NISTIR 4975

Test Methods for Detention and Correctional Facility Locks

C.W.C. Yancey

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Building and Fire Research Laboratory
Gaithersburg, Maryland 20899

U.S. Department of Commerce
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Prepared for:
National Institute of Justice
Office of Justice Programs
U.S. Department of Justice
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TABLE OF CONTENTS

ABSTRACT

Draft test methods are presented for evaluating locks installed in detention and correctional facilities. The methods have been developed by ASTM (American Society for Testing and Materials) Committee F 33 on Detention and Correctional Facilities and are drafted in ASTM standard test method format. The NIST contribution to this effort is to assist the F 33 Committee in drafting, balloting and obtaining consensus approval for these test methods. Existing standards for residential and commercial locks have been reviewed to determine their applicability to the evaluation of locks subject to the abuse common to detention and correctional facilities. Synopses of relevant standards are presented in this report.

A case is made for performing laboratory tests on prototype locks to quantify current performance levels and to establish a classification system for detention-facility locks. Gaps in the knowledge base are identified and recommendations are advanced for performing a series of cyclical operations, impact and lockbolt retraction tests. The results from the recommended laboratory test program would be used to prepare a minimum performance standard for promulgation by the National Institute of Justice (NIJ). To ensure broad application of the NIJ standard, the test results would feed directly into standards-making activities of ASTM Committee F 33.

key words: bullet resistance test; detention and correctional facilities; fire resistance test; impact test; lockbolt retraction test; locks;

I. BACKGROUND

Locks, like virtually all other hardware designed and selected for detention/correctional facilities, are expected to contribute to the facilities' designated security level. Specifically, detention/correctional facility locks are subjected to a relatively large number of cycles of locking and unlocking under normal operating conditions. Depending upon the level of security of the facility and the location within the facility, locks are subjected to various forms of inmate abuse. For the safety of facility personnel and to prevent inmates from gaining access to restricted spaces, locks are required to remain in a locked position after being subjected to modes of abuse such as: 1) attack with small tools (i.e. picking, prying, etc.), 2) impact from hand-held objects, 3) handgun attack, and 4) fire exposure. Additionally, locks must be strong enough to allow lockbolt retraction (i.e. unlock) when inmates attempt to jam them by applying a lateral force to the door.

Lock manufacturers are required to provide cost-effective locks that are relatively simple to install, operate, maintain, and repair while satisfying the facility's security criteria. During the past decade, several studies of detention/correctional facility equipment and systems have been documented [1,2]. Survey questions about the performance of locking systems have generated mixed responses. Institutions at all levels of security have reported varying degrees of success with the facilities locking systems. One need that has consistently been stated or inferred is that of developing a set of performance standards for locking systems. These standards would specify performance requirements for various levels of security and identify means of evaluating locks for their performance attributes. To achieve an effective evaluation system, it is also necessary to develop standardized test methods for measuring lock performance. Moreover, standard performance criteria and test methods promote innovation in lock design and application.

According to the results of a 1987 survey conducted at the University of Cincinnati [2] among adult correctional institutions, about three-fourths of the 111 institutions responding use either a combination of mechanical (manual) and electro-mechanical locks or electronic locks exclusively. The remaining institutions use manual locks only, pneumatic locks only or a combination of electronic and pneumatic locks. The combination of manual and electro-mechanical locking systems is the most prevalent lock application across the three levels of security (minimum, medium, and high). Manual locks are in greatest use among minimum-security institutions, while electronic locks had the highest percentage of response from maximum-security institutions. Slightly more than half of the medium-security institutions reported using a combination of manual and electronic locks.

During the period from late 1986 through 1988, the National Institute of Standards and Technology (NIST) conducted a study for the National Institute of Corrections (NIC). The primary objective of the study was to "develop guidelines, test methods and technical bases for standards which would assist in the selection, application, and maintenance of building materials, equipment and systems for use in detention and correctional facilities." The first phase of the study was devoted to determining the state-of-the-art in the design and

construction of detention and correctional facilities [3]. Based on the information gathered during the first phase, it was concluded that the materials, equipment and systems specification process could be improved through the establishment of performance criteria and product standards. A recommended priorities list for future activities was developed as the culmination of the study. The development of test methods for locks and access control systems was one of the activites assigned to the high priority category. The second phase of the NIST study was devoted to developing a performance-criteria document for building materials, equipment and systems used in detention and correctional facilities. A report [4] containing preliminary performance criteria was published in 1989. The chapter of the report relating to locks and locking systems has been extracted and presented in Appendix A of this report.

