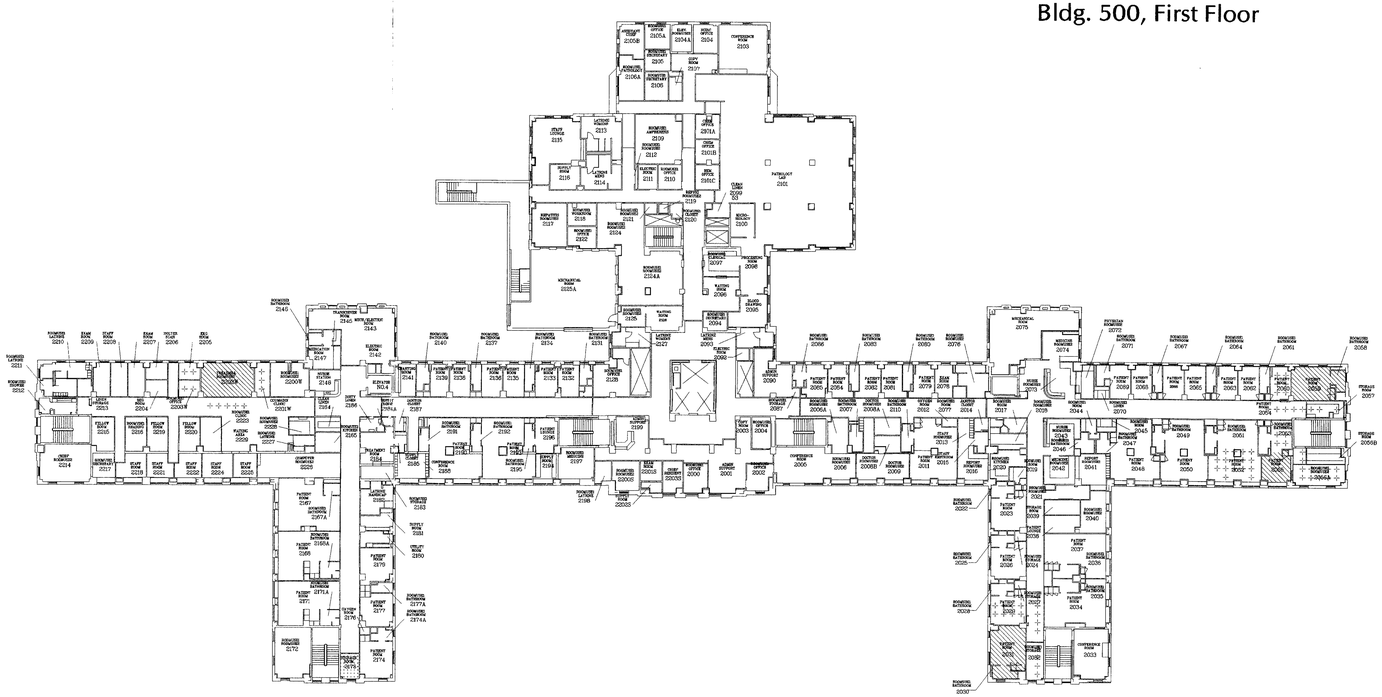
SOURCE:
U.S. Army Garrison, Fitzsimons

Location of Historical Radioisotope Use, Storage or Disposal Buildings 404 and 505

Projection: None (units feet)



Bldg. 500, First Floor



Bldg. 500, Second Floor

Legend

- Suspected Affected Area
- Indeterminate Area
- Unaffected Area

N

0 30 60

FEET

1 inch = 30 feet

REVISION	DATE	DESCRIPTION	BY
A	10/96	Draft Historical Survey Report	JS
B	11/96	Final Historical Survey Report	JS

HISTORICAL SURVEY
U.S. ARMY GARRISON, FITZSIMONS

SOURCE:
U.S. Army Garrison, Fitzsimons

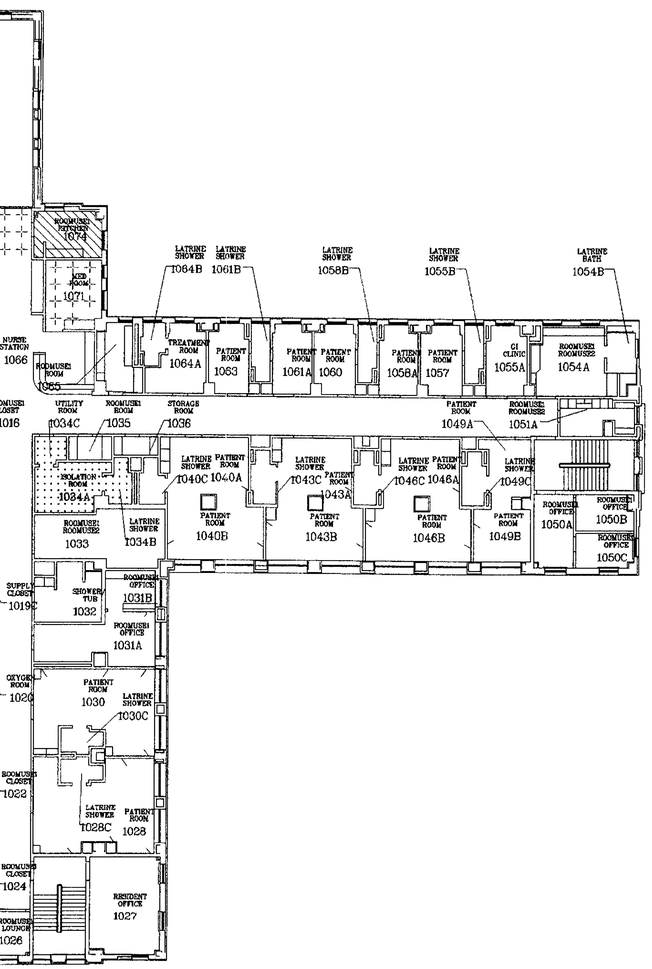
Location of Historical Radioisotope Use, Storage or Disposal
Building 500 -Floors 1 and 2

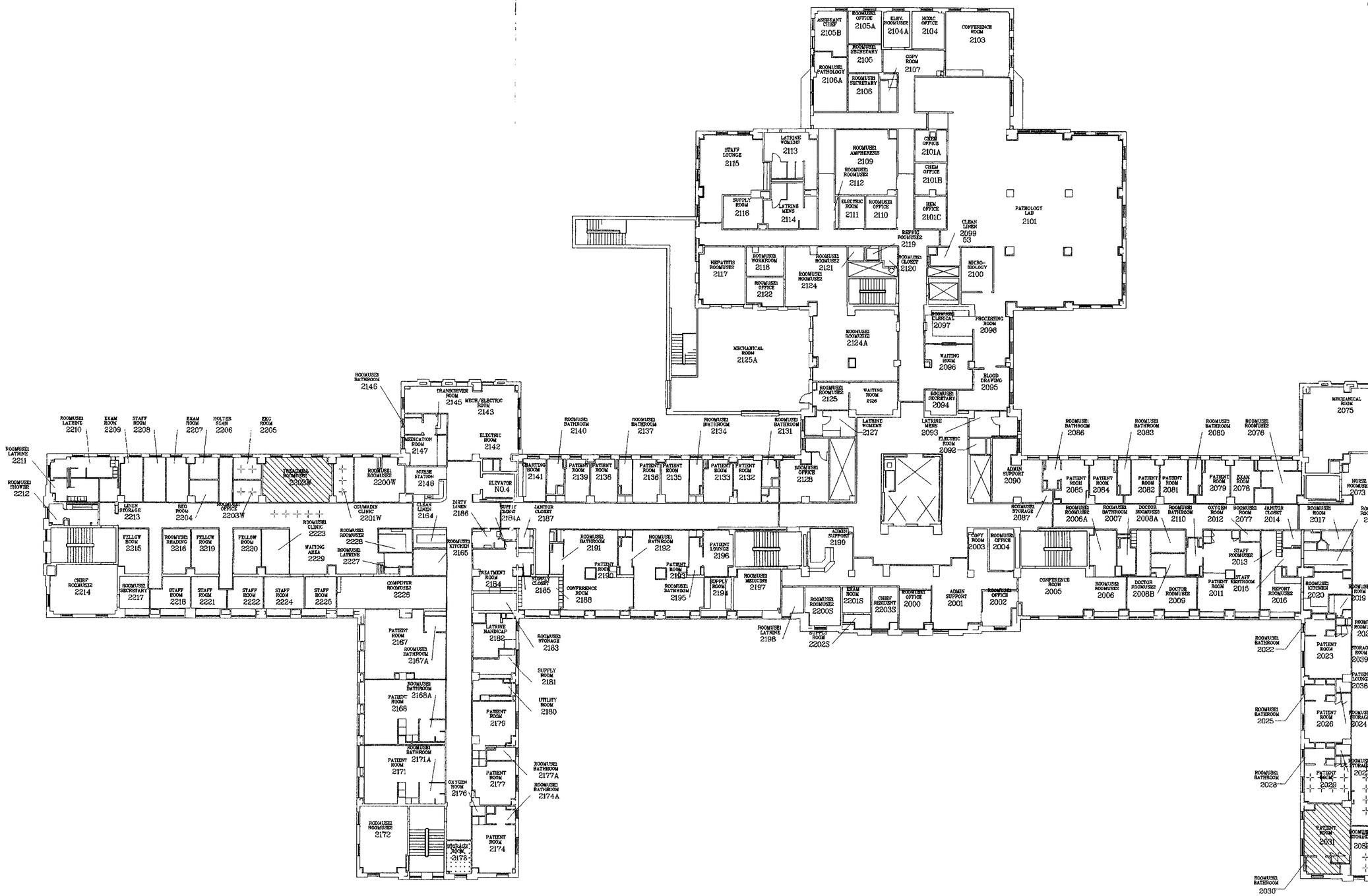
Projection: None (units feet)

ROOM/USE: OFFICE 1100
TRAY ASSEMBLY 1099
ROOM/USE: STAGING 1098
ROOM/USE: ROOM/USE2 1097
ROOM/USE: OFFICE 1096
ROOM/USE: KITCHEN 1095
WORK ROOM 1101
ROOM/USE: OFFICE 1102
ROOM/USE: OFFICE 1103
ROOM/USE: OFFICE 1104
DISH WASH 1105
ROOM/USE: SERVERY 1092
ELECTRIC CLOSET 1093
DINING ROOM 1094
DINING ROOM 1106
ROOM/USE: OFFICE 1106B
ROOM/USE: OFFICE 1106A
ROOM/USE: CLOSET 1091
EXECUTIVE OFFICE 1089C
ROOM/USE: PROTOCOL 1090
FAX/DENTRY OFFICE 1106C
MECHANICAL ROOM 1105B
ADMIN SUPPORT 1107B
ROOM/USE: SECRETARY 1107A
ADMINISTRATIVE RESIDENT 1089B
ADMIN RESIDENT 1089A
ROOM/USE: LATRINE 1107C
ROOM/USE: CASHIER 1111A
ROOM/USE: ROOM/USE2 1109B
ROOM/USE: ROOM/USE2 1109A
ROOM/USE: ROOM/USE2 1108
SECRETARY OFFICE 1089
UTILITY ROOM 1087
RESIDENT LATRINE 1088
MECH ROOM 1075
PATIENT ROOM/USE2 1082
ROOM/USE: OFFICE 1085
SECRETARY OFFICE 1084
ROOM/USE: ROOM/USE2 1083
ROOM/USE: ASSET 1081
ROOM/USE: ROOM/USE2 1076
ELECTRIC ROOM 1076
ROOM/USE: ROOM/USE2 1086
ROOM/USE: FEMALE 1116
JANITOR CLOSET 1117
ROOM/USE: OFFICE 1115
ROOM/USE: MALE 1118
OPTMGM ROOM/USE2 1114A
OPTMGM ROOM/USE2 1114B
EXAM ROOM 1131
CONFERENCE ROOM 1132
ROOM/USE: OFFICE 1130
ROOM/USE: OFFICE 1129
ROOM/USE: OFFICE 1128
ROOM/USE: OFFICE 1127
ROOM/USE: OFFICE 1126
ROOM/USE: OFFICE 1125
ROOM/USE: OFFICE 1124
ROOM/USE: OFFICE 1123
ROOM/USE: OFFICE 1122
ROOM/USE: OFFICE 1121
RESIDENT OFFICE 1120
ROOM/USE: OFFICE 1113
ROOM/USE: OFFICE 1112B
ROOM/USE: OFFICE 1112A
ROOM/USE: OFFICE 1112C
ROOM/USE: OFFICE 1110
ROOM/USE: VAULT 1111B
WET LAB 1135
ROOM/USE: ROOM 1143
ROOM/USE: LATRINE 1141
ROOM/USE: ROOM 1144
ROOM/USE: ROOM 1142
SUPPLY ROOM 1154
DARK ROOM 1184C
ROOM/USE: LAB 1187
ROOM/USE: ROOM/USE2 1189A
ROOM/USE: HALLWAY 1012
JANITOR CLOSET 1014
ROOM/USE: CLOSET 1015
RECEPTION ROOM 1139
EXAM ROOM 1140A
NURSES STATION 1149
DIALYSIS ROOM 1148A
BREAK ROOM 1152
DIALYSIS ROOM 1148B
OPERATING ROOM 1185A
RECOVERY ROOM 1186 104
ROOM/USE: ROOM/USE2 1188
WIRE LOCKER 1189B
COMMON ROOM/USE2 1191
COMMON ROOM/USE2 1007
ROOM/USE: ROOM 1009
ROOM/USE: ROOM/USE2 1010
ROOM/USE: ROOM/USE2 1011
STAFF LOUNGE 1017
ROOM/USE: OFFICE 1137
COPY ROOM 1138
EXAM ROOM 1140B
REUSE ROOM 1145
ROOM/USE: ROOM 1147
ISOLATION ROOM 1153
WAITING AREA 1183
ROOM/USE: X-RAY 1184B
RECEPTION ROOM 1184A
OPERATING ROOM 1185B
OPERATING ROOM 1185C
ROOM/USE: OFFICE 1190
ROOM/USE: ROOM/USE2 1190A
SECRETARY OFFICE 1190B 151
ROOM/USE: VESTIBULE 1008
ROOM/USE: OFFICE 1011A
LATRINE SHOWER 1013
ROOM/USE: STORAGE 1018
DIALYSIS ROOM 1148H
DIALYSIS ROOM 1148G
DIALYSIS ROOM 1148F
DIALYSIS ROOM 1148E
DIALYSIS ROOM 1148D
DIALYSIS ROOM 1148C
MECH ROOM 1156
ROOM/USE: LATRINE 1184B
ROOM/USE: SECRETARY 1194
ROOM/USE: CLOSET 1005
ROOM/USE: OFFICE 1006
ROOM/USE: LATRINE 1004
PATIENT ROOM 1019A
LATRINE SHOWER 1019B
ROOM/USE: RECEPTION 1175
ROOM/USE: OFFICE 1174
SUPPLY ROOM 1173
BODY PLETHYSMOGRAPH 1157
SUPPLY ROOM 1172
ROOM/USE: CLINIC 1160
ROOM/USE: ROOM/USE2 1195
ROOM/USE: VESTIBULE 1003
ROOM/USE: OFFICE 1002
LATRINE SHOWER 1021B
PATIENT ROOM 1021A
ROOM/USE: OFFICE 1196
ROOM/USE: ROOM/USE2 1001
COMPUTER ROOM 1171
SPIROMETRY ROOM 1161
ROOM/USE: LATRINE 1162
SYSTEM MANAGER 1167
LATRINE SHOWER 1023B
PATIENT ROOM 1023A
SLEEP INSTRUMENTATION 1164
SLEEP ROOM 1165
ADMIN SUPPORT 1166
LATRINE SHOWER 1024B
PATIENT ROOM 1024A

