RAS 9456 SEC-10

Exhibit 5

NUREG/CR-1378
Rev. 1

Hardening Existing Strategic Special Nuclear Material Storage Facilities

Manuscript Completed: March 1981
Date Published: August 1981

Prepared by
A. Garrett, *P. MacMurdy

U.S. Army Materiel Systems Analysis Activity
Aberdeen Proving Ground
Aberdeen, MD 21005

*Staff, U.S. Nuclear Regulatory Commission

Prepared for
Division of Safeguards
Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555
NRC FIN B6989

NUCLEAR REGULATORY COMMISSION

Docket No. 50-413/414-OLA Official Exh. No. SEC-10
In the matter of Duke Catawba
Staff ______ IDENTIFIED 1/13/05
Applicant ______ RECEIVED 1/13/05
Intervenor ✓ REJECTED ______
Cont'g Off'r ______
Contractor ______ DATE ______
Other ______ Witness ______
Reporter ______

Template = SECY-028 SECY-02

ABSTRACT

This report provides guidance to aid NRC fuel fabrication licensees in evaluating the integrity of special nuclear material (SNM) storage vaults, and presents specific designs for hardening (i.e., increasing the penetration resistance of) such facilities. The report also contains the results (reported in terms of tools used and elapsed time) of penetration attempts against several of the hardening designs. The document was developed to provide guidance in support of the Physical Protection Upgrade Rule, effective March 25, 1980, and supersedes the guidance provided by NUREG/CR-1378 (June, 1980).

TABLE OF CONTENTS

1. INTRODUCTION

This report provides guidance to licensees in their efforts to meet the requirements of the Physical Protection Upgrade Rule for Fixed Sites (10 CFR 73.20, 73.45, 73.46). This rule requires Special Nuclear Material (SNM) to be stored in vaults designed to provide penetration resistance sufficient to prevent the removal of SNM prior to the arrival of on-site security or local law enforcement personnel capable of neutralizing the design basis threat described in 10 CFR 73.1. Such vaults must also be capable of preventing entry by a single action in a forced entry attempt, except as such single action would both destroy the barrier and render the SNM incapable of being removed. This document provides guidance on methods to upgrade SNM vaults (and hence partially meet the requirements of the above referenced rule) by providing general guidelines to aid licensees in evaluating existing SNM vaults, discussing methods and tools that could be employed to penetrate such facilities, and providing simple, cost-effective hardening (i.e., penetration-resisting) techniques. In addition, the document contains the results of penetration testing of several of the recommended hardening techniques. The resulting penetration times are derived from field testing conducted by the U.S. Army Materiel Systems Analysis Activity (AMSAA), Aberdeen Proving Ground (APG), Aberdeen, Maryland, 21005. This report supersedes the guidance provided by a previous report, Hardening Existing Strategic Special Nuclear Material Storage Facilities (NUREG/CR-1378).

2. SCOPE AND ASSUMPTIONS

The following assumptions and limitations have been placed on the scope of this effort:

a. This report is primarily concerned with the penetration resistance associated with the physical barriers (e.g., walls, floor, roof, doors and various apertures) of SNM storage vaults;

b. For the purposes of this report, an "SNM storage vault" is defined as an enclosure with walls, floor, roof, and door(s) designed and constructed to delay penetration from forced entry. "Penetration time" is defined as the time required to make an opening with a diameter of approximately 18 inches in an SNM storage vault and includes, for example, time for setting up mechanical or power tools and/or placement of explosives;

c. This report will describe and test hardening techniques designed to meet the requirements of the Physical Protection Upgrade Rule for Fixed Sites and defend SNM storage facilities against the threat defined in 10 CFR Part 73.1;

d. Penetration scenarios involving the use of explosives in such quantities that SNM in vaults would be rendered unusable by the adversary are expressly excluded;

e. This report will not consider physical barriers adjacent to an SNM storage vault which might affect a penetration attempt;

f. This report will not consider time delays associated with health, safety or environmental factors normally considered in the handling and storage of special nuclear material.