The end user is faced with the problem of selecting from a variety of lock types without the aid of performance criteria and test methods especially adapted to detention and correctional facility lock systems. Although there are several standards which cover the performance of various types of residential and commercial locks, there are no national standards which address important performance attributes such as impact and bullet resistance for locks used in institutions such as jails and prisons.

In June 1990, the Technology Assessment Program Advisory Council (TAPAC) established a standing committee on Detention and Corrections. TAPAC was established in 1975 by NIJ through its Technology Assessment Program Information Center to serve in an advisory capacity. Among the recommendations made at the first meeting of the Detention and Corrections Committee was the development of standards and test methods for pneumatic locks and locking systems. Based on written highlights of that meeting, it is noted that TAPAC already had on its priority list the development of a standard for hinges and locks in correctional facilities. Pneumatic lock standards were given a higher priority because of the relative newness of this type of lock. The more fundamental reason for developing performance standards and standard test methods is to support comparative evaluations among new and existing lock products.

II. PROJECT OBJECTIVE, SCOPE AND APPROACH

II.1 Objective and Scope

The objective of this project is the development of standard test methods and performance criteria for various types of locks used in detention and correctional facilities. The scope is currently limited to electro-mechanical, electric, pneumatic and mechanical locks used with swinging doors.

II.2 Approach

The NIST approach in this endeavor is to provide a technical basis for a NIJ standard and to support the development and promulgation of national consensus standards for detention and correctional facility locks. Precedence for the NIST approach has been established in the development of NILECJ-STD-0306.00 [5] and NIJ Standards 0316.00 and 0318.00 [6,7]. Results from laboratory research provided the technical bases for the aforementioned standards.

Another key element of the NIST approach is to work closely with ASTM Committee F33 on Detention and Correctional Facilities. In late 1990 Committee F33 initiated the development of proposed standard test methods for detention locks. The scope of these methods will include physical tests (continuous usage, impact, lockbolt retraction under lateral load, small arms bullet resistance and fire resistance) for electric, pneumatic, and manual (key) locks used in detention and correctional facilities. Test method development will utilize existing lock and/or door standards (e.g. UL 437, "Key Locks" and UL 1034 "Burgulary Resistant Locking Mechanisms") where applicable. In addition, Committee F33 is developing a standard specification for detention/correctional facility swinging doors ("Standard Specification for Detention Hollow Metal Swinging Door Assemblies") which will become a companion standard to the lock test method standard.

The Building and Fire Research Laboratory (BFRL) of NIST has been assisting ASTM Committee F33 in the preparation of drafts of the standard for detention locks. Beginning with a draft dated August 1991, BFRL has revised drafts of the proposed standard test methods based on comments received from task group members. To facilitate an interaction between BFRL and Committee F33, BFRL personnel have attended the semi-annual meetings of F33 and have been active participants in the meetings of Task Group F33.04 (on Operational Systems). Currently, BFRL is cooperating with the chairman of F33.04 in an effort to prepare a draft that can be distributed with a letter ballot.

The establishment of a comprehensive experimental program at NIST would greatly assist Committee F33 in the development of performance standards and the promulgation of standardized test methods. The development of ASTM Standard F 476 ("Standard Test Methods for Security of Swinging Door Assemblies") is an excellent example of a standard resulting from the combined efforts of NIST, NIJ and ASTM. NILEC-STD-0306.00 was the forerunner to ASTM Standard F 476.

III. REVIEW OF EXISTING LOCK STANDARDS

A number of industry test methods standards already have been established for assisting in the selection and evaluation of locks for residential and light commercial applications. While some of the attack methods to defeat the locks are common to residential/commercial and penal institution locking systems, locks used in detention and correctional institutions are generally subjected to a larger number of normal-use cycles and to more severe levels of physical abuse. It is instructive to begin the process of test method development for detention- and correctional-facility locks by reviewing existing lock standards primarily intended for residential and commercial locks.

Standard test methods developed by or for the American Society for Testing and Materials (ASTM), American National Standards Institutue (ANSI), Underwriters Laboratories, Inc. (UL), Builders Hardware Manufactureres Association (BHMA), and National Fire Protection Association (NFPA) were reviewed for their possible application to detention- and correctional-facility locks. Summaries of the standards that have features which appear to be adaptable are presented here. In some cases, the synopsis pertains to only selected parts of the standard and in others the entire standard is applicable. The distinction is noted in the heading of the subsequent subparagraphs.