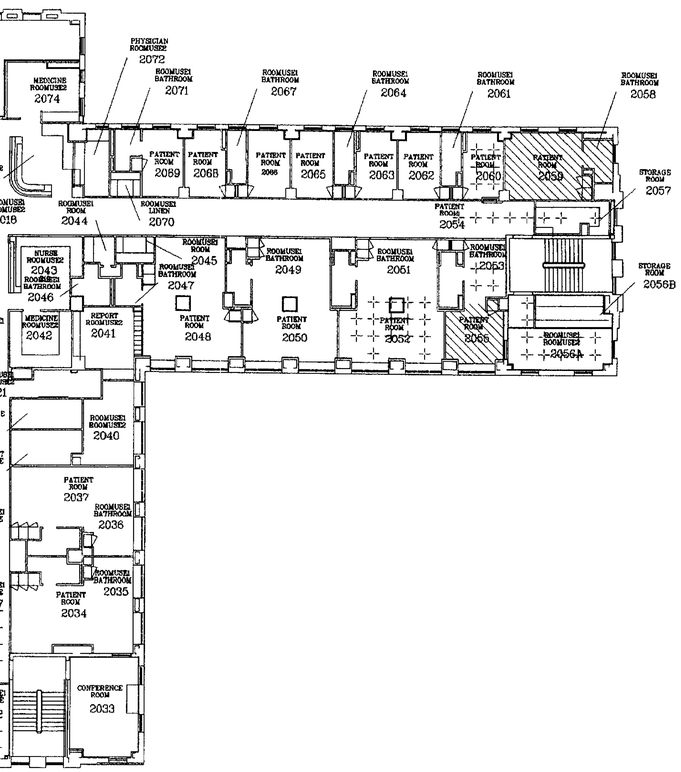
Legend

- Suspected Affected Area
- Indeterminate Area
- Unaffected Area




ASSISTANT CHIEF 2105B
ROOMUSE1 OFFICE 2105A
ELEV. ROOMUSE2 2104A
MCOAC OFFICE 2104
CONFERENCE ROOM 2103
ROOMUSE1 SECRETARY 2105
COPY ROOM 2107
ROOMUSE1 PATHOLOGY 2106A
ROOMUSE1 SECRETARY 2106
STAFF LOUNGE 2115
LATRINE WOMEN 2113
ROOMUSE1 AMPHEREZ3 2109
ROOMUSE1 ROOMUSE2 2112
CHEM OFFICE 2101A
CHEM OFFICE 2101B
SUPPLY ROOM 2116
LATRINE MENS 2114
ELECTRIC ROOM 2111
ROOMUSE1 OFFICE 2110
HEM OFFICE 2101C
PATHOLOGY LAB 2101
REFRIG ROOMUSE2 2119
CLEAN LINEN 2099 S3
HEPATITIS ROOMUSE2 2117
ROOMUSE1 WORKROOM 2118
ROOMUSE1 ROOMUSE2 2121
ROOMUSE1 ROOMUSE2 2124
ROOMUSE1 CLOSET 2120
MICRO-BIOLOGY 2100
ROOMUSE1 OFFICE 2122
MECHANICAL ROOM 2125A
ROOMUSE1 ROOMUSE2 2124A
ROOMUSE1 CLINICAL 2097
PROCESSING ROOM 2098
WAITING ROOM 2096
BLOOD DRAWING 2095
ROOMUSE1 ROOMUSE2 2125
WAITING ROOM 2126
ROOMUSE1 SECRETARY 2094
LATRINE MENS 2093
ELECTRIC ROOM 2092
LATRINE WOMEN 2127
ROOMUSE1 BATHROOM 2146
TRANSCEIVER ROOM 2145
MECH/ELECTRIC ROOM 2143
ELECTRIC ROOM 2142
MEDICATION ROOM 2147
ROOMUSE1 LATRINE 2210
EXAM ROOM 2209
STAFF ROOM 2208
EXAM ROOM 2207
HOLTER SCAN 2206
EKG ROOM 2205
ROOMUSE1 LATRINE 2211
ROOMUSE1 SHOWER 2212
TREADMILL ROOMUSE2 2202W
ROOMUSE1 ROOMUSE2 2200W
NURSE STATION 2148
ELEVATOR NO.4
LINEN STORAGE 2213
BED ROOM 2204
ROOMUSE1 OFFICE 2203W
COUMADIN CLINIC 2201W
CLEAN LINEN 2164
DIRTY LINEN 2186
SUPPLY CLOSET 2181A
JANITOR CLOSET 2187
ROOMUSE1 BATHROOM 2140
ROOMUSE1 BATHROOM 2137
ROOMUSE1 BATHROOM 2134
ROOMUSE1 BATHROOM 2131
STARTING ROOM 2141
PATIENT ROOM 2139
PATIENT ROOM 2138
PATIENT ROOM 2136
PATIENT ROOM 2135
PATIENT ROOM 2133
PATIENT ROOM 2132
ROOMUSE1 OFFICE 2128
ADMIN SUPPORT 2090
ROOMUSE1 BATHROOM 2086
ROOMUSE1 BATHROOM 2083
ROOMUSE1 BATHROOM 2080
ROOMUSE1 ROOMUSE2 2076
MECHANICAL ROOM 2075
PATIENT ROOM 2085
PATIENT ROOM 2084
PATIENT ROOM 2082
PATIENT ROOM 2081
PATIENT ROOM 2079
EXAM ROOM 2078
NURSE ROOMUSE2 2073
ROOMUSE1 STORAGE 2087
ROOMUSE1 ROOMUSE2 2006A
ROOMUSE1 BATHROOM 2007
DOCTOR ROOMUSE2 2008A
ROOMUSE1 BATHROOM 2110
OXYGEN ROOM 2012
ROOMUSE1 ROOM 2077
JANITOR CLOSET 2014
ROOMUSE1 ROOM 2017
FELLOW ROOM 2215
ROOMUSE1 READING 2216
FELLOW ROOM 2219
FELLOW ROOM 2220
ROOMUSE1 CLINIC 2223
WAITING AREA 2229
ROOMUSE1 ROOMUSE2 2228
ROOMUSE1 LATRINE 2227
ROOMUSE1 KITCHEN 2165
TREATMENT ROOM 2184
SUPPLY CLOSET 2185
ROOMUSE1 BATHROOM 2191
ROOMUSE1 BATHROOM 2192
PATIENT ROOM 2190
PATIENT ROOM 2193
PATIENT LOUNGE 2196
ADMIN SUPPORT 2199
COPY ROOM 2003
ROOMUSE1 OFFICE 2004
STAFF ROOMUSE2 2013
CHIEF ROOMUSE2 2214
ROOMUSE1 SECRETARY 2217
STAFF ROOM 2218
STAFF ROOM 2221
STAFF ROOM 2222
STAFF ROOM 2224
STAFF ROOM 2225
COMPUTER ROOMUSE2 2226
CONFERENCE ROOM 2188
ROOMUSE1 BATHROOM 2195
SUPPLY ROOM 2194
ROOMUSE1 MEDICINE 2197
ROOMUSE1 ROOMUSE2 2200S
EXAM ROOM 2201S
CHIEF RESIDENT 2203S
ROOMUSE1 OFFICE 2000
ADMIN SUPPORT 2001
ROOMUSE1 OFFICE 2002
CONFERENCE ROOM 2005
ROOMUSE1 ROOMUSE2 2006
DOCTOR ROOMUSE2 2008B
DOCTOR ROOMUSE2 2009
PATIENT ROOM 2011
STAFF RESTROOM 2015
REPORT ROOMUSE2 2016
ROOMUSE1 KITCHEN 2020
ROOMUSE1 LATRINE 2198
SUPPLY ROOM 2202S
PATIENT ROOM 2167
ROOMUSE1 BATHROOM 2167A
LATRINE HANDICAP 2182
ROOMUSE1 STORAGE 2183
SUPPLY ROOM 2181
UTILITY ROOM 2180
ROOMUSE1 BATHROOM 2168A
PATIENT ROOM 2168
PATIENT ROOM 2179
ROOMUSE1 BATHROOM 2171A
PATIENT ROOM 2171
OXYGEN ROOM 2176
PATIENT ROOM 2177
ROOMUSE1 BATHROOM 2177A
ROOMUSE1 BATHROOM 2174A
ROOMUSE1 ROOMUSE2 2172
STORAGE ROOM 2178
PATIENT ROOM 2174
ROOMUSE1 BATHROOM 2022
PATIENT ROOM 2023
ROOMUSE1 BATHROOM 2025
PATIENT ROOM 2026
ROOMUSE1 BATHROOM 2028
PATIENT ROOM 2029
PATIENT ROOM 2031
ROOMUSE1 BATHROOM 2030

Bldg. 500, First Floor



Bldg. 500, Second Floor

N

0 30 60

FEET

1 inch = 30 feet

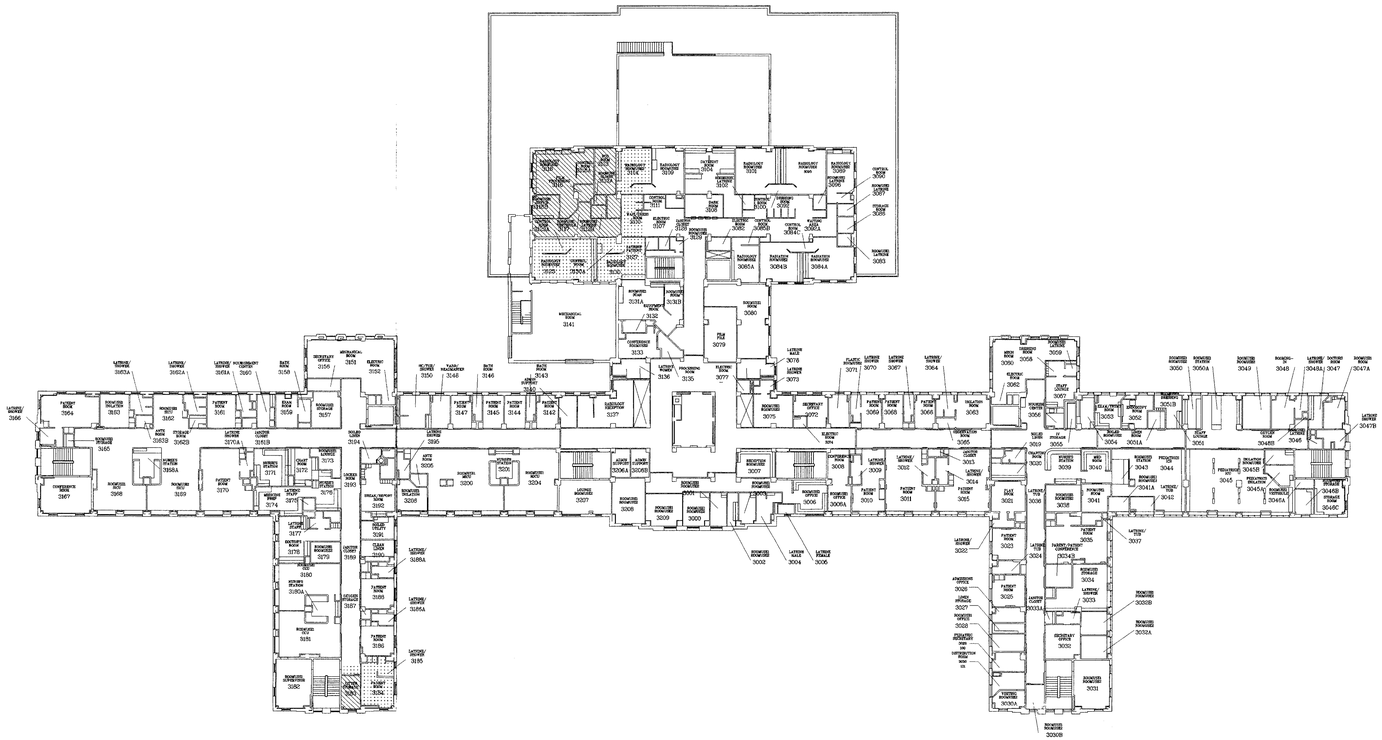
REVISION	DATE	DESCRIPTION	BY
A	10/96	Draft Historical Survey Report	JS
B	11/96	Final Historical Survey Report	JS

HISTORICAL SURVEY
U.S. ARMY GARRISON, FITZSIMONS

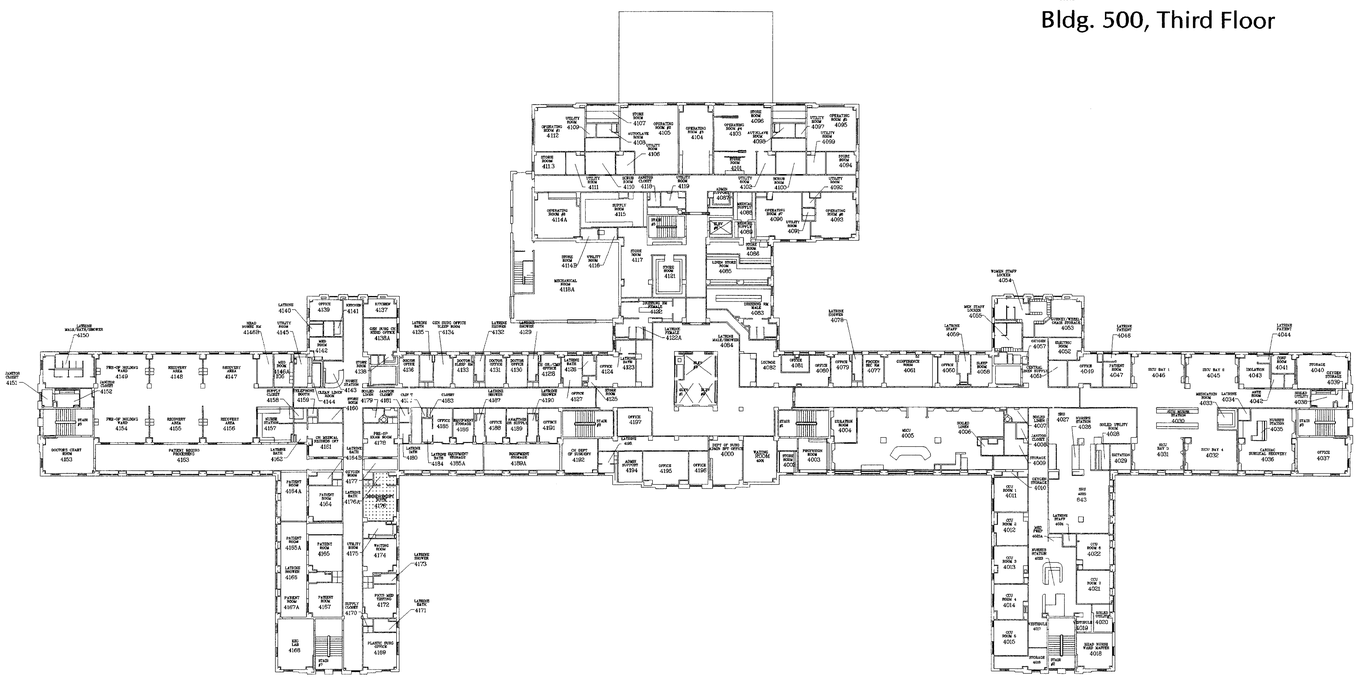
SOURCE:
U.S. Army Garrison, Fitzsimons

Location of Historical Radioisotope Use, Storage or Disposal Building 500 -Floors 1 and 2

Projection: None (units feet)



Bldg. 500, Third Floor



Bldg. 500, Fourth Floor

Legend

- Suspected Affected Area
- Indeterminate Area
- Unaffected Area

N

0 30 60

FEET

1 inch = 30 feet

REVISION	DATE	DESCRIPTION	BY
A	10/96	Draft Historical Survey Report	JS
B	11/96	Final Historical Survey Report	JS

HISTORICAL SURVEY
U.S. ARMY GARRISON, FITZSIMONS

SOURCE:
U.S. Army Garrison, Fitzsimons

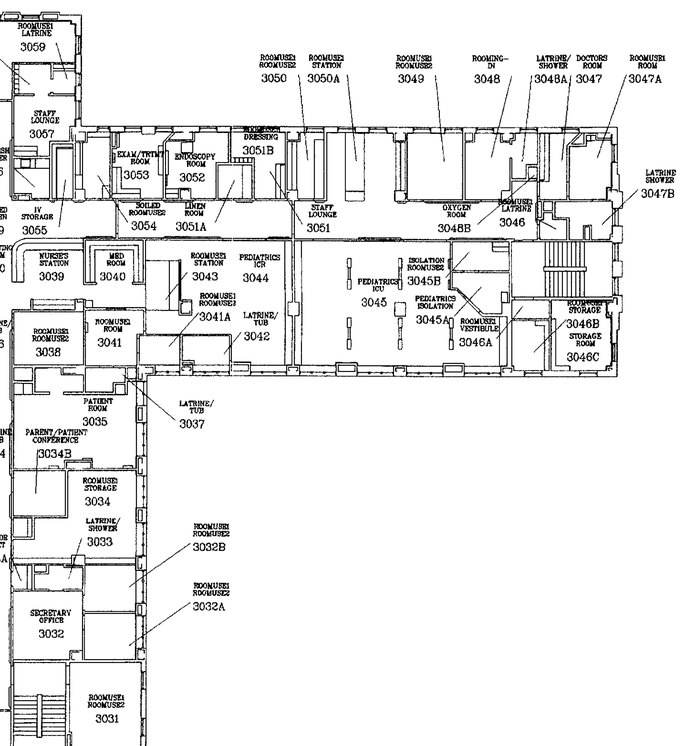
Location of Historical Radioisotope Use, Storage or Disposal
Building 500 -Floors 3 and 4

Projection: None (units feet)

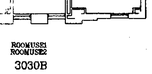
RADIOLOGY ROOMUSE2 3118
CONTROL ROOM 3119A
DOG ROOM 3113
ROOMUSE2 CLOSET 3112A
FILM PROCESSING 3116
ROOMUSE2 3115B
CONTROL ROOM 3129A
ROOMUSE2 3127
ROOMUSE2 LATRINE 3128B
RADIOLOGY ROOMUSE2 3123
CONTROL ROOM 3130A
RADIOLOGY ROOMUSE2 3114
RADIOLOGY ROOMUSE2 3109
CONTROL ROOM 3111
VAN/ESSES ROOM 3110
ELECTRIC ROOM 3107
LATRINE PATIENT 3127
RADIOLOGY ROOMUSE2 3130
DAYLIGHT ROOM 3104
DARK ROOM 3108
JANITOR CLOSET 3126
ROOMUSE2 ROOMUSE2 3129
RADIOLOGY ROOMUSE2 3101
RUSSIAN LATRINE 3102
CONTROL ROOM 3100
ELECTRIC ROOM 3082
CONTROL ROOM 3085B
RADIOLOGY ROOMUSE2 3085A
RADIOLOGY ROOMUSE2 8095
DRESSING ROOM 3092
CONTROL ROOM 3084C
RADIATION ROOMUSE2 3084B
RADIOLOGY ROOMUSE2 3089
WAITING AREA 3092A
RADIATION ROOMUSE2 3084A
ROOMUSE2 LATRINE 3096
CONTROL ROOM 3090
ROOMUSE2 LATRINE 3087
STORAGE ROOM 3086
ROOMUSE2 LATRINE 3083
MECHANICAL ROOM 3141
ROOMUSE2 SCAN 3131A
ROOMUSE2 ROOM 3131B
EQUIPMENT ROOM 3132
CONFERENCE ROOMUSE2 3133
ROOMUSE2 ROOM 3080
FILM FILE 3079
LATRINE/ WOMEN 3136
PROCESSING ROOM 3135
ELECTRIC ROOM 3077
LATRINE MALE 3076
LATRINE SHOWER 3073
PLASTIC ROOMUSE2 3071
LATRINE SHOWER 3070
LATRINE SHOWER 3067
LATRINE/ SHOWER 3064
MECH ROOM 3060
DRESSING ROOM 3058
ELECTRIC ROOM 3062
LATRINE/ SHOWER 3163A
LATRINE/ SHOWER 3162A
LATRINE/ SHOWER 3161A
NOURISHMENT CENTER 3160
BATH ROOM 3158
SECRETARY OFFICE 3156
MECHANICAL ROOM 3151
ELECTRIC ROOM 3152
HC/TUB/ SHOWER 3150
WARD/ HEADMASTER 3148
BATH ROOM 3146
BATH ROOM 3143
ADMIN SUPPORT 3140
PATIENT ROOM 3147
PATIENT ROOM 3145
PATIENT ROOM 3144
PATIENT ROOM 3142
RADIOLOGY RECEPTION 3137
ROOMUSE2 ROOMUSE2 3075
SECRETARY OFFICE 3072
ELECTRIC ROOM 3074
PATIENT ROOM 3069
PATIENT ROOM 3068
PATIENT ROOM 3066
ISOLATION ROOM 3063
OBSERVATION ROOM 3065
LATRINE/ SHOWER 3166
PATIENT ROOM 3164
ROOMUSE2 ISOLATION 3163
ROOMUSE2 3162
ANTE ROOM 3163B
STORAGE ROOM 3162B
PATIENT ROOM 3161
EXAM ROOM 3159
ROOMUSE2 STORAGE 3157
ROOMUSE2 STORAGE 3165
LATRINE SHOWER 3170A
JANITOR CLOSET 3161B
SOILED LINEN 3194
LATRINE SHOWER 3195
ANTE ROOM 3205
ROOMUSE2 MICU 3200
NURSES STATION 3201
ROOMUSE2 MICU 3204
ADMIN SUPPORT 3206A
ADMIN SUPPORT 3206B
LOUNGE ROOMUSE2 3207
ROOMUSE2 ROOMUSE2 3208
ROOMUSE2 ROOMUSE2 3209
ROOMUSE2 ROOMUSE2 3000
ROOMUSE2 ROOMUSE2 3001
ROOMUSE2 ROOMUSE2 3003
RECEPTION ROOMUSE2 3007
CONFERENCE ROOM 3008
LATRINE/ SHOWER 3009
LATRINE/ SHOWER 3012
JANITOR CLOSET 3013
LATRINE/ SHOWER 3014
PATIENT ROOM 3010
PATIENT ROOM 3011
PATIENT ROOM 3015
ROOMUSE2 OFFICE 3006
ROOMUSE2 OFFICE 3006A
ROOMUSE2 ROOMUSE2 3002
LATRINE MALE 3004
LATRINE FEMALE 3005
CONFERENCE ROOM 3167
ROOMUSE2 SICU 3168
NURSES STATION 3168A
ROOMUSE2 SICU 3169
PATIENT ROOM 3170
NURSES STATION 3171
CHART ROOM 3172
ROOMUSE2 LOUNGE 3173
MEDICINE PREP 3174
LATRINE STAFF 3175
NURSES STATION 3176
LATRINE STAFF 3177
DOCTOR'S ROOM 3178
ROOMUSE2 ROOMUSE2 3179
ROOMUSE2 CCU 3180
NURSES STATION 3180A
ROOMUSE2 CCU 3181
ROOMUSE2 SUPERVISOR 3182
LOCKER ROOM 3193
BREAK/REPORT ROOM 3192
SOILED UTILITY 3191
CLEAN LINEN 3190
JANITOR CLOSET 3189
OXYGEN STORAGE 3187
LATRINE/ SHOWER 3188A
PATIENT ROOM 3188
LATRINE/ SHOWER 3186A
PATIENT ROOM 3186
LATRINE/ SHOWER 3185
LATRINE STORAGE 3183
PATIENT ROOM 3184
ROOMUSE2 ISOLATION 3206
LATRINE/ SHOWER 3022
PATIENT ROOM 3023
PATIENT ROOM 3025
ADMISSIONS OFFICE 3026
LINEN STORAGE 3027
ROOMUSE2 OFFICE 3028
PEDIATRIC SECRETARY 3029 100
DISTRIBUTION ROOM 3030 101
VISITING ROOMUSE2