3. THE THREAT

The external threat is characterized as a small group, highly dedicated to obtaining SNM. They are assumed to have expertise in the use of manual and powered hand tools and sophisticated explosives used to penetrate physical barriers, and to have the capability to fabricate task-specific equipment. Since possession of intact SNM is the mission goal, penetration of the storage vault without damage to SNM containers or contents is of utmost importance. As it is assumed that personal risk would be acceptable to the external threat group, concerns such as waiting times for fumes, smoke and other byproducts (from the use of explosives) to dissipate or maintaining a safe distance from blast and pressure effects would be minimized. This external adversary group (acting with or without the assistance of an insider) is assumed to have complete knowledge of the design, composition, fabrication, and location of the SNM storage vault. It is feasible to assume that rehearsals of the attack could be conducted on appropriate models of storage vaults.

4. PENETRATION TOOLS

Tools and materials considered available to the adversary and appropriate for use in penetration operations include hand tools, power tools, thermal tools, and explosives. It has been assumed that penetration attempts would most likely use explosives or man-operated hand tools weighing less than 100 pounds, i.e., those that could be carried on site. Consequently, only tools and materials in these categories are used in the penetration testing. The licensee should also be aware, however, of potential penetration tools that are available at a facility. For example, a forklift with ignition keys left unattended could provide a convenient and effective penetration tool. Appendices A & B provide additional information on penetration tools.

5. GENERAL GUIDELINES FOR SNM STORAGE FACILITY EVALUATION

The licensee, in determining if his SNM storage facility meets the proposed upgraded level of security, must first evaluate his present structure. The following general guidelines are presented to aid with this task:

a. Examine the Existing Construction:

Using the Sandia Barrier Penetration Handbook (referenced in the Fixed Site Physical Protection Upgrade Rule Guidance Compendium), Appendix C (Barrier Penetration Data) of this publication, or other reliable data on materials penetration (derived from sources such as engineering handbooks), determine the penetration resistance of the material presently utilized in the walls, floor, roof, door(s), and other apertures. Be certain to consider the weakest part of each component, such as joints, casing, hinges, and locks.

b. Evaluate Existing Apertures:

Determine if existing utility ports or electrical, heating, ventilation, and air conditioning ducts would allow entry into the vault. Determine if these apertures are constructed such that, although preventing physical entry, they would allow mechanical arms or grabbers to be used to remove material. (It should be noted that windows are not permitted in SNM storage vaults under the Physical Protection Upgrade Rule.)

c. Evaluate the Location:

How accessible is the SNM storage vault area from outside the building? Determine, for example, if relocating the vault closer to or away from existing walls would improve the penetration resistance.

d. Determine the Location and Control the Availability of Electric Power

If possible, electric power in the immediate vicinity of the vault should not be readily available to the adversary.

Following a determination of the penetration resistance of vault components, compare each penetration time to the time estimated for arrival of response personnel capable of neutralizing the design basis threat stated in 10 CFR Part 73.1. Identify the components with a penetration time less than the response force reaction time; these are the components of the SNM storage vault that should be considered for upgrading.

Once the vulnerable components have been identified, the licensee should refer to the next two sections of this report, HARDENING TECHNIQUES and PENETRATION TESTING OF HARDENING DESIGNS. These sections address typical components of SNM storage vaults, evaluate a variety of structural materials presently used in these components, describe techniques for improving their penetration resistance, and present the results of penetration tests against ten specific hardening designs.

6. HARDENING TECHNIQUES

The hardening techniques and designs described in the following pages are provided as simple and cost effective ways of increasing the penetration resistance of both existing and new SNM storage facilities. The application of specific hardening techniques should, however, be reviewed with NRC prior to significant investment or adaptation as physical characteristics and operational requirements of facilities may vary from site to site.

In general, the goal of hardening techniques is to extend time expended in an attempted penetration by requiring the adversary to use multiple tools and sophisticated explosives. With respect to SNM storage vaults, several specific techniques (such as using multiple barriers of different materials) may be employed. Specifically, consideration should be given to different material compositions to require changes in penetration tools, e.g., metal and wood; rubber and metal; concrete and wood; and metal and concrete. To minimize the effects of a single explosive charge, techniques that provide space between barriers to dissipate blast effects (thus requiring more than one charge for multiple barriers) should be considered. The concept of a suppressive shield, which breaks up an explosive shock wave and vents gases to minimize the energy applied to a solid portion of a structure, is also valuable in minimizing blast effects. Material compositions and layering that require the use of a specific tool but also defeat the tool because of its inherent limitations (e.g., wood backed with metal would generally require the use of a chain saw or skill saw; however, contact of the wood cutting blade with metal would result in damage to the saw) are to be used when possible. In addition, material compositions that require the use of explosive charges but also require exact calculations of charge weight to prevent blast and spall damage to SNM containers may be employed.