The scope of the test method is presented first, followed by a description of the test method and, when present in the standard, a statement of the acceptance criteria.

A. Parts of UL 1034 - "Standard for Burglary-Resistant Electric Locking Mechanisms"

Forcing Tests

1. Pushing Test - Withstand a 1.33 kN (300-pound) force applied gradually over the locking point in the direction that the door opens. Force is to be held for 1 minute.

After the test, the door shall not open and the locking mechanism shall operate as intended.

2. Torque Test - Apply a 305-Nm (225 lbf-ft) torque to a rotating handle in the direction used for normal operation. Torque applied gradually and held for 1 minute.

Tool Attack Test

Lock to be mounted as intended in service and the attack is to be conducted for a net time of 5 minutes. The method of attack is to be determined by the construction of the product. List of tools for use includes: hammers, chisels, adjustable wrenches, pry bars, punches, screwdrivers, picking tools and wires.

As a result of the attack there shall not be damage to the locking mechanism to the extent that it will not operate as intended.

B. **ASTM Standard F 476 – "Standard Test Methods for Security of Swinging Door Assemblies"**

Scope

Test methods for door assemblies and for individual components such as the hinge, lock, door, and jamb/wall.

a. Static Bolt Load Test
b. Jamb/Wall Stiffness Test
c. Knob Impact Test
d. Cylinder–Core Tension Test
e. Knob Torque Test
f. Cylinder Torque Test
g. Cylinder Impact Test
h. Door Impact Test
i. Hinge Impact Test
j. Hinge Pin Tensile Load
k. Bolt Impact Test

Lock Types

Type A Lock – A lock that uses a single bolt, or separate latch and lock bolts that are mechanically interconnected.

Type B Lock – A lock in which the latch bolt is mechanically independent from the lock bolt.

Apparatus

1. Door Ram – 200 J (148 ft–lbf); 45 kg (99.2 lb)

2. Component Ram – 100 J (74 ft–lbf); mass, 16 kg (35.3 lb); drop height, 637 mm (2.09 ft)

3. Vertical Impactor – 100 J (74 ft–lbf); mass, 10 kg (22 lb); drop height, 1.02 m (3.35 ft)

4. Torque Applicator – Commercial Torque Wrench, 163 J (120 ft–lbf)

5. Tensile Loading Device – 17.8 kN (4000 lbf)

6. Jamb Spreading Device – 22 kN (5000 lbf)

7. Compression Loading Device – 900 N (200 lbf)

Acceptance Criteria and Classification

Acceptance criteria proposed by the NIJ is included in the appendix of the standard. In the form of a general requirement, it is stated that an item

shall fail a test if, at any time during the test, an individual can open the door from the outside by the following methods: pushing or pulling on it; turning the knob; manipulating an exposed lock mechanism; reaching through damaged portions of the door and unlocking it from the inside; entering through damaged portions of the door even though it might not be possible to open the door; or depressing the dead latch or dead bolt using static load applied by hand. Specific criteria is presented for each test. Four grades of security, with grade 40 being the highest grade and grade 10 the lowest, are used to categorize the door assemblies. Selection of grade levels should be in accordance with the security objectives desired.

C. UL 752 – "Bullet-Resisting Equipment"

Scope

Requirements cover materials, devices, and fixtures used to form bullet-resiting barriers designed to protect against robbery or holdup. The term "bullet-resisting" indicates the ability to resist complete penetration, passage of fragments of projectiles, or spalling of the protective material to the extent that injury would be caused to a person standing directly behind the bullet-resisting barrier.

Test Method

Section 15 (Ballistics Test) contains the specifications for the test frame, test setup, procedure, and acceptance criteria for conducting a ballistics test on bullet-resisting materials. Tests are to be conducted at close range, 4.6 m (15 ft) or less, using the weapon and ammunition identified for a particular power rating.

Classification

Bullet-resisting materials are assigned ratings in accordance with their performance when subjected to bullets fired by weapons with one of four power ratings. The four weapons power ratings, beginning with the highest, are: 1) High-Rifle, 2) Super-small Arms, 3) High-Small Arms, and 4) Medium-Small Arms.

D. UL 437 – "Standard for Key Locks"

Scope

This standard contains performance attributes and test requirements for key locks categorized as follows: 1) Door Locks, 2) Locking Cylinders, 3) Security Container Key Locks, and 4) Two-Key Locks.