Legend

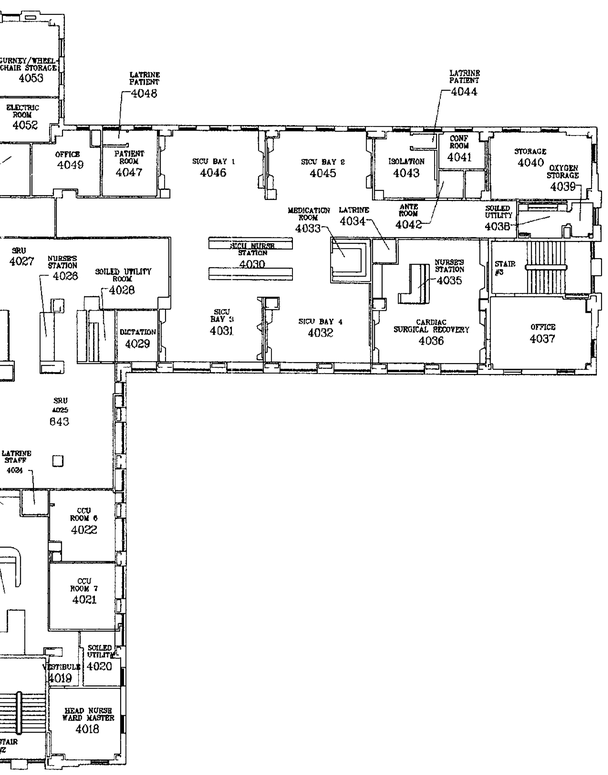
- Suspected Affected Area
- Indeterminate Area
- Unaffected Area



OPERATING ROOM #1 4112
UTILITY ROOM 4109
STORE ROOM 4107
OPERATING ROOM #2 4105
AUTOCLAVE ROOM 4108
UTILITY ROOM 4106
OPERATING ROOM #3 4104
STORE ROOM 4096
OPERATING ROOM #4 4103
AUTOCLAVE ROOM 4098
UTILITY ROOM 4097
OPERATING ROOM #5 4095
UTILITY ROOM 4099
STORIE ROOM 4113
UTILITY ROOM 4111
SCRUB ROOM 4110
JANITOR CLOSET 4118
UTILITY ROOM 4119
STORE ROOM 4101
UTILITY ROOM 4102
SCRUB ROOM 4100
STORE ROOM 4094
UTILITY ROOM 4092
ADMIN SUPPORT 4087
MEDICAL SUPPLY 4088
OPERATING ROOM #6 4114A
SUPPLY ROOM 4115
STAIR #5
ELEV #5
OPERATING ROOM #7 4090
UTILITY ROOM 4091
OPERATING ROOM #8 4093
MEDICAL SUPPLY 4089
STORE ROOM 4114B
UTILITY ROOM 4116
STORE ROOM 4117
STORE ROOM 4086
LINEN STORE ROOM 4085
MECHANICAL ROOM 4118A
STORE ROOM 4121
DRESSING RM FEMALE 4122
DRESSING RM MALE 4083
LATRINE FEMALE 4122A
LATRINE MALE/SHOWER 4084
WOMEN STAFF LOCKER 4054
MEN STAFF LOCKER 4055
LATRINE SHOWER 4076
LATRINE STAFF 4059
OXYGEN 4057
CENTRAL LINEN SUPPLY 4061
LATRINE 4140
OFFICE 4139
KITCHEN 4141
KITCHEN 4137
LATRINE MALE/BATH/SHOWER 4150
HEAD NURSE RM 4148B
UTILITY ROOM 4145
MED ROOM 4142
GEN SURG CH RESID OFFICE 4138A
LATRINE BATH 4135
GEN SURG OFFICE SLEEP ROOM 4134
LATRINE SHOWER 4132
LATRINE SHOWER 4129
LATRINE FEMALE 4122A
JANITOR CLOSET 4151
PRE-OP HOLDING WARD 4149
RECOVERY AREA 4148
RECOVERY AREA 4147
MED ROOM 4146A 106
STORE ROOM 4136
DOCTOR OFFICE 4136
DOCTOR SLEEP RM 4133
DOCTOR OFFICE 4131
DOCTOR OFFICE 4130
CH GR./CMS OFFICE 4128
LATRINE BATH 4126
OFFICE 4124
LATRINE 4123
ELEV #3
ELEV #4
LOUNGE 4082
OFFICE 4081
OFFICE 4080
OFFICE 4079
FROZEN SEC RM 4077
CONFERENCE ROOM 4061
OFFICE 4060
SLEEP ROOM 4058
JANITOR CLOSET 4152
NURSE STATION 4143
SUPPLY CLOSET 4158
TELEPHONE BOOTH 4159
CLEAN LINEN ROOM 4144
STORE ROOM 4160
SOILED LINEN 4179
JANITOR CLOSET 4181
CLOSET 4163
LATRINE SHOWER 4187
LATRINE SHOWER 4190
OFFICE 4127
STORE ROOM 4125
STAIR #6
PRE-OP HOLDING WARD 4154
RECOVERY AREA 4155
RECOVERY AREA 4156
NURSE STATION 4157
CH MEDICAL RECORDS OFF 4161
PRE-OP EXAM ROOM 4176
OFFICE 4185
EQUIPMENT STORAGE 4186
OFFICE 4188
ANASTHESION SUPPLY 4189
OFFICE 4191
STAIR #8
OFFICE 4197
STAIR #1
EXCLATION ROOM 4004
MICU 4005
SOILED LINEN 4006
SOILED LINEN 4007
JANITOR CLOSET 4008
DOCTOR'S CHART ROOM 4153
PATIENT RECORD PROCESSING 4163
LATRINE BATH 4162
LATRINE BATH 4164B
LATRINE BATH 4180
LATRINE BATH 4184
EQUIPMENT STORAGE 4185A
EQUIPMENT STORAGE 4189A
CH DEPT OF SURGERY 4192
LATRINE 4193
ADMIN SUPPORT 4194
OFFICE 4195
OFFICE 4196
DEPT OF SURG ADMIN SPT OFFICE 4000
WAITING ROOM 4001
STORE ROOM 4002
PROFUSION ROOM 4003
STORAGE 4009
OXYGEN STORAGE 4010
OXYGEN ROOM 4177
PATIENT ROOM 4164A
PATIENT ROOM 4164
LATRINE BATH 4176A
SHOWER BATH 4176
CCU ROOM 1 4011
CCU ROOM 2 4012
MED PREP 4022A
NURSES STATION 4023
PATIENT ROOM 4165A
PATIENT ROOM 4165
UTILITY ROOM 4175
WAITING ROOM 4174
LATRINE SHOWER 4173
LATRINE SHOWER 4166
CCU ROOM 3 4013
CCU ROOM 4 4014
PATIENT ROOM 4167A
PATIENT ROOM 4167
SUPPLY CLOSET 4170
PHYS MED TESTING 4172
LATRINE BATH 4171
VESTIBULE 4017
CCU ROOM 5 4015
STORAGE 4018
EEG LAB 4168
STAIR #7
PLASTIC SURG OFFICE 4169



Bldg. 500, Third Floor



Bldg. 500, Fourth Floor

N

0 30 60

FEET

1 inch = 30 feet

REVISION	DATE	DESCRIPTION	BY
A	10/96	Draft Historical Survey Report	JS
B	11/96	Final Historical Survey Report	JS

HISTORICAL SURVEY
U.S. ARMY GARRISON, FITZSIMONS

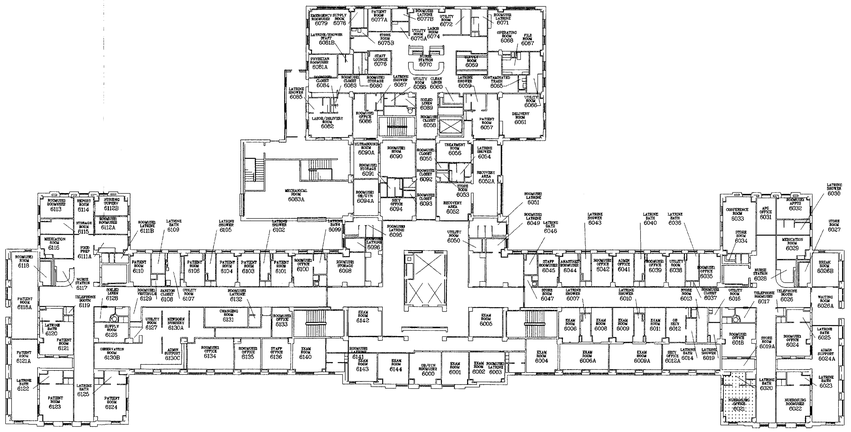
SOURCE:
U.S. Army Garrison, Fitzsimons

Location of Historical Radioisotope Use, Storage or Disposal Building 500 -Floors 3 and 4

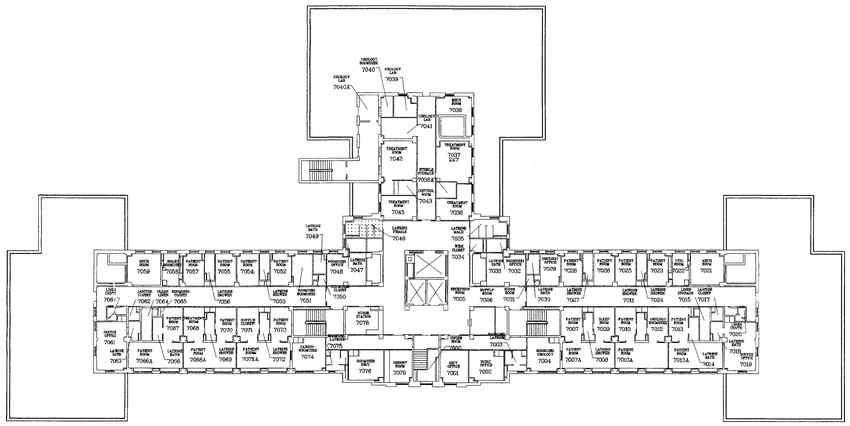
Projection: None (units feet)

Legend

- Suspected Affected Area
- Indeterminate Area
- Unaffected Area



Bldg. 500, Sixth Floor



Bldg. 500, Seventh Floor

N

0 30 60

FEET

1 inch = 30 feet

REVISION	DATE	DESCRIPTION	BY
A	10/96	Draft Historical Survey Report	JS
B	11/96	Final Historical Survey Report	JS

HISTORICAL SURVEY
U.S. ARMY GARRISON, FITZSIMONS

SOURCE:
U.S. Army Garrison, Fitzsimons

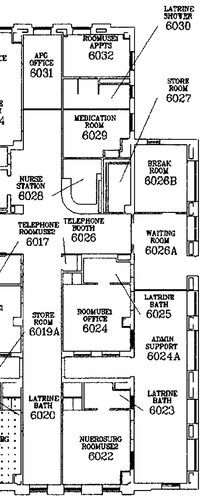
Location of Historical Radioisotope Use, Storage or Disposal
Building 500 -Floors 6 and 7

Projection: None (units feet)

EMERGENCY SUPPLY ROOM/USED ROOM 6079 6078
PATIENT ROOM 6077A
ROOM/USED LATRINE 6077B
UTILITY ROOM 6072
ROOM/USED LATRINE 6071
LATRINE/SHOWER HELPT 6081B
STORE ROOM 6075B
UTILITY ROOM 6075A
LABOR ROOM 6074
OPERATING ROOM 6068
FILE ROOM 6067
PHYSICIAN ROOM/USED 6081A
STAFF LOUNGE 6076
NURSE STATION 6070
SURGICAL ROOM 6069
ROOM/USED CLOSET 6084
ROOM/USED CLOSET 6083
ROOM/USED STORAGE 6080
LATRINE SHOWER 6087
UTILITY ROOM 6088
CLEAN LINEN 6060
LATRINE SHOWER 6059
CONTAMINATED TRASH 6065
LATRINE SHOWER 6085
SOILED LINEN 6089
UTILITY ROOM 6066
LABOR/DELIVERY ROOM 6082
ROOM/USED OFFICE 6086
ROOM/USED CLOSET 6058
PATIENT ROOM 6057
DELIVERY ROOM 6061
ULTRASOUND ROOM 6090A
ROOM/USED ROOM 6090
ROOM/USED CLOSET 6055
TREATMENT ROOM 6056
LATRINE SHOWER 6054
ROOM/USED STORAGE 6091
ROOM/USED CLOSET 6092
RECOVERY AREA 6052A
MECHANICAL ROOM 6063A
ROOM/USED OB/GYN 6094A
SECY OFFICE 6094
ROOM/USED CLOSET 6093
STORE ROOM 6053
RECOVERY AREA 6052
ROOM/USED LATRINE 6051
ROOM/USED LATRINE 6049
LATRINE BATH 6046
UTILITY ROOM 6050
LATRINE SHOWER 6043
LATRINE BATH 6040
LATRINE BATH 6036
ROOM/USED ROOM 6113
REPORT ROOM 6114
NURSING SUPPRV 6112B
STORAGE ROOM 6115
ROOM/USED ROOM/USED 6112A
ROOM/USED LATRINE 6111B
LATRINE BATH 6109
LATRINE SHOWER 6105
LATRINE SHOWER 6102
LATRINE BATH 6099
ROOM/USED LATRINE 6095
ROOM/USED LATRINE 6096
MEDICATION ROOM 6116
FOOD PREP 6111A
ROOM/USED ROOM 6118
NURSE STATION 6117
PATIENT ROOM 6110
PATIENT ROOM 6106
PATIENT ROOM 6104
PATIENT ROOM 6103
PATIENT ROOM 6101
ROOM/USED OFFICE 6100
ROOM/USED STORAGE 6098
STAFF ROOM/USED 6045
ANASTHES ROOM/USED 6044
ROOM/USED OFFICE 6042
ADMIN OFFICE 6041
ROOM/USED OFFICE 6039
UTILITY ROOM 6038
ROOM/USED OFFICE 6035
PATIENT ROOM 6118A
TELEPHONE BOOTH 6119
SOILED LINEN 6126
ROOM/USED VESTIBULE 6129
JANITOR CLOSET 6108
UTILITY ROOM 6107
ROOM/USED LATRINE 6132
STORE ROOM 6047
LATRINE SHOWER 6007
LATRINE SHOWER 6010
STORE ROOM 6013
ROOM/USED CLOSET 6037
UTILITY ROOM 6016
LATRINE BATH 6120
PATIENT ROOM 6121
SUPPLY ROOM 6126
UTILITY ROOM 6127
NEWBORN NURSERY 6130A
CHANGING ROOM 6131
ROOM/USED OFFICE 6133
EXAM ROOM 6142
EXAM ROOM 6005
EXAM ROOM 6006
EXAM ROOM 6008
EXAM ROOM 6009
EXAM ROOM 6011
OB SECY 6012
PATIENT ROOM 6121A
OBSERVATION ROOM 6130B
ADMIN SUPPORT 6130C
ROOM/USED OFFICE 6134
ROOM/USED OFFICE 6135
STAFF OFFICE 6136
EXAM ROOM 6140
ROOM/USED LATRINE 6141
EXAM ROOM 6143
EXAM ROOM 6144
OB/GYN ROOM/USED 6000
EXAM ROOM 6001
EXAM ROOM 6002
ROOM/USED LATRINE 6003
EXAM ROOM 6004
EXAM ROOM 6006A
EXAM ROOM 6009A
SECY OFFICE 6012A
LATRINE BATH 6014
LATRINE SHOWER 6019
LATRINE BATH 6122
PATIENT ROOM 6123
LATRINE BATH 6125
PATIENT ROOM 6124