7. PENETRATION TESTING OF HARDENING DESIGNS

The purpose of these tests was to determine the penetration time for several hardening designs originally proposed in a previous study (Hardening Existing Strategic Special Nuclear Material Storage Facilities: NUREG/ CR-1378). The testing program included evaluations of individual steel components (e.g., Rebar and angle iron) as well as representative portions (e.g., walls) of specific designs.

The tests were conducted in two major phases. Recognizing the high utility of thermal cutting tools, the first phase examined the oxygen/ acetylene torch cutting times for several individual and combinations of steel components. The second phase examined the penetration resistance of ten specific hardening designs. Although penetration testing was conducted on only ten of the 15 proposed designs,* those selected were representative of the materials and major design characteristics of the remaining five proposals.

Phase One Tests: Cutting Rebar and Angle Iron

The tests were conducted by an experienced welder who made ten cuts on each of the test items. The cutting times were measured from the time the torch touched the material to the time the cut portion of the material fell free. Table 1 on page 7 presents the mean and standard deviation of the cutting times for the 11 test items. Figures 1 through 5 show some examples of the test items and technique.

As would be expected, an analysis of the results presented in Table 1 reveals that increased resistance to cutting by oxygen/aceteylene torch can be achieved by varying the combination and configuration of various materials. For example, if cut separately, three pieces of Number 5 Rebar and three pieces of 1-1/4 inch pipe would require a total cutting time of approximately 117 seconds. However, by arranging the three pieces of pipe in a triangular configuration and inserting a piece of Rebar inside each pipe, the cutting time increases to approximately 255 seconds (Figures 3 and 4).

*Design 16 presents general guidelines rather than a specific hardening design.