Test Method

The requirements for a range of performance tests are described including: 1) Endurance Test, 2) Hand-Tool Attack Resistance Tests (i.e. Drilling, Picking, Impression, Sawing, Prying, Pulling, Forcing and Driving), 3) Salt Spray Corrosion Test, and 4) Polymeric Materials Tests.

A table is provided to specify the net working time for each test.

1) **Endurance Test**
10,000 complete cycles of operation at a rate not exceeding 50 cycles per minute.

2) **Hand-Tool Attack Resistance Tests**
Common hand tools are specified, including length and weight limitations where applicable. No force levels and specific procedures are included.

3) **Salt Spray Corrosion Test**
Primarily applicable to products intended for outdoor use. Requires that products be subjected to 96 hours of exposure to a salt spray in accordance with ASTM B 117, Method of Salt Spray (Fog) Testing.

4) **Polymeric Materials Tests**
Requires that polymeric materials be subjected to strength, aging-stress distortion and moisture absorption tests.

E. UL 10B/NFPA 252/ASTM E 152 - "Fire Tests of Door Assemblies"

Scope
Presents methods of fire testing for door assemblies of various materials and types of construction. The door assemblies are intended for use in wall openings and are expected to retard the passage of fire. Data obtained from these fire tests should assist in determining a door assembly's ability to remain in an opening during a predetermined test exposure.

Test Methods

Two test methods are described: 1) Fire Endurance Test and 2) Hose Stream Test.

1) **Fire Endurance Test** - The door assembly is mounted inside a furnace whose temperature is controlled in accordance with a prescribed time-temperature curve. The time of expsoure is dependent on the fire rating being sought for the door assembly.

2) **Hose Stream Test** - Immediately following the fire endurance test, the surface of the door assembly is subjected to a specified hose stream. The size of the hose, water pressure at the base of the nozzle, and the distance from the tip of the nozzle to the face of the door assembly are specified.

Acceptance Criteria
General and specific conditions of acceptance are presented for door assemblies subjected to first the fire exposure test followed by the hose stream test. One of the specific conditions requires the hardware used on the fire door to hold the door closed and in addition the latch bolt shall remain projected and intact after the test. The hardware does not have to be operable after the tests are conducted.

F. ANSI A156.2 "American National Standard for Bored and Preassembled Locks & Latches"

Scope

This standard establishes performance requirements for key-in-knob locks and latches. It includes strength, operational, and finish tests and dimensional criteria.

Test Fixtures

Two basic test fixtures are described: 1) a mechanically operated door or panel and 2) a static load testing fixture consisting of a hinged test door or panel.

Test Methods

Operational Tests

1) Torque testing of the knob or lever to retract the latch bolt of an unlocked lock.

2) The force applied perdendicular to the face of the door in order to fully latch the door is measured and compared with a specified maximum force.

Strength Tests

A series of strength tests are described, accompanied by a table of specified load values for determination of acceptance. Qualification requirements call for conducting most of the following tests first, followed by the aforementioned operational tests.

1) **Torque Test** - A torque load is applied to the outside knob or lever.

2) **Axial Load Test** - A load is applied to the outside knob or lever along the knob or lever axis perpendicular to the face of the door to load the latch bolt against the strike.

3) **Vertical Load Test** - A load is applied vertically to the outside knob or lever perpendicular to the axis of the knob or lever.

4) **Warped Door Test** - The torque required to retract the latch bolt while a specified force is applied perpendicular to the face of the door, near the lock edge, is measured. The test is conducted with the torque applied first in one direction and then in the opposite direction.

5) **Bolt Strength Test** - The strength of the bolt is measured by applying a load perpendicular to the face of the door, close to the lock edge and on the centerline of the bolt in the direction of opening while the bolt is projecting into the strike.

Recommended test apparatus is described pictorially for the static load tests described above.

Cycle Tests

Test locks are installed in test door fixtures and subjected to repeated cycles of operations, first in the clockwise direction and then in the counterclockwise direction. Prior to conducting the cycle tests, the test lock shall be subjected to all of the Operational Tests, followed by the Warped Door Test. The maximum number of cycles in each direction and the maximum rate of operation are specified. At the completion of the Cycle Test, locks must be completely operational. Recommended test apparatus is described pictorially for the cycle tests.

Material Evaluation Tests

Unlocked Outside Knob Torque Test – A torque load is applied to the outside knob in both directions. The maximum torque required to retract the latch bolt is measured and compared with an allowable value.