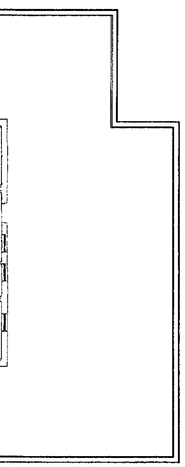
Legend

- Suspected Affected Area
- Indeterminate Area
- Unaffected Area



Bldg. 500, Sixth Floor

UROLOGY ROOM USE2 7040
UROLOGY LAB 7039
UROLOGY LAB 7040A
MECH ROOM 7038
UROLOGY LAB 7041
TREATMENT ROOM 7042
TREATMENT ROOM 7037 247
STERILE STORAGE 7036A
CONTROL ROOM 7043
TREATMENT ROOM 7045
TREATMENT ROOM 7036
LATRINE BATH 7049
LATRINE FEMALE 7046
LATRINE MALE 7035
WIRE CLOSET 7034
MECH ROOM 7059
SOILED ROOM USE2 7058
PATIENT ROOM 7057
PATIENT ROOM 7055
PATIENT ROOM 7054
PATIENT ROOM 7052
ROOM USE2 OFFICE 7048
LATRINE BATH 7047
LATRINE BATH 7033
ROOM USE2 OFFICE 7032
UROLOGY OFFICE 7029
PATIENT ROOM 7028
PATIENT ROOM 7026
PATIENT ROOM 7025
PATIENT ROOM 7023
UTIL ROOM 7022
MECH ROOM 7021
LINEN CHUTE 7061
JANITOR CLOSET 7062
CLEAN LINEN 7064
ROOM USE2 CLOSET 7065
LATRINE SHOWER 7056
LATRINE SHOWER 7053
ROOM USE2 ROOM USE2 7051
ROOM USE2 CLOSET 7050
RECEPTION ROOM 7005
SUPPLY ROOM 7006
STORE ROOM 7031
LATRINE BATH 7030
LATRINE SHOWER 7027
LATRINE SHOWER 7011
LATRINE SHOWER 7024
LINEN STORAGE 7015
JANITOR CLOSET 7017
DOCTOR OFFICE 7061
PATIENT ROOM 7067
TREATMENT ROOM 7068
PATIENT ROOM 7070
SUPPLY CLOSET 7071
PATIENT ROOM 7073
NURSE STATION 7078
PATIENT ROOM 7007
SLEEP ROOM 7009
PATIENT ROOM 7010
UROLOGY ROOM USE2 7012
PATIENT ROOM 7013
LINEN CHUTE 7020
LATRINE BATH 7018
DOCTOR OFFICE 7019
LATRINE BATH 7063
PATIENT ROOM 7066A
LATRINE BATH 7066
PATIENT ROOM 7068A
LATRINE SHOWER 7069
PATIENT ROOM 7071A
LATRINE SHOWER 7072
CARDIO-ROOM USE2 7074
ROOM USE2 LATRINE 7075
ROOM USE2 SHOT 7076
REPORT ROOM 7079
COPIER ROOM 7000
ROOM USE2 LATRINE 7003
SDCY OFFICE 7001
NCOIC OFFICE 7002
ROOM USE2 UROLOGY 7004
PATIENT ROOM 7007A
LATRINE SHOWER 7008
PATIENT ROOM 7010A
PATIENT ROOM 7013A
LATRINE BATH 7014



Bldg. 500, Seventh Floor

N

0 30 60

FEET

1 inch = 30 feet

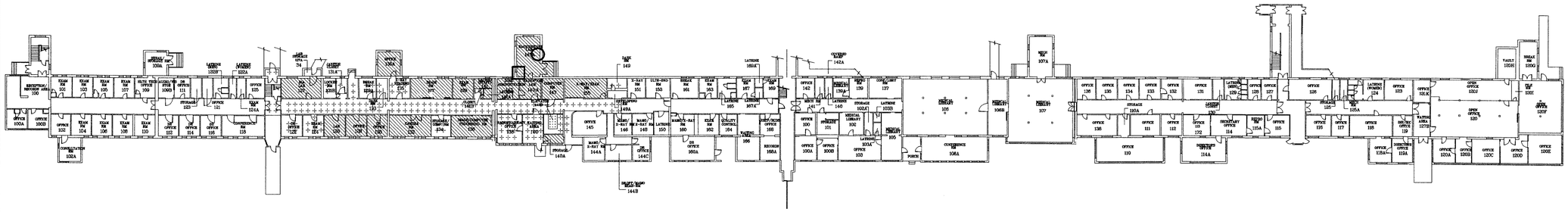
REVISION	DATE	DESCRIPTION	BY
A	10/96	Draft Historical Survey Report	JS
B	11/96	Final Historical Survey Report	JS

HISTORICAL SURVEY
U.S. ARMY GARRISON, FITZSIMONS

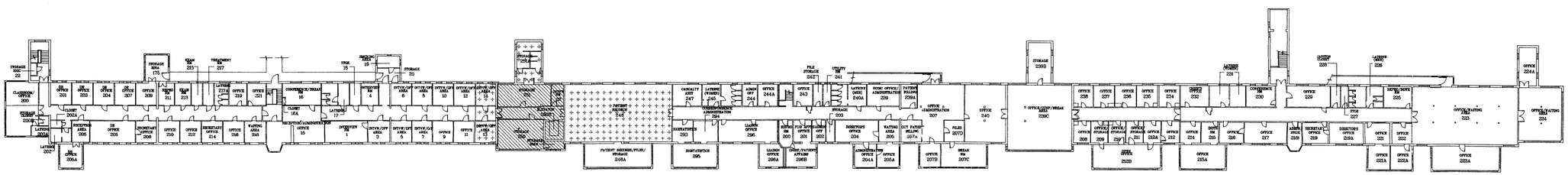
SOURCE:
U.S. Army Garrison, Fitzsimons

Location of Historical Radioisotope Use, Storage or Disposal
Building 500 -Floors 6 and 7

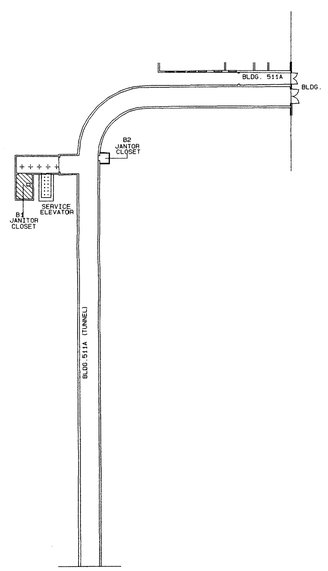
Projection: None (units feet)



Bldg. 511, First Floor



Bldg. 511, Second Floor



Bldg. 511A, Tunnel

Legend

- Suspected Affected Area
- Indeterminate Area
- Unaffected Area
- △ Former or Present Hood Location
- ○ Former or Present Sink/Shower Location
- □ Former or Present Refrigerator Location

N

0 30 60

FEET

1 inch = 30 feet

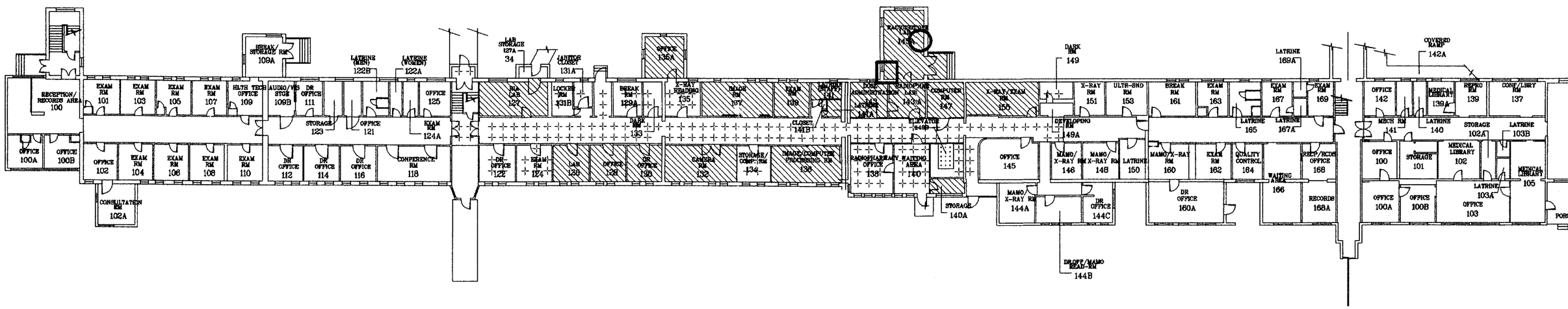
REVISION	DATE	DESCRIPTION	BY
A	10/96	Draft Historical Survey Report	JS
B	11/96	Final Historical Survey Report	JS

HISTORICAL SURVEY
U.S. ARMY GARRISON, FITZSIMONS

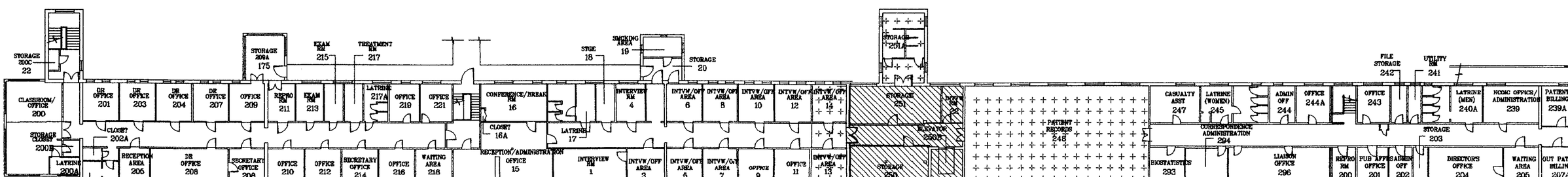
SOURCE: U.S. Army Garrison, Fitzsimons

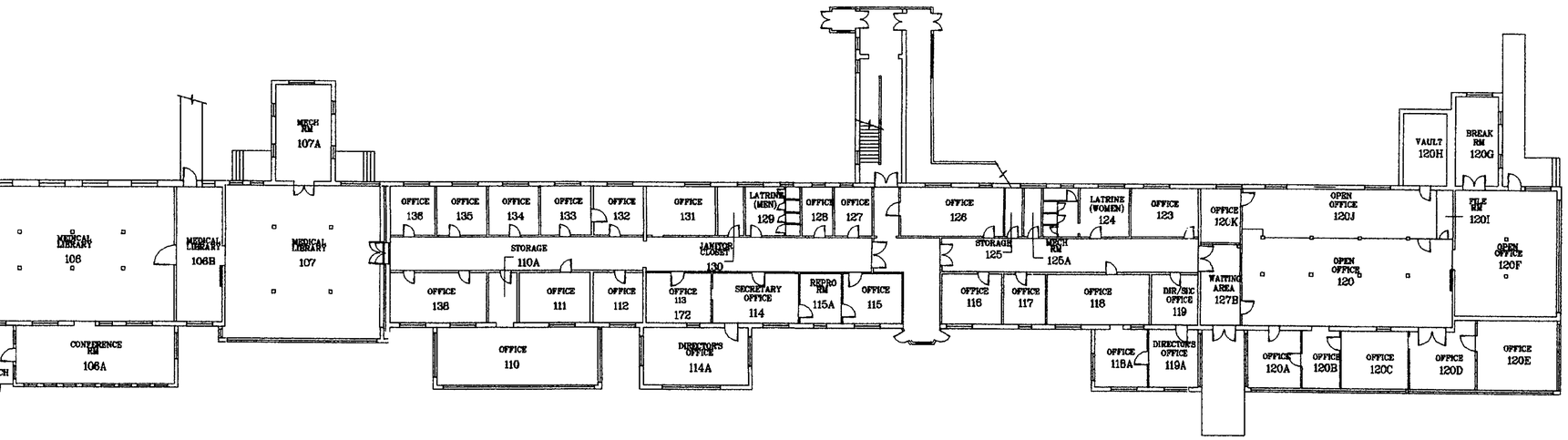
Location of Historical Radioisotope Use, Storage or Disposal Buildings 511 and 511A

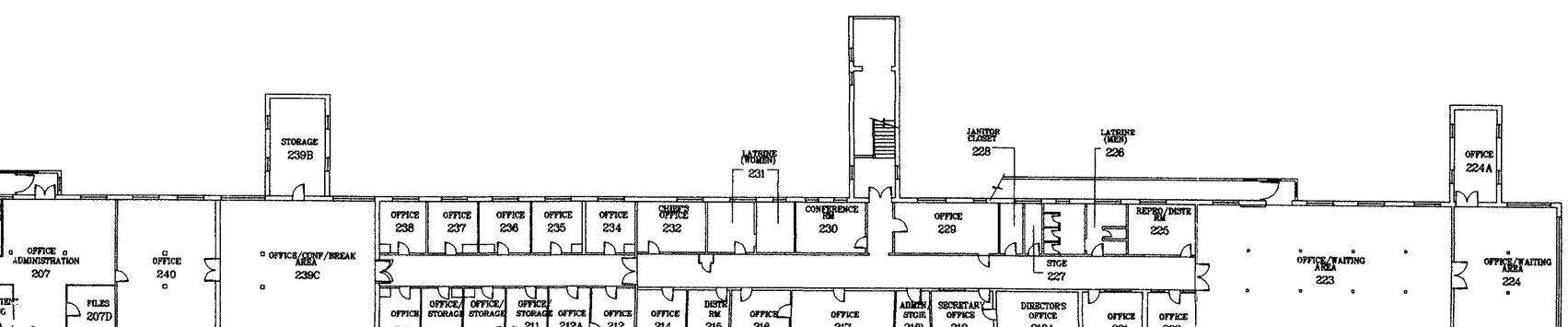
Projection: None (units feet)



Bldg. 511, First Floor



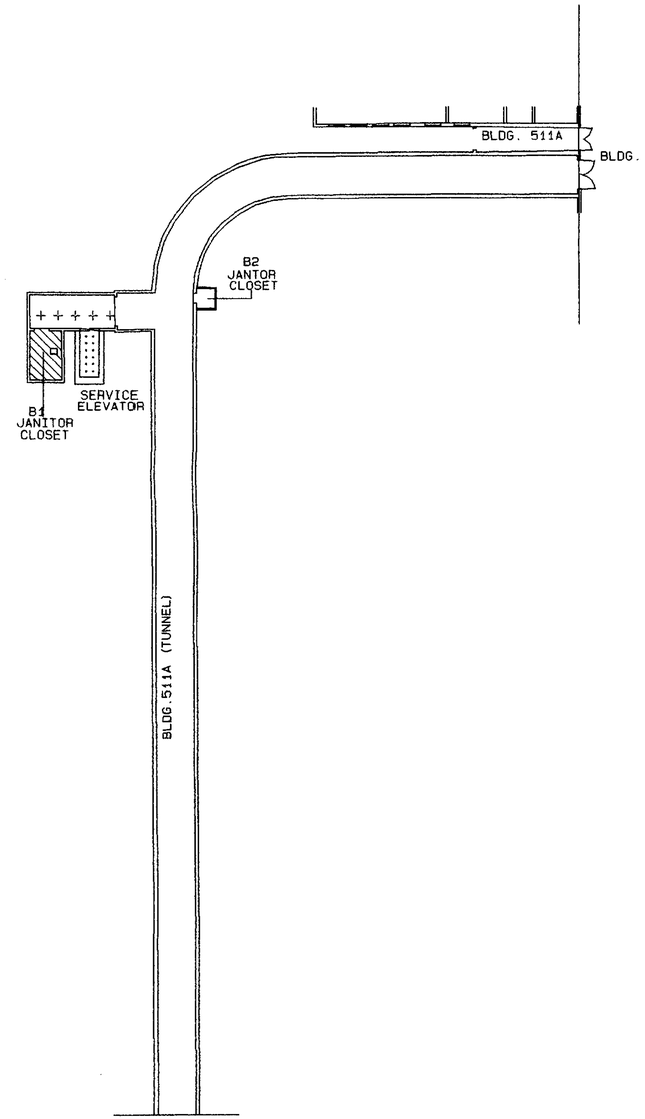




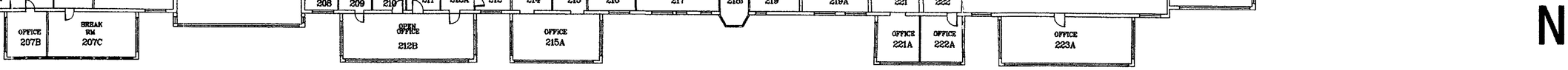
Legend

- Suspected Affected Area
- Indeterminate Area
- Unaffected Area
- △ Former or Present Hood Location
- ○ Former or Present Sink/Shower Location
- □ Former or Present Refrigerator Location

Bldg. 511, Second Floor



Bldg. 511A, Tunnel



0 30 60

FEET

1 inch = 30 feet

REVISION	DATE	DESCRIPTION	BY
A	10/96	Draft Historical Survey Report	JS
B	11/96	Final Historical Survey Report	JS

HISTORICAL SURVEY
U.S. ARMY GARRISON, FITZSIMONS

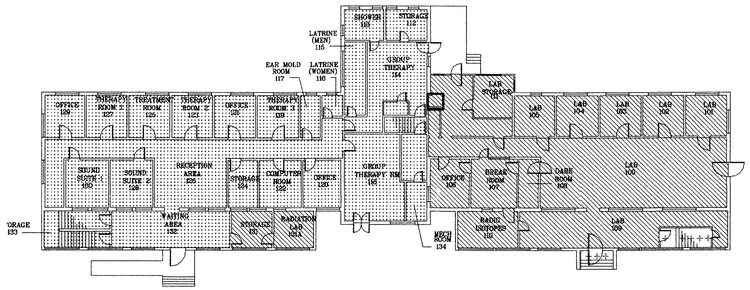
SOURCE:
U.S. Army Garrison, Fitzsimons

Location of Historical Radioisotope Use, Storage or Disposal Buildings 511 and 511A