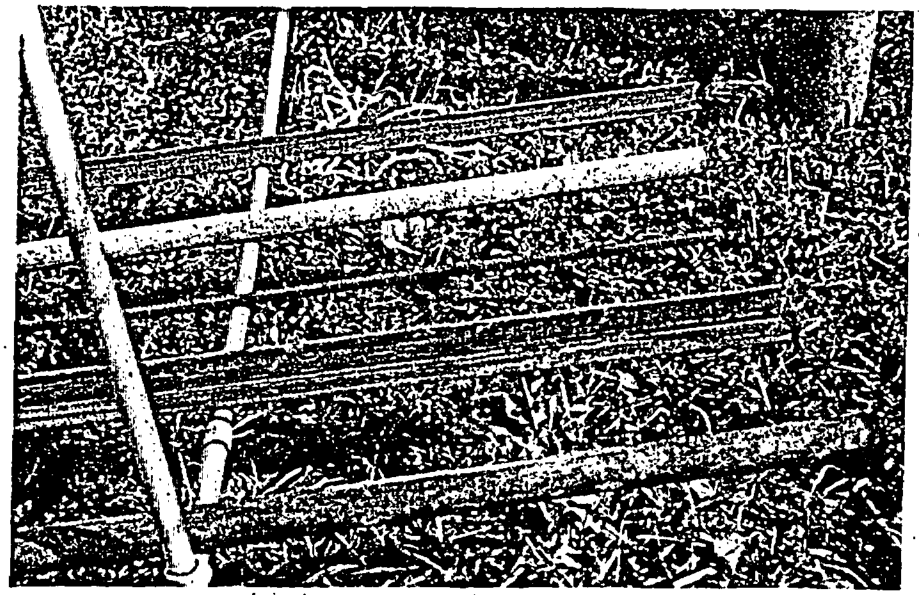

Figure 1

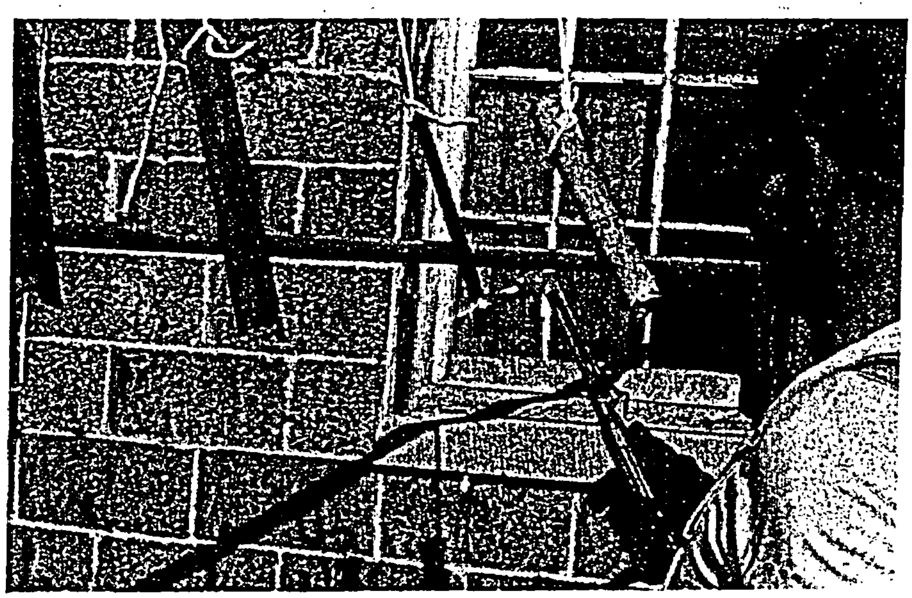

Figure 2

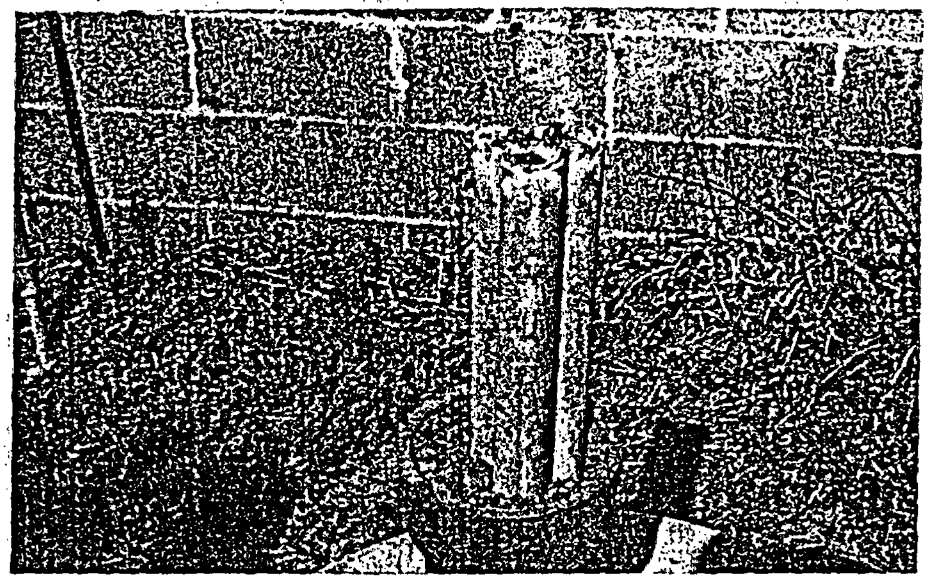

Figure 3

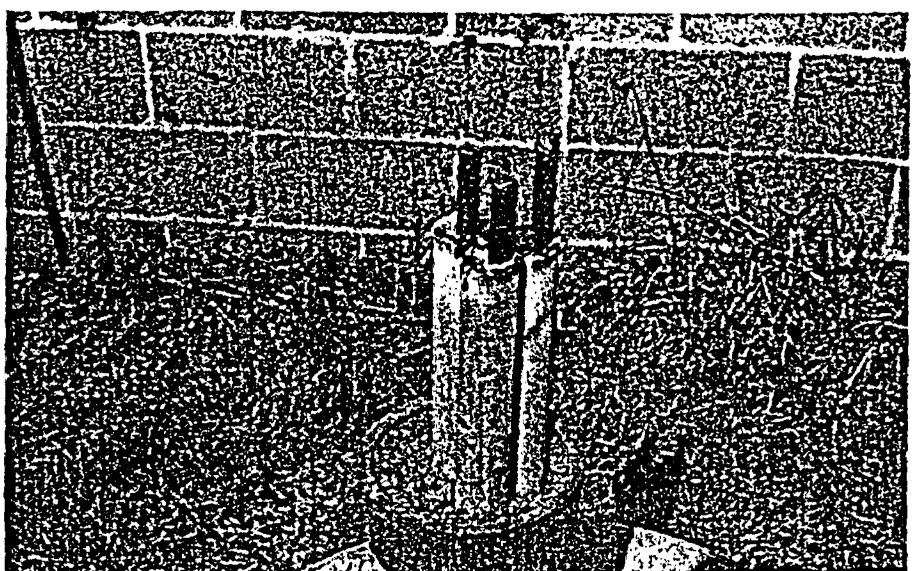

Figure 4

Table 1: Results of Phase one tests--Oxygen/Acetylene Cutting Times for Steel Components (Specifications: No. 5 LINDE Cutting head; Oxygen: 22 lbs; Acetylene: 10 lbs.--10 trials per component)

Component	Mean cutting time (min:sec)	Standard deviation (sec)
No. 5 Rebar	0:12	0.7
1½" angle iron	0:18	0.6
2" angle iron	0:25	1.0
2" angle iron (2) (Box configuration)	1:35	1.5
1¼" pipe	0.27	1.0
1¼" pipe (sand filled)	1:06	2.5
1¼" pipe (3) (triangular configuration)	2:05	1.3
1¼" pipe (3) (triangular configuration with Rebar)	4:15	0.7
1¼" pipe (3) (triangular configuration sand filled)	5:36	1.9
1¼" pipe (3) (triangular configuration with Rebar, sand filled)	9:33	4.1
10 guage steel plate (6 foot linear cut)	8:04	3.4

A rather unusual effect is also created when sand is added to the triangular pipe and Rebar combination. The initial synergism is still present; however, the sand increases the cutting time to an average of nine minutes and 