Knob Crush Test – The knob is tested in compression to measure its crushing strength. At the specified maximum compressive load, the deformation of the knob is measured.

Dead Latch and Strike Impact Test – The test lock is subjected to an impact test in accordance with ASTM/ANSI Standard F 476. Failure is declared when a lock component is damaged so substantially as to allow the door to be opened.

Other Material Evaluation Tests – Other tests include: 1) Rose Dent, 2) Outside Rose Deformation, 3) Weather Exposure, and 4) Abrasion Resistance.

Finish Tests

A series of quality control tests are prescribed to ensure consistent finish quality. The finish test series includes: 1) Salt Spray, 2) Humidity, 3) Pencil Hardness and 4) Perspiration tests. Minimum exposure times and other values are tabulated.

IV. DRAFT TEST METHODS FOR DETENTION LOCKS FOR SWINGING DOORS

The draft test methods that follow are intended to simulate various acts of physical abuse conducted by inmates at penal institutions on swinging door locks. The draft is based on the developmental work of ASTM Task Group F33.04 on Operating Systems. They are written in accordance with ASTM standard test method format and are offered as the foundation for future standards developmental work related to detention and correctional facility locks.

1.0 Scope:

1.1 These test methods describe the apparatus, procedures, and acceptance conditions for evaluating the normal operational performance and the performance characteristics under assault conditions of locks used in swinging door assemblies in detention and correctional institutions.

1.2 It is the intent of these test methods to help ensure that detention locks operate at or above minimum acceptable levels to control passage to unauthorized or secure areas, to confine inmates and to delay and frustrate escape attempts.

1.3 The laboratory tests described in this standard simulate normal operating conditions and conditions in which detention doors and locks come under attack. Thus, they only give an indication of the performance characteristics of locks in actual service. Such variables as competence of installation and type of maintenance conditions are not considered.

1.4 These test methods involve hazardous materials, operations and equipment. They do not address all of the safety problems associated with their use. It is the responsiblity of the user of these test methods to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

1.5 The values stated in Customary U.S. units are the standard. The S.I. (Metric) values given in parentheses are for information only.

2.0 Referenced Documents and Agencies

2.1 Referenced Documents

ASTM Standards:
E152 Standard Methods of Fire Tests of Door Assemblies.
FXXX-9X Standard Test Method for Hollow Metal Swinging Door Assemblies for Detention Facilities.

NAAMM Standards:
ANSI/NAMM HMMA-863-90 - Guide Specifications for Detention Security Hollow Metal Doors and Frames.

NFPA Standards:
NFPA 252 - Methods of Fire Tests of Door Assemblies.

UL Standards:
UL-10(B) Fire Tests of Door Assemblies.
UL-752 Standard for Bullet-Resisting Equipment.
UL-437 Standard for Key Locks.
UL-1034 Standard for Burglary Resistant Electric Locking Mechanisms

2.2 Referenced Agencies

ANSI American National Standards Institute
111 West 42nd Street
New York, N.Y. 10036

ASTM American Society for Testing and Materials
1916 Race Street
Philadelphia, PA 19103

UL Underwriters Laboratories
333 Pfingsten Road
Northbrook, IL 60062

NFPA National Fire Protection Association
Battery March Park
Quincey, MA 02269

3.0 Terminology

3.1 Bolt - A metal bar which when actuated, is projected (or thrown) either horizontally or vertically into a retaining member, such as a strike plate, to prevent a door from moving or opening.

3.2 Bolt Projection - The distance lock bolt extends from lock case measured with lock bolt in retracted position.

3.3 Bolt Throw - The distance lock bolt travels from retracted to fully-extended position.

3.4 Detention Security - Assurance of the restriction of mobility of inmates to designated areas within a correctional or detention facility.

3.5 Hinged Door - A door equipped with hinges that permit it to swing about the vertical hinge axis, either right hand or left hand.

3.6 Hollow Metal – A term used in reference to such items as doors, frames, partitions, enclosures and other items which are fabricated from metal sheet. These products are internally reinforced but hollow, hence the term "hollow metal".

3.7 Lock – A fastener which secures a door or window assembly against unauthorized entry. A door lock includes the cylinder, bolt, strike plate, knobs or levers, tumblers, etc.

3.8 Manufacturer – The party responsible for the fabrication of the lock.

3.9 Performance Characteristics – The response attributes of the lock in any one of the tests described.

3.10 Strike or