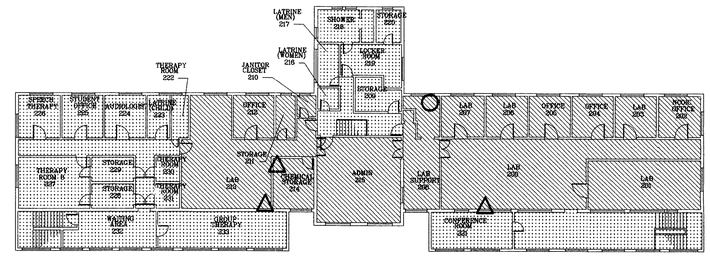
Projection: None (units feet)

Legend

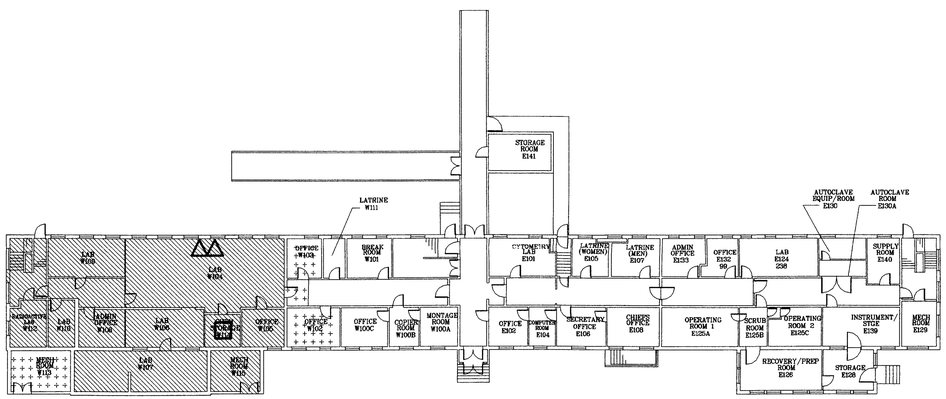
- Suspected Affected Area
- Indeterminate Area
- Unaffected Area
- △ Former or Present Hood Location
- ○ Former or Present Sink/Shower Location
- □ Former or Present Refrigerator Location



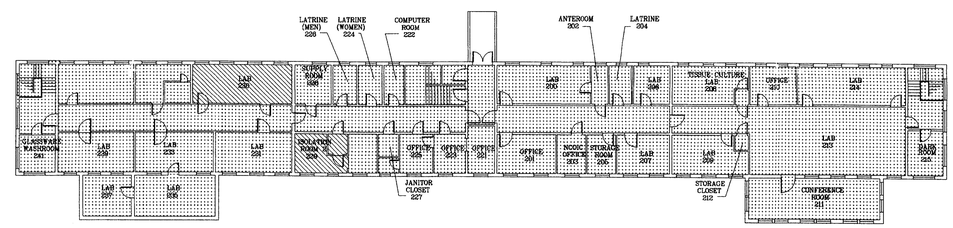
Bldg. 600, First Floor



Bldg. 600, Second Floor



Bldg. 601, First Floor



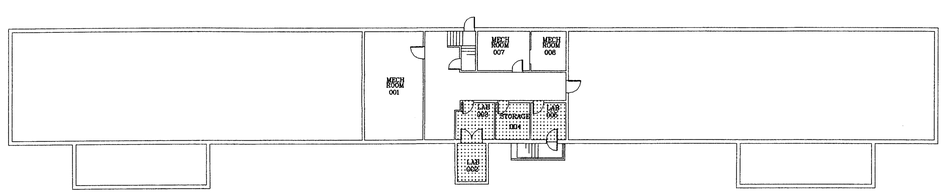
Bldg. 601, Second Floor

N

0 20 40

FEET

1 inch = 20 feet



Bldg. 601, Basement

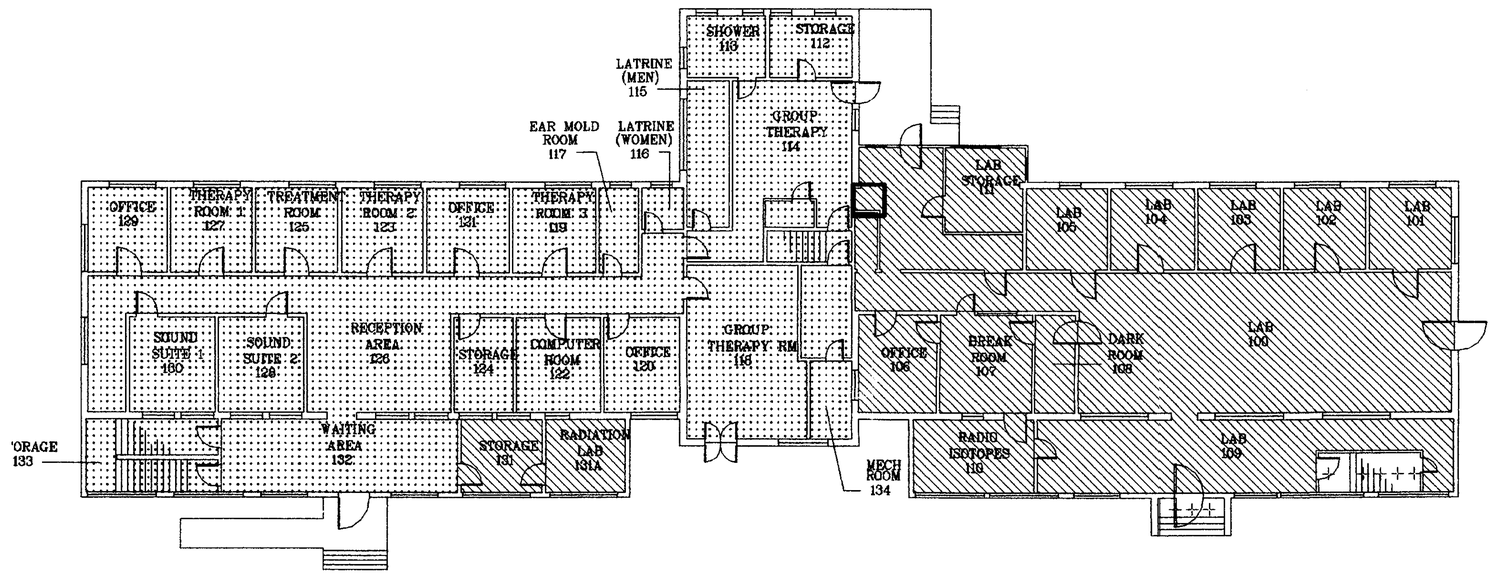
REVISION	DATE	DESCRIPTION	BY
A	10/96	Draft Historical Survey Report	JS
B	11/96	Final Historical Survey Report	

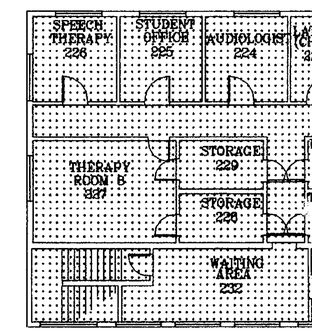
HISTORICAL SURVEY
U.S. ARMY GARRISON, FITZSIMONS

SOURCE: U.S. Army Garrison, Fitzsimons

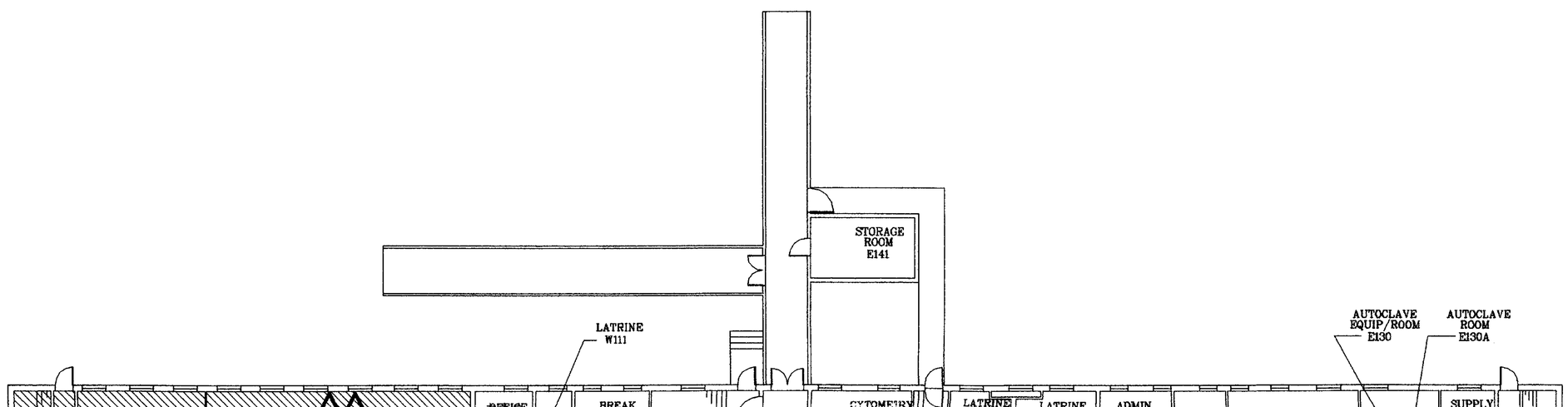
Location of Historical Radioisotope Use, Storage or Disposal Buildings 600 and 601

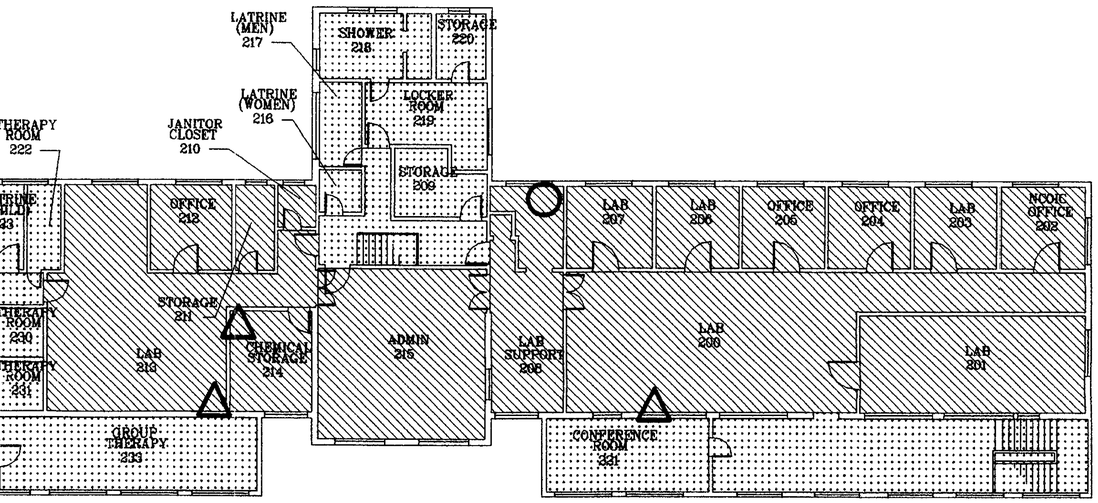
Projection: None (units feet)





Bldg. 600, First Floor





Legend

- Suspected Affected Area
- Indeterminate Area
- Unaffected Area
- △ Former or Present Hood Location
- ○ Former or Present Sink/Shower Location
- □ Former or Present Refrigerator Location

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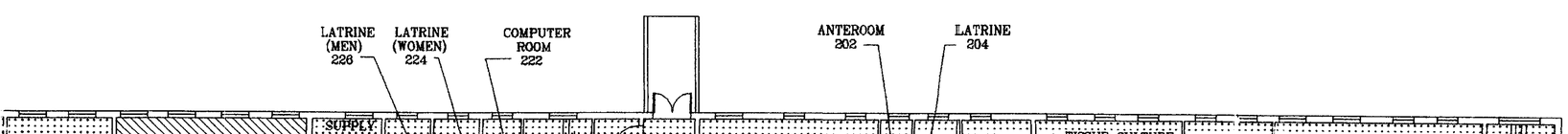

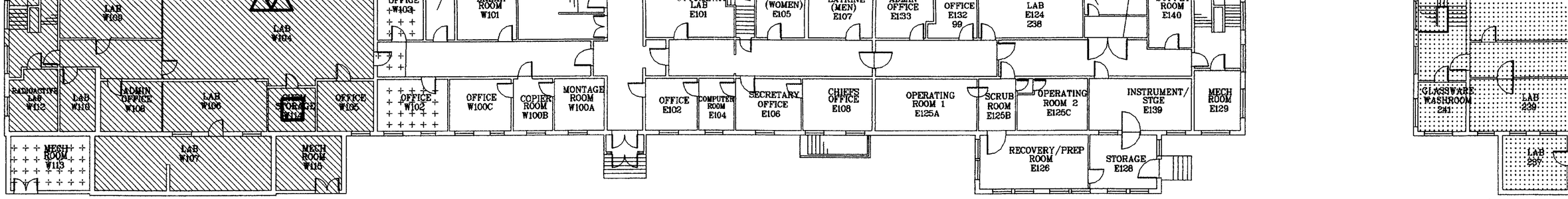

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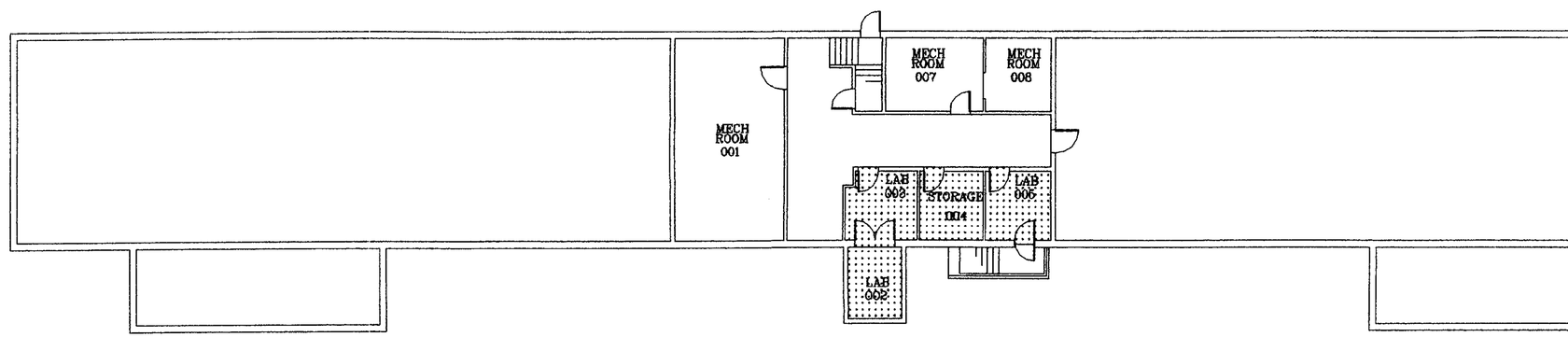

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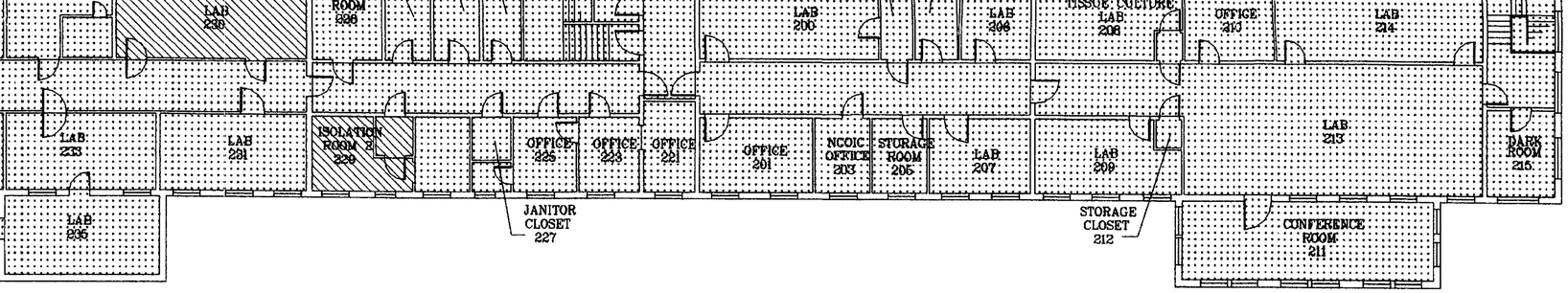


Bldg. 601, Second Floor

N

0 20 40

FEET

1 inch = 20 feet

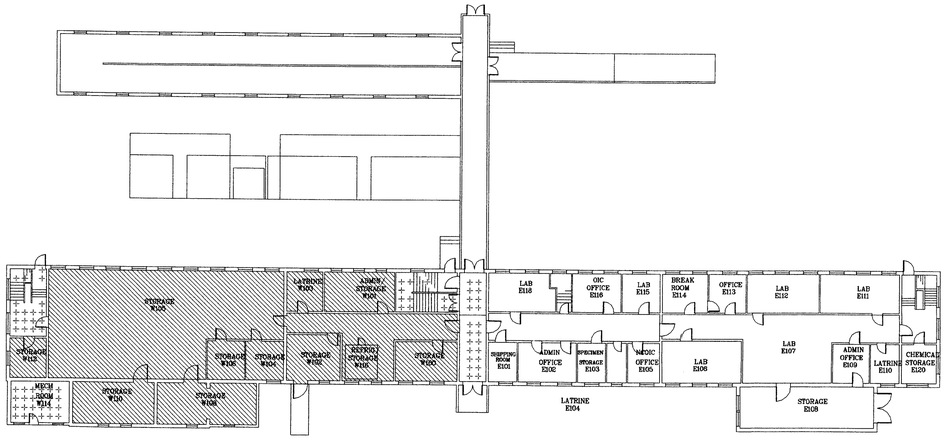
REVISION	DATE	DESCRIPTION	BY
A	10/96	Draft Historical Survey Report	JS
B	11/96	Final Historical Survey Report	

HISTORICAL SURVEY
U.S. ARMY GARRISON, FITZSIMONS

SOURCE: U.S. Army Garrison, Fitzsimons

Location of Historical Radioisotope Use, Storage or Disposal Buildings 600 and 601

Projection: None (units feet)