33 seconds. This represents an average increase of five minutes and 18 seconds, a greater than 100% increase over the cutting time for the "unsanded" triangular pipe and Rebar arrangement.

A "box" arrangement of 2-inch angle iron will also produce a desirable effect (Figure 5). Cut separately, two pieces of 2-inch angle iron have an average total cutting time of 50 seconds. However, when placed in the box configuration, the mean cutting time is increased to one minute and 35 seconds.

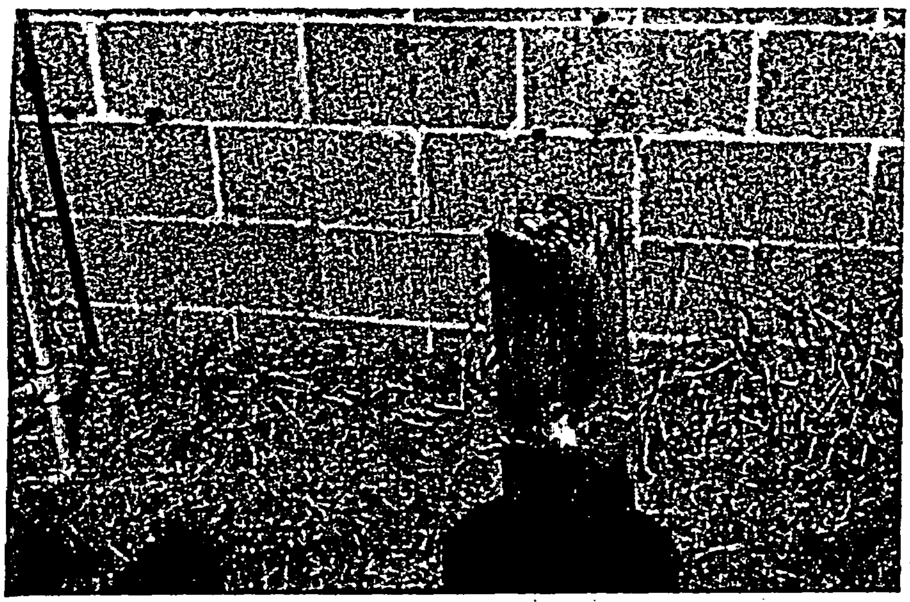

Figure 5

The synergisims noted in these tests can be attributed to several factors. First, the different configurations effectively increase the thickness of the test item, requiring it to be cut from more than one side. This necessitates removal of additional material to provide access to the rear and center portions of the item. Secondly, the sand used in the triangular pipe-Rebar arrangement is transformed into a low-grade "glass" by the intense heat and acts as a shield to break up the cutting stream. The "glass" must be removed before the cutting can be continued, thus increasing the time expended.