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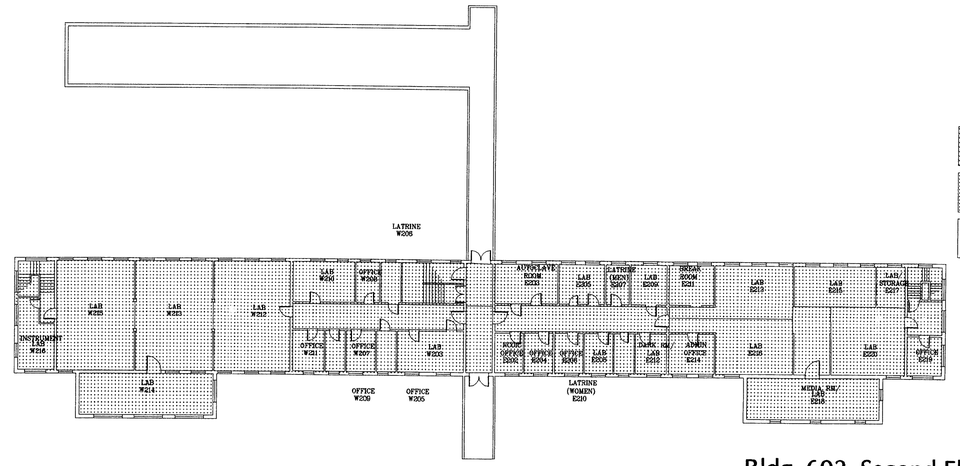

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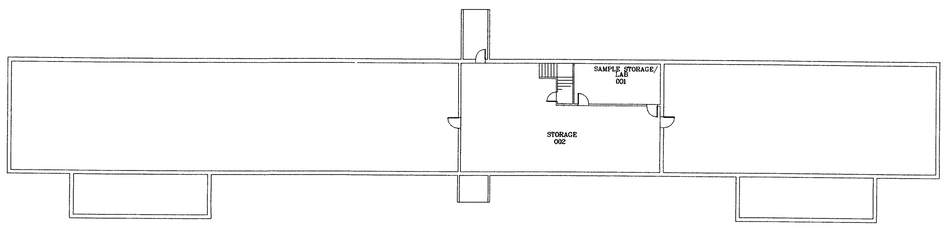

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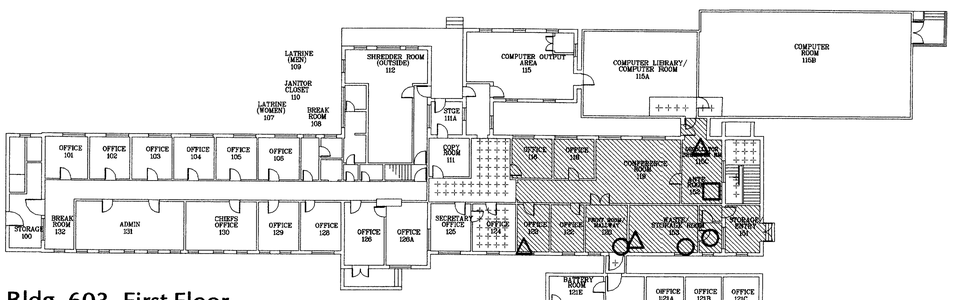
- Indeterminate Area
- Unaffected Area
- △ Former or Present Hood Location
- ○ Former or Present Sink/Shower Location
- □ Former or Present Refrigerator Location



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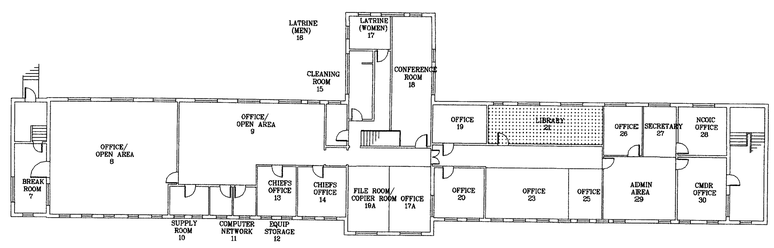

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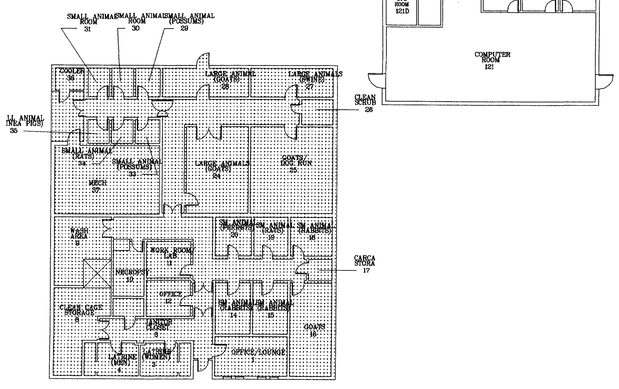

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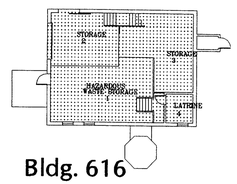


Bldg. 616

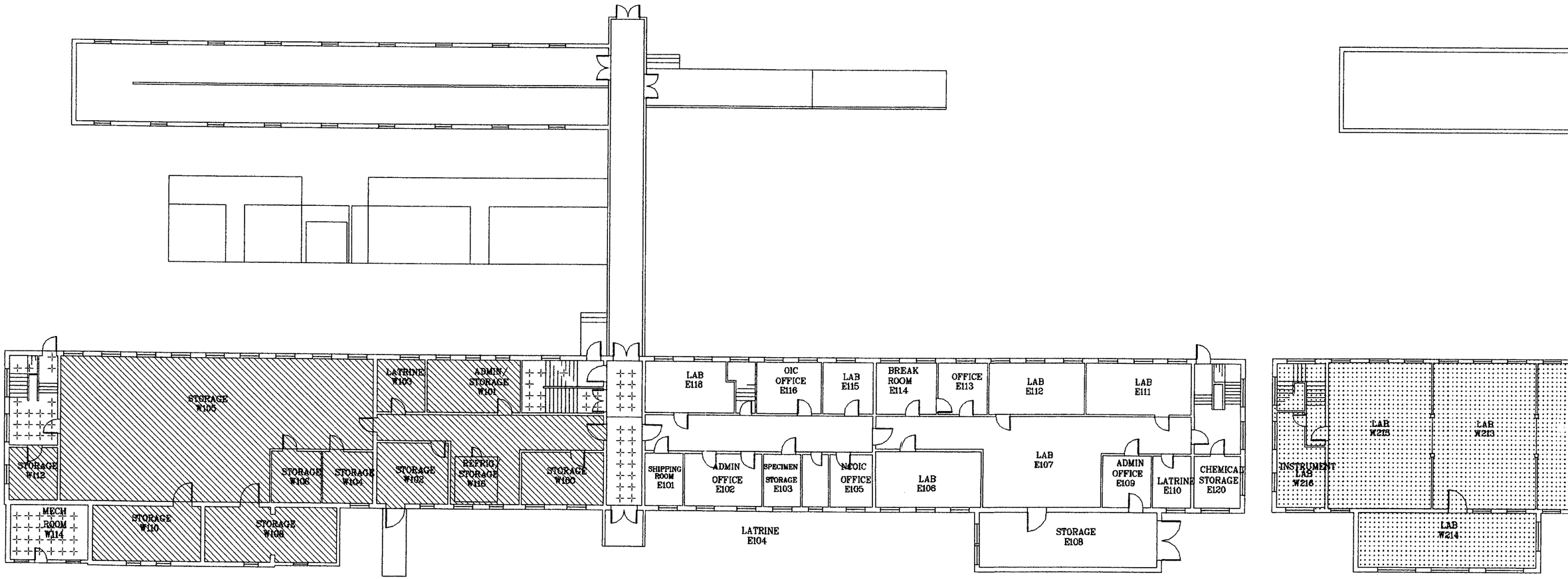
REVISION	DATE	DESCRIPTION	BY
A	10/96	Draft Historical Survey Report	JS
B	11/96	Final Historical Survey Report	JS

HISTORICAL SURVEY
U.S. ARMY GARRISON, FITZSIMONS

SOURCE: U.S. Army Garrison, Fitzsimons

Location of Historical Radioisotope Use, Storage or Disposal Buildings 602, 603, 610 and 616

Projection: None (units feet)



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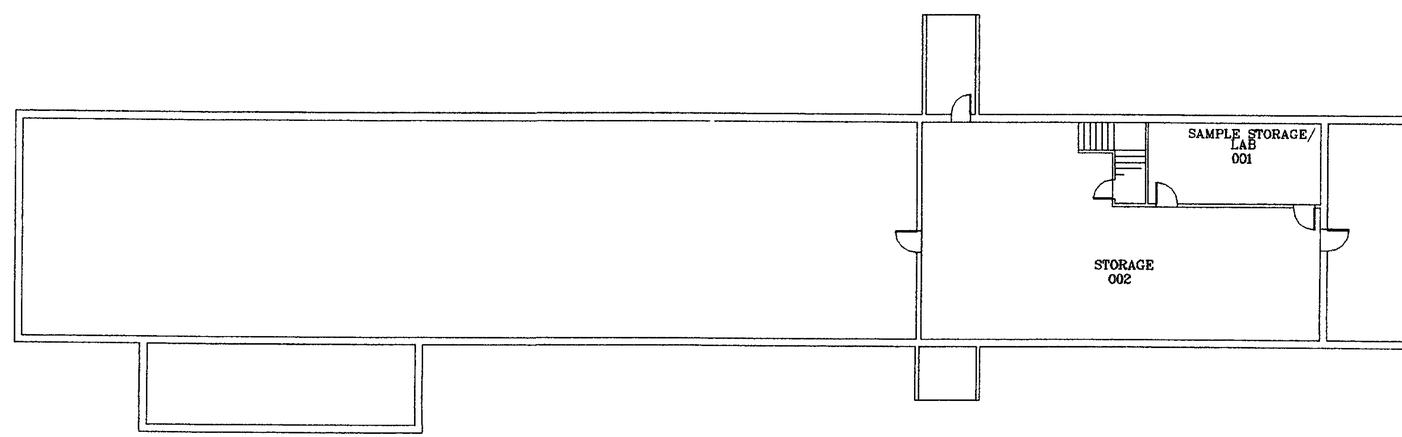

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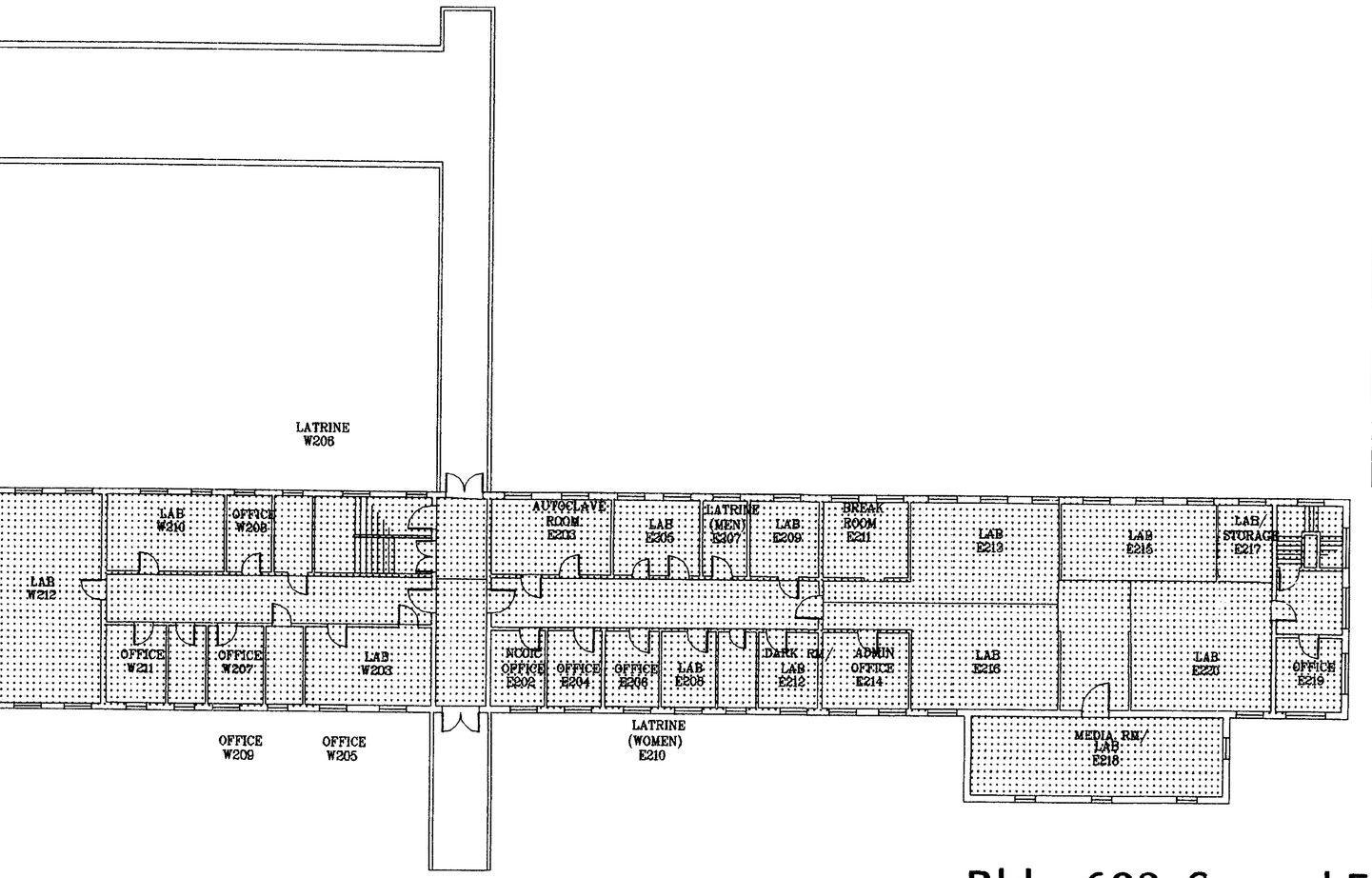
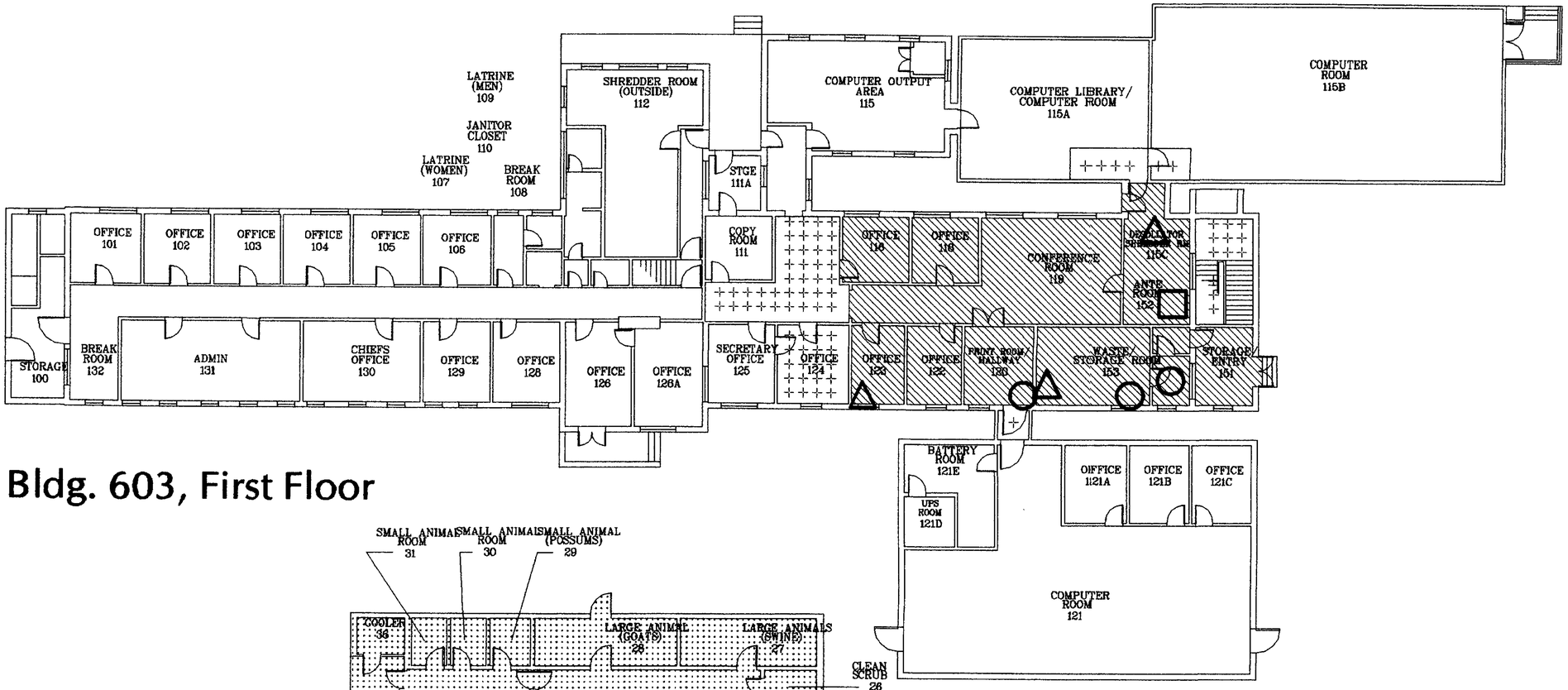


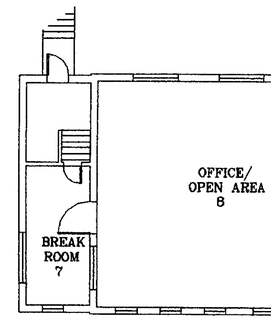
Bldg. 602, Second Floor

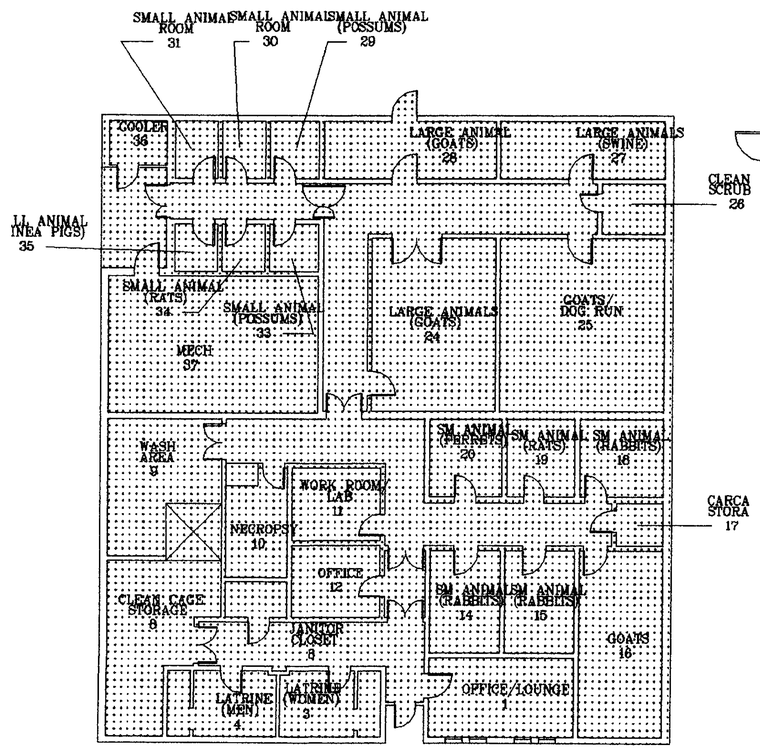
Legend

- Suspected Affected Area
- Indeterminate Area
- Unaffected Area
- △ Former or Present Hood Location
- ○ Former or Present Sink/Shower Location
- □ Former or Present Refrigerator Location

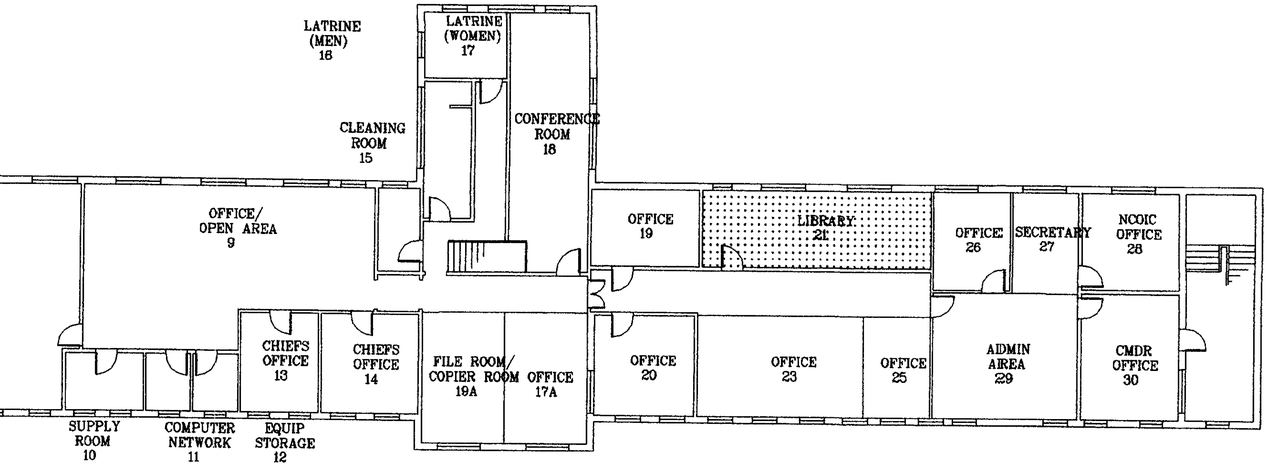


Bldg. 603, First Floor





Bldg 610



Bldg. 603, Second Floor

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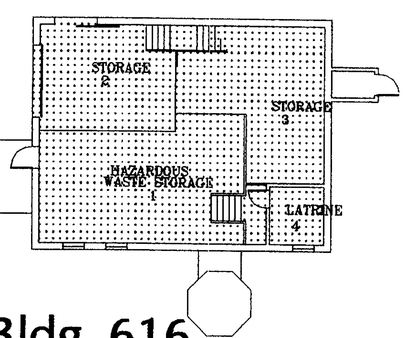
1 inch = 20 feet



Bldg. 616

REVISION	DATE	DESCRIPTION	BY
A	10/96	Draft Historical Survey Report	JS
B	11/96	Final Historical Survey Report	JS

HISTORICAL SURVEY
U.S. ARMY GARRISON, FITZSIMONS

SOURCE:
U.S. Army Garrison, Fitzsimons

Location of Historical Radioisotope Use, Storage or Disposal Buildings 602, 603, 610 and 616

Projection: None (units feet)

APPENDIX C

APPENDIX C

LANDFILL 5 CONTRACTOR REPORT

U.S. ARMY GARRISON

FITZSIMONS

DRAFT
FINAL REPORT

OCTOBER 1996

ALLIED TECHNOLOGY GROUP

U.S. ARMY GARRISON - FITZSIMONS
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U.S. ARMY GARRISON - FITZSIMONS
FINAL REPORT

1.0 INTRODUCTION

Allied Technology Group (ATG) was contracted by the Industrial Operations Command (IOC), Radioactive Waste Disposal Office for the excavation and disposal of radioactive materials and contaminated soils from twelve (12) burial sites at the former Fitzsimons Army Medical Center (FAMC) now the U.S. Army Garrison at Fitzsimons. The Project Number established for the work at the Fitzsimons U.S. Army Garrison was USA 96-048. The Basic Ordering Agreement (BOA) for this project was DAAA09-95-G-0007. The scope of the work was performed in two phases. Phase I included a site visit and preparation of health and safety, quality assurance, and work plan. Phase II included all work necessary to exhume, sample, survey, package for transport, backfill, and dispose of all radioactive materials and contaminated surrounding soils. This effort was performed in order to support the license termination of this site under the Nuclear Regulatory Commission criteria. A modification was added to this contract to allow for the shipment of various radioactive material and mixed waste generated as a result of the operation of the Fitzsimons Army Medical Center. This contract also called for the restoration of the fence line.

2.0 SITE INFORMATION

2.1 Site History

Between November 22, 1961 and October 24, 1962 radioactive waste generated by the U.S. Army Medical Research and Nutrition Laboratory was placed in twelve (12) grave like burial sites on what was then, a remote area on the eastern most fence line of the Fitzsimons Army Medical Center (FAMC). The isotopes that were originally buried include tritium (H^3), carbon (C^{14}), sulfur (S^{35}), zinc (Zn^{65}), iodine (I^{131}), and gold (Au^{198}). The known waste included chicken feces, rat carcasses, paper, trash, rat feces, chicken carcasses, chicken food, rabbit carcasses, guinea pig feces, bottles, carrots, milk, pork, and guinea pig carcasses. There were thirteen (13) pits or burial sites that were originally opened for disposal of the waste in the 1961 to 1962 time frame. The thirteenth site was opened but never used. The pits were opened in a north to south direction parallel with the original eastern fence line and approximately 15 feet west of the original fence line. The composition of the soil was Fort Collins loam which is a gritty and well rounded angular sand that in this area lies to a depth of approximately three (3) feet. Underneath this sand is a hard pack clay layer. The pits were opened in a square 4 feet by 4 feet and excavated to a depth of 4 feet. This one foot of opening in the clay was where the radioactive and organic waste was

deposited. The waste was contained within waxed paper bags as steel drum containers were not required for disposal during this period. The burial pits were then re-covered with the loam soil upon placing the waste within the pits.

In 1970, four of the original thirteen burial pits were excavated and analyzed for radioactivity. The waste was monitored and analyzed and no activity above .05 microcuries per gram of activity was detected. The excavated material was removed from the trenches and disposed of in the regular waste of the U.S. Army Medical Research and Nutritional Laboratory. The sites were numbered from North to South with the number 1 site being the Northern most site. The sites that were excavated were pits number #1, #10, #11, #12. Due to the determination that the activity of the organic material in the pits was less than .05 microcuries/gram which was below the 1960 regulatory guidance of disposal of radioactive material per 10 CFR 20.306, "Disposal of Specific Wastes", Fitzsimons Army Medical Center deregulated the area in 1971 and removed all signs and postings. Fitzsimons Army Medical Center maintained controlled access to the current time by the use of an exclusion fence (a triangular fence that encompassed the area). The Nuclear Regulatory Commission (NRC) approved a request for deregulation of the site and approved Amendment 50 to the FAMC NRC License. The Colorado DEH continued to list the site as "contaminated".

2.2 Site Conditions at Time of Final Remediation/Survey

By 1996 due to the removal of activity from pits #1, #10, #11, and #12 and radioactive decay, the amount of radioactivity that was left was 131.7 microcuries of carbon (C^{14}) and 49.4 microcuries of tritium (H^{3}). Due to decay, the other four isotopes of S^{35}, Zn^{65}, I^{131}, and Au^{198} were no longer detectable. Two sites or pits had no residual activity due to decay, these were pits #6 and #7. Thus this residual activity was spread among six pits (#2, #3, #4, #5, #8, and #9).

The original line of burial pits was placed approximately 15 feet west of the eastern most fence line of the base. The burial site was encompassed by a triangulated section of fencing with the base of the triangle situated to the north and the point of the triangle lying to the south. The eastern section of the fence line was situated on the edge of a high bank above a small stream (sand creek). Due to erosion and age, the fence line had been moved at least once since the original burial. The relationship between the original fence line and the current fence line could not be established.

The Fitzsimons Army Medical Center was placed under Base Realignment and Closure (BRAC). The U.S. Army Environmental Center (USAEC) requested assistance from the Headquarters, U.S. Army Industrial Operations Command (HQ, IOC), Radioactive Waste Disposal Division for the excavation and disposal

of radioactive materials and contaminated soils from the 12 burial pits. The Industrial Operations Command awarded the contract for this remediation to the Allied Technology Group. The work was to be performed in two phases. Phase I included a site visit and preparation of health and safety, quality assurance, and work plans. Phase II included all work to exhume, handle, package, transport, and dispose of all unwanted radioactive material; verify the burial sites are suitable for free release; and backfill the sites with clean fill material. A modification to this contract called for the shipment of various radiological waste and mixed waste generated due to the operation of the Fitzsimons Army Medical Center.

2.3 Identity of Potential Contaminants and Release Criteria

Based upon knowledge of site operations and the results of preliminary assessments the significant radiological contaminants were determined to be carbon (C^{14}) and tritium (H^3). The average acitivty ratios of the contaminants are:

H-3 27%
C-14 73%

On the basis of this combination of contaminants the surface contamination guideline release values were:.

1,000 DPM/100cm^2 β, Loose Surface Contamination

5,000 DPM/100cm^2 β, Fixed Contamination

The release criteria was established at 5 pCi/gm for tritium (H^3) and 10 pCi/gm for carbon (C^{14}) in the soil. This was the minimum detectable level that the lab performing the counting would be able to detect. The laboratory that would perform the analysis would be Paragon Analytical in Fort Collins, Co., a Colorado certified laboratory. Ten (10) per-cent of all samples would be sampled by representatives from the Center for Public and Preventive Medicine (CHPPM). Representatives from CHPPM would also be present for all sampling along with representatives from the Base Radiological Safety Office.

The Nuclear Regulatory Commission's (NRC) regulations in 10 CFR 20 are being amended to include radiological criteria for decommissioning of lands and structures at nuclear facilities. 10 CFR Part 20, Subpart E established criteria for the remediation of contaminated sites or facilities that will allow their release for future use with or without restrictions. The criteria includes a Total Effective Dose Equivalent (TEDE) limit of 15 mrem/yr. that should not be exceeded by an average individual among those who could potentially receive the greatest exposure from any residual activity within a facility or on a site. Per guidance

established in NUREG-1500, 'Working Draft Regulatory Guide on Release Criteria for Decommissioning: NRC Staff's Draft for Comment'; Appendix A, 'Annual Total Effective Dose Equivalent Factors'; Table A-1, 'Residential Scenario, Maximum Dose in 1000 years, based on 1 pCi/gm of initial activity'; the limits of 5 pCi/gm of tritium and 10 pCi/gm of carbon-14 would result in an annual total dose of 4.3 mrem/yr. This is the most conservative estimate of full residential occupancy and falls well within the guidance for Total Effective Dose of 15 mrem/yr.

In addition to the radiological standards established for the remediation, the U.S. Army Environmental Center requested a modification to ensure that all thirteen (13) burial pits were samples and a full toxicity characteristic leaching process (TLCP) testing was performed on the samples. This was to ensure no organics, solvents, heavy metals, pesticides, herbicides, and the like existed in the burial pits before filling in the pits. This testing in addition to the search for radiological contamination would help alleviate future EPA concerns which might have existed in this area.

3.0 PHASE I-SITE VISIT, MEETINGS, RESEARCH, AND PREPARATION

During the week of June 10, 1996, William Haney, Project Director and Chad Becker, Health and Safety Manager/Industrial Hygienist, visited the site to perform Phase I activities (perform a site visit and prepare the Detailed Work Plan, Health and Safety Plan, and the Q.A. Plan). The first day of this visit a meeting was conducted to brief and answer concerns from all interested and related parties and to recover as much historical data as possible. This included representatives from Allied Technology Group and the Industrial Operations Command as well as the Fitzsimons Radiological Protection Office, the Base Environmental Coordinator, the Fitzsimons Redevelopment Authority, the Fitzsimons Department of Public Works, the Fitzsimons Medical Command, the U.S. Army Environmental Center, the Colorado Department of Public Health and Education--Radiological Control Division, and Parsons Engineering Services. After the meeting the remediation plan was discussed in great detail and the work site was walked down.

During this visit a great deal of effort went into the review of historical data to try and pinpoint the exact location of the burial pits. None of the revelant documents showed a reference of the burial pits to anything but the original fence line. Research of past remediation efforts was conducted as well as talks with Parsons Engineering Services about the status of the current base remediation effort. A review of requirements for the Work Plan, Health and Safety Plan, and the Q.A. Plan also took place with Susan Errett, Base Environmental Coordinator; Shiela McCartney, U.S. Army Environmental Center; and William Metcalf, Industrial Operations Command participating.

A public meeting was held with the Base Radiological Safety Committee. A presentation of the remediation effort and a question and answer session with members and attendees was conducted following the meeting.

A thorough survey of the area of concern within the triangulated fence line was conducted. This including the use of metal detectors to try to find indications of the burial site location. Based on historical data to the point and visual indications it was decided to start excavation on the north side of the area approximately 15 feet off the existing fence line. The decision was also made to rent a Sprung structure (heavy duty tent) to serve as a work enclosure. This would serve to protect the area from the environment during restoration and also to protect the work area from visual observation by casual on-lookers. The area, since the original burial, has become quite populated. Directly across from the sand creek is a large trailer park. In order not to raise unnecessary concerns about this effort this device was constructed. Briefings were conducted with the media during the first week to ensure the public was well informed of the ongoing remedial effort.

4.0 ORGANIZATION AND RESPONSIBILITIES

The IOC Point of Contact for this project was *Mr. William Metcalf*, Health Physicist. The Radiological Safety Officer for U.S. Army Garrison, Fitzsimons was *Capt. Annette Boatwright*. The Base Environmental Coordinator was *Ms. Susan Errett*. The U.S. Army Environmental Center, Restoration Oversight Division, was represented by *Mrs. Shiela McCartney*. The Center for Health Prevention and Preventive Medicine (CHPPM) was represented on site by *Mr. Michael Bush* and *Mr. Perry Brown*. The ATG project Director was *Mr. William Haney*. The ATG Project Manager was *Mr. Frank Whitaker*. The ATG Project Supervisor was *Mr. Neal Whatley*. The ATG Health and Safety Manager (Industrial Hygienist) was *Mr. Chad Becker*.

5.0 DESCRIPTION OF WORK

5.1 General

The Detailed Work Plan, Health and Safety Plan, and Q.A. Plan (see Appendix A, B, and C) were drafted in the ATG Oak Ridge, TN office and submitted for approval. The review process included reviews by the following organizations: the Industrial Operations Command (IOC), the Colorado Environmental Protection Agency (EPA), the Colorado Department of Public Health and Engineering, the U.S. Army Corp of Engineering, the U.S. Army Environmental Center, the Center for Health Prevention and Preventive Medicine (CHPPM), and the Fitzsimons Radiation Protection Office. There were approximately 200

comments from these organizations which were resolved and incorporated within the Detailed Work Plan, Health and Safety Plan, and the Q.A. Plan. With the comments resolved, project mobilization was ready to commence. The actual work phase was scheduled from August 26, 1996, to September 20, 1996.

The decision was made to start the excavations for the burial site on the north side of the affected area approximately 15 feet west of the existing fence line on the north side directly across from the estimated position of the tie pole. The Sprung structure would be situated over the site for the excavations to protect the excavation site from environmental conditions, to mitigate the release of radioactive material to the environment, and also to mitigate unnecessary public attention at the site during the excavation and remediation work.

A "Report of Proposed Activities in Non-Agreement States" (Reciprosity Agreement) was submitted and permission received from Region 4 of the Nuclear Regulatory Committee to use the State of Washington, Radiological Operating License, WN-10292-1, for the purpose of removing contaminated material from the Fitzsimons site. (See Appendix M, "Reciprosity Agreement").

All work was to be performed in accordance with the guidance of Appendix A, "Fitzsimons Project Detailed Work Plan"; Appendix B "Fitzsimons Health and Safety Plan"; and Appendix C "Fitzsimons Quality Assurance Plan".

5.2 Health And Safety

5.2.1 General

Site specific training was conducted for the Detailed Work Plan, Health and Safety Plan and the Quality Assurance Planduring the first two days at the job site for all members of the work crew. This training was documented on Appendix D, "Daily Training Safety Meeting Records". The primary radiological health hazard on site was from potential exposure to carbon-14 and tritium. The primary physical health hazards were; exposure to heat, heavy equipment operation, and fall hazards. The Fitzsimons Base Hospital was notified of our presence and the nature of the work by the Fitzsimons Radiation Protection Office. The Fitzsimons Radiation Protection Office was established as the primary point of contact in the event of any medical emergency.

5.2.2 Radiological

Radiological controls consisted of, but were not limited to, contamination surveys, radiation surveys of posted boundaries, and air sample surveys.

All personnel performing work under the direction of a Radiation Work Permit (Appendix G, "Radiation Work Permit").