Phase Two Tests: Penetration Attempts

The second portion of the testing program consisted of 12 penetration attempts against a total of ten hardening designs or design variations.* The penetrations were conducted by a three-man U.S. Army Special Forces contingent from the John F. Kennedy Special Warfare Center, Fort Bragg, North Carolina.

The objective of the penetration team was to create an 18-inch diameter opening in the barrier without causing significant damage to simulated SNM containers positioned behind the barrier. The penetration attempt was timed from a starting point 50 feet from the barrier and ended when the team returned to the starting point with a simulated SNM container. The penetration team was provided engineering drawings of the each of the hardening designs two months prior to testing. The intent was to provide "complete knowledge" of the various barriers so that appropriate tools and equipment could be acquired and training accomplished. There were no restrictions on the specific type of equipment that could be used; however, the team was restricted to a total equipment load of 120 pounds.

As the use of explosive charges resulting in damage to the simulated SNM was to be considered an unsuccessful penetration, a method was developed to measure SNM container damage. Blast and fragmentation were measured by placing a "spall wall" between the barrier and the containers, which were arranged on shelves (Figure 6). The spall wall was constructed of

Figure 6

*Two penetration times were derived for Design 4. The two variations of Design 2 (2-1/2-2) received a total of three penetration attempts; the two variations of Design 6 (6-1/6-2) each received a penetration attempt.

1/4 inch plywood with SNM containers simulated by tin cans filled with sand. A subjective evaluation of damage was made by measuring the weight of the spall which penetrated the wall and the movement of the cans on the shelves.

To abide by Aberdeen Proving Ground (APG) regulations, all explosives were primed and fired by authorized APG specialists. Although the attack team designed and fabricated all charges and placed them on the barriers, an administrative halt was called after each placement to permit APG specialists to prime and fire charges. All personnel were required to be inside a safety bunker during the firing of explosive charges.

Video tape and still photography were used to record the penetration attempts. Four test controllers recorded the time increments for each separate action; i.e., movement to target, placement of charges, tool usage, and return to starting point.

Table 2 on page 11 presents a summary of the results of the penetration tests against the selected designs in terms of equipment used, individual activity time, and total time elapsed. The diagrams, photographs and text in the following pages describe each design, the sequence of penetration actions carried out against it, and the conclusions from each penetration attempt.

	K-250 Rescue Saw	Chain Saw	Explosives	Oxygen/Acetylene Torch	Axe	Wrecking Bar	Crowbar	Bolt Cutters	Debris Removal	Movement To and From Target	TOTAL PENETRATION TIME
Design 1		1:41	1:18	9:56				:59		:16	14:10
Designs 2-1/2-2											
Penetration 2A (2-1)	26:25	2:20					:53		1:15	:16	31:09
Penetration 2B (2-1)		4:12	:41		2:30	:12	:15			:16	8:06
Penetration 2C (2-2)		6:02	1:02	8:45	6:17	:06			:59	:16	23:27
Design 3		4:34	:16	4:48				:31	:17	:16	10:42
Design 4	19:36	1:56	:18	*				1:51	3:14	:16	27:11
Design 5			5:40	60:34						:16	66:30
Designs 6-1/6-2											
Penetration 6A (6-1)				14:33			:55			:18	15:46
Penetration 6B (6-2)				26:38			:15			:36	27:29
Design 9			1:01	46:27		:14				:49	48:31
Design 13			:37	19:36						:19	20:32

*Penetration time is decreased by 10:55 (from 27:11 to 16:16) when oxygen/acetylene torch is used in place of the K-250 rescue saw.

Table 2 Phase Two results - Penetration times of selected designs (showing individual tool and activity times)