Airborne contamination concentration limits were set at 25% of the Derived Air Concentration (DAC) limit for single radionuclide not specified in 10CFR20, "Standards for Protection Against Radiation", Appendix B "Concentrations in Air and Water Above Natural Background" with a decay mode other than alpha emission or spontaneous fission and with a radioactive half-life greater than two hours. This concentration value was 1E-9 μCi/ml. This was a more conservative Derived Air Concentration Value than either DAC value for carbon-14 or tritium.

All personnel working on the Radiation Work Permit (RWP) involved in working with or the handling of radioactive material provided separate entry and exit bioassay urine samples for the purpose of determining internal dose assessment of the individual. The laboratory analysis of these samples are provided in Appendix E, "Bioassay Analysis".

All personnel involved in handling radioactive materials were issued TLDs (thermoluminescent dosimeters) for the purpose of determining the external dose received while conducting these project activities. These monitoring results are provided in Appendix F, "Dosimetry Reports". No substantial dose was anticipated during this project as initial characterization surveys showed only general area dose rates in the range of 22 μR/hr. The isotopes of concern were tritium and carbon-14 which are both only low energy beta emitters and thus project no significant external dose rate. The dose received for this project was 0.000 person-rem (See Attachment F, "Dosimetry Report").

5.3 Site Preparation and Initial Characterizations

Upon arrival at the site all personnel were briefed during the Daily Training Safety Meetings. All personnel were verified to have documented current 40-hour OSHA Hazardous Waste Operator (HAZWOPER) Training and physicals.

Initial radiological characterization surveys were performed in the affected area. Background radiation levels were uniform and were approximately 22 μR/hr. A metal survey was performed using a Shonstat Ferrous Metal Detector in hopes of finding evidence of some of the burial sites. No definitive positive evidence of any metal could be found with this survey.

Two pieces of heavy equipment, a back-hoe and man-lift were delivered to aid in setting up the area. The inside (west fence) was removed for access to the area. Vegetation in the area was removed by use of a weed eater in preparation for the tent setup and remediation in the area. Until the middle of the first week the majority of the effort was focused on setting up the Sprung Structure (work enclosure structure). This structure was set directly over (or centered over) the estimated pit location of pit #1, which was on the north end of the affected area approximately 15 feet west of the current fence line. The equipment end of the Sprung Structure was situated facing to the north. A representative from Sprung Structures was present during the erection of the enclosure.

During the erection of the tent enclosure structure, radiological control instrumentation was set up in the east wing of Building 609. This area was also the temporary office for Allied Technology Group personnel for the balance of the work at Fitzsimons.

The area was then prepared for radiological work. An Exclusion Area (Radiation Area, Radiation Work Permit (RWP) Required) was established at the boundary of the work enclosure structure (tent). A Contamination Reduction Zone was established at the north, east, and south boundary of the fence and on a roped boundary on the west side of this area. The Support Zone was then established in the back corner of the Community Center Parking Lot. These areas were then posted appropriately.

A Radiation Work Permit (RWP) Form ATGF-002 was created to control radiological work at this site. The Radiation Work Permit number was Fitz 96-001 (See Appendix G, "Radiation Work Permit"). All personnel were briefed on the RWP and then signed onto the RWP to acknowledge the fact of their understanding of the conditions and requirements of the RWP. At this juncture, radiological work was ready to commence.

During the course of work in the first week, a media presentation was conducted by Mr. William Haney of Allied Technology Group and Mr. William Metcalf of the Industrial Operations Command. In attendance were members of the Denver media including newspapers, radio, and television stations covering the local area. Also in attendance were representatives from Fitzsimons Radiation Protection Office, Fitzsimons Base Environmental Coordinator, the Colorado Environmental Protection Agency, and the U.S. Army Environmental Center. A presentation was made on the scope and methodology of the remediation effort and then a walk down of the work site was performed. (See Appendix Q, "Press Release").

5.4 Remediation of Burial Pits

Excavation commenced on the north side of the affected area within the work enclosure structure by use of the backhoe. The dig site was chosen in conjunction with the best historical evidence and some positive indications from the Shonstat Ferrous Metal Detector. The excavation trenches were 2 foot wide by 8 foot long and approximately 4 foot deep. With no positive indication in this area, a second trench of approximately the same dimensions was made to the east of the original trench with the same results. This same process was conducted in a trench line to the west of the original trench line. With the exception of small pieces of pottery and glass no positive indications were found in this area. ATG continued to look for positive indication of burial pits with medical waste in this manner within the boundaries of the entire tent. A 2 foot wide swath was made approximately 8 foot long and 4 feet deep. These swaths in the approximate centerline of the tent were then followed by corresponding swaths to the east and west of the of the centerline, searching for positive indications of a burial site with medical waste. In this manner, the entire length of the containment enclosure structure (tent) was covered which was 70 feet in length and 30 feet in width with no positive indication of any medical waste.

Airborne radioactive contamination samples were performed through out the course of this excavation and radiological surveys were performed of the excavated soil. No airborne contamination samples approached any of the established Derived Air Concentration Values (DAC) and the surveyed soil showed no indications of any radioactivity above background. (See Appendix I, "Radiological Surveys, Air Sample Survey Data Sheets"). To mitigate any airborne contamination in the area, the soil was misted with water during the excavation.

At the same time the excavations in the tent were being performed, a gasoline earth auger was obtained and a series of exploratory holes were excavated to an approximate depth of 6 feet in all directions outside of the tent area. Approximately sixty of these exploratory holes were excavated. In one of these exploratory holes 2 to 6 feet off the existing fence line and south of the tent location, positive indications of a pit buried with radioactive medical waste was identified. This included a bottle cap (similar to a prescription bottle cap) and a small piece of yellow and magenta (colors used to identify radioactive markings) tape.

ATG personnel continued to use the gasoline earth auger to try and identify the layout of the line of burial pits. There were 13 original burial pits approximately 8 feet on center from each other or a run of approximately 96 feet. Burial sites #1, #10, #11, and #12 had been remediated in the 1970 time frame and the contents

removed and disposed of. Burial pit #13 (the southern most burial pit) had been excavated but never used. Thus visual indication of the burial sites would only exist in a lines of pits approximate 56 feet long between burial site #2 and burial site #9. ATG continued identification with the gasoline powered earth auger and confirmed the layouts of the pits which ran parallel with the existing fence line.

In the middle of the second week of work, a crane company was contracted and the work enclosure structure was moved to cover the 56 feet of known un-remediated burial pits. The burial pits were excavated with the repositioning of the Sprung work enclosure structure and the re-establishment of the work site's boundaries and controls. Excavation commenced with the backhoe within the work enclosure structure. Definitive physical evidence of medical waste defining the exact pit locations of pits #2 through #9 were found. The physical evidence defining the medical waste consisted of remnants of latex gloves, chicken skeletons, needles, radioactive material tape (yellow and magenta with radioactive "propeller") and remnants of metal cans. All excavations from the pits were surveyed with 100 square cm. gas proportional probes and micro-R meters. No indications of any radiological activities above background were found on this material. (See Appendix I, "Radiological Surveys, Air Sample Survey Data Sheets"). Medical residue was often just six inches below the surface and in some areas of the burial pits they were as wide as ten (10) feet.

ATG personnel used the backhoe to excavate a swath north of pit #2 looking for any physical evidence (medical waste) to define the location of the next pit. Physical evidence was found and located the next pit 8 feet north of pit #2. ATG used this same methodology on the south end of the trench line to define pits #10, #11, #12, and #13.

William Metcalf of the Industrial Operations Command was able to locate a site map which showed the location of the burial pits and the original fence line tie pole to then Buildings 411 and 413 (now numbered buildings 408 and 409). (See Appendix N, "Site Map"). This print showed the tie pole to be off the north edge of what is now Bldg. 608. From this building to the tie pole is 478' due east. Fifteen (15) feet from the tie pole due west is on a line that is directly in line with the exhumed pits. This confirmed the currently excavated burial pit locations to be in the appropriate location. To confirm the northern most pit line, the trench line excavation continued for an additional 37 feet in the northern direction. No additional physical evidence of pits could be found in this direction.

The contents of the burial pits, radioactive medical waste, were placed in ten 30-gallon drums. These drums were lined with a 4 mil watertight liner. Lime and vermiculite (an absorbent) were added to the waste at a ratio of one part lime to 10 parts absorbent (vermiculite) to thirty parts of waste. The watertight liner was

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The contents of the burial pits, radioactive medical waste, were placed in ten 30-gallon drums. These drums were lined with a 4 mil watertight liner. Lime and vermiculite (an absorbent) were added to the waste at a ratio of one part lime to 10 parts absorbent (vermiculite) to thirty parts of waste. The watertight liner was

hermetically sealed. The 30-gallon drum was placed inside a 55-gallon drum with at least 4 inches of vermiculite on the bottom and surrounding the 30-gallon drum. Both drum tops were sealed with ring and bolt closures. These drums were weighed and staged on site for shipping. They were roped off and posted accordingly.

With the completion of these activities, the burial pit locations were ready to be sampled.

5.5 Final Sampling

5.5.1 Background Samples

ATG obtained four (4) background samples of the area during the first week with Sgt. Wofford of the Fitzsimon's Radiation Protection Office. These four soil samples were taken in the north, south, east, and west direction adjacent to the area of interest. These samples were taken in areas not fertilized, or using base water which has the potential for radioactive activity. The location of these samples is shown in a map in Appendix J, "Fitzsimon' Sample Data". The eastern and northern sample (FB-03 and FB-04) were taken downstream of the drainage runoff for the affected area.

5.5.2 Burial Pit Samples

Samples were obtained in the pits and the excavated soils from the pit areas. These samples were conducted with Sgt. Wofford of the Fitzsimon's Radiation Protection Office and Mike Bush and Perry Brown of the Center for Health Prevention and Preventive Medicine (CHPPM). Two samples were taken in each burial pit by Allied Technology Group. One sample of each of these pits was taken by CHPPM personnel. Two samples were taken from the soils of each of the excavated burial pits. Each of these samples would be analyzed for carbon-14 and tritium. A fingerprint of all samples were given to Sgt. Wofford of the Fitzsimon's Radiation Protection Office in case of any necessity for additional analysis. In each burial pit one sample was obtained for a full Toxicity Characteristic Leaching Process (TCLP) Analysis. Each of the ten drums of packaged radioactive biological waste were also sampled.

The samples were prepared and sent to Paragon Analytical, Inc., a certified Colorado laboratory in Fort Collins, Co. There was a total of 46 samples to be analyzed for tritium and carbon-14 obtained from the burial pits and exhumed dirt from the pits. There were four background samples to be

analyzed for tritium and carbon-14. There were ten samples (one from each drum of radioactive organic waste) to be analyzed for tritium and carbon-14. There were 13 samples, one from each pit to be analyzed for a full TCLP (toxicity characteristic leaching process) series.

5.5.3 Sample Results

The results of all the samples showed that no sample approached the limit of 5 pCi/gm. for tritium and 10 pCi/gm. for carbon-14. No burial pit sample or exhumed soil sample approached these limits nor did any of the ten drum samples. For the thirteen TCLP series no detectable quantities were found for the semivolatile organics, the volatile organics, the pesticides, and the herbicides. For the TCLP heavy metal analysis no results approached the CERCLA heavy metal limits. Confirmation analysis conducted by the Center for Health Prevention and Preventive Medicine (CHPPM) confirmed these results for tritium and carbon-14 in the burial pit area. (The locations, chains of custody, and lab analysis results may be found in Appendix I, "Radiological Surveys/Air Sample Survey Data Sheets", Appendix K "Chain of Custody", and Appendix J, "Fitzsimon's Sample Data".

With the sample data results confirming no carbon-14 and tritium results above release limits and the Toxicity Characteristic Leaching Process (TCLP) analysis showing no limits were exceeded for semivolatile organics, volatile organics, pesticides, herbicides, and heavy metals the burial pits were ready to be filled and the work enclosure structure removed. Brokerage (shipment) was ready to be performed on the ten drums of generated radioactive biological waste as well as the Fitzsimon's Army Medical Center (FAMC) generated waste.

5.6 Shipping/Brokerage

Willie Bremmer of Allied Technology Group arrived on site during the final week to broker (ship) the generated 10 30-gallon drums of radioactive, biological waste along with solid hospital radioactive waste (mostly sources) and liquid hospital waste (uranyl nitrate, tritium and alcohol, and fluor scintillation cocktail). This waste, other than the 10 30-gallon drums, was staged in Building 602.

Two (2) 30-gallon drums of liquid hospital waste which included uranyl nitrate, tritium and alcohol, and fluor scintillation were surveyed, packaged, weighed, and labeled. These drums were shipped to NSSI/Recovery Services in Houston, Texas for stabilization and disposal. This shipment was performed on September

17, 1996 and the carrier was Tri-State Motor Transport Corporation. This shipment was a dromedary load. (See Appendix L, "Shipping Documentation").

Two (2) 55-gallon drums of sources, lab trash (paper, plastic, and glass), uranyl acetate crystals were surveyed, packaged, weighed, and labeled from the storage area of Building 602. This waste along with the 10 55-gallon drums of radiological, biological waste were loaded aboard a sole source Diablo Trucking Company closed container transport. This shipment was then made to the Allied Technology Richland Consolidation Facility (RCF) in Richland, Wa. There, the waste will be processed, compacted, and repackaged if necessary and brokered into the Hanford Disposal Facility in Hanford, Washington. (See Appendix L, "Shipping Documentation").

5.7 Demobilization

Upon receipt of the sample results, the exhumed soil was returned to the trenches and the area graded out to a level surface. The Sprung work enclosure structure was then taken apart and dismantled. All parts of the Sprung work enclosure structure were surveyed and released during disassembly. (See Appendix I, "Radiological Surveys/Air Sample Survey Data Sheets"). A representative of Sprung Industries was available during the disassembly. The parts of the work enclosure structure were then transported back to the Sprung Industries Facilities in Denver, Co. The backhoe and manlift were surveyed and released from site and transported back to Hertz Rental. All radiological and work site signs were removed, and the area deposted at this time.

Grass seed was sown in the area to try to refoliate the area. The inner fence line was restored by Aray Fence Company of Denver, Co. New post holes were dug and new post were set in concrete. The original wire was re-stretched and hung. The affected area was again physically secured.

All issued individual dosimetry was collected and sent to Thermo NUtech of Albuquerque, N.M. for analysis. The dosimetry results for all individuals at the Fitzsimon's ATG remediation work was 0.000 person-rem. Exit bioassay (exit void) samples were collected for all individuals involved in the project. These results were subsequently sent to a laboratory, Controls for Environmental Pollution; Santa Fe, New Mexico for analysis for tritium and carbon-14. No radiological activity was detected in these samples.

All tools, material, equipment, and instrumentation were surveyed for residual radiactive contamination and free released. Tools, equipment, materials, and instrumentation used on site by Allied Technology Group were packed and removed from site.

The job/work site was walked down with Col. Aiken, Capt. Boatwright, Sue Errett, Bill Metcalf, and Frank Whitaker. All personnel were satisfied with the completion of the job. A conference call was made with Shiela McCartney, Sue Errick, Col. Aiken, Bill Metcalf, and Frank Whitaker to ensure the job was completed in a satisfactory manner and that all personnel were informed of the cessation of work activities. Notified William Haney, Project Director, ATG, and Robert Matthys, Contracting Officer, Industrial Operations Command of the completion of the project.

The biological waste was excavated and packaged for disposal into 30-gallon drums which were then overpacked into 55-gallon drums and then shipped to the ATG Richland Consolidation Facility (RCF) in Richland, Wa. for final disposal at the Hanford Facility in Hanford, Wa. Two (2) 55-gallon drums of laboratory were also shipped along with the biological waste to the Richland Consolidation Facility. Two (2) 30-gallon drums of ethanol with tritium, uranyl acetate, liquid scintillation standards, and uranyl nitrate crystals (mixed waste) were shipped to NSSI/Recovery Services, Inc. for neutralization and disposal.

APPENDIX D

REFERENCES

REFERENCES

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APPENDIX E

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INTERVIEW SUMMARIES

INTERVIEW SUMMARIES

The following is a compiling of general interviews that were performed during the course of the historical survey. These interviews were performed in addition to the interviews that were conducted during the EBS (Parsons ES, 1996a) and SSEBS for Building No. 500 (Parsons ES, 1996b). For the most part, no significant information beyond previous interviews or actual historical file information was found. Name of interviewee, phone number, buildings/department worked in, date of interview, a listing of radiological information, and any recommendations are summarized below.

Byron O'Bailey, 361-8532, Maintenance Department, October 1996. Mr. O'Bailey indicated that use of radiological materials was performed in Building No. 602 and the southeast corner of Building No. 603.

Paul Davis, 361-4398, October 1996. Mr. Davis indicated that some of the piping system within Building No. 511 was "bad".

Dan Sullivan, 361-3500, October 1996. Mr. Sullivan indicated that Nuclear Medicine in Building No. 511 stored radioactively contaminated urine. He also indicated that previous sewer line piping breaks under the building may have contaminated the soil.

CPT Annette Boatwright, 361-8285, Radiation Protection Office. CPT Boatwright has been interviewed several times and has also been reviewing historical records and our documentation throughout the whole survey process. She confirmed radioisotope usage and storage of sealed sources in Building No. 500, 3rd floor-north and in select rooms of 2nd floor-east. Some additional information provided by CPT Boatwright and the Radiation Protection Office includes:

- Building No. 500, 3rd Floor. Cesium seeds (in sealed form) were used and leak tested in accordance with the license. Also, confirmed use of radioisotopes in room 3118.

Geoff Warren, 361-3826, Radiation Protection Office. Mr. Warren has been interviewed several times to confirm the locations of sealed and unsealed sources. He has provided input into operations management and provided and confirmed historical radiation survey reports.

Dave Thornton, Radiation Protection Office, 10 October 1996. Mr. Thornton reviewed the building maps produced for the Draft Historical Survey Report. He specifically reviewed Building Nos. 404 and 511. Any rooms that he pointed out as possibly using, storing, or disposing of radioisotopes were highlighted. He reviewed and confirmed some of the suspected rooms in Building No. 404. Mr. Thornton also confirmed that the room (as identified in the Draft) in the basement of the tunnel

between Building Nos. 500 and 511 was used for radioisotope storage. Additional information on Building No. 511 includes:

- Room 145A has been a "hot" laboratory since at least 1987.
- Has not heard of any major spills within the building.
- RIA laboratory rooms 250B, and 251.
- Room 140A stored generators and sealed sources.
- Room 127A had a refrigerator with radioisotope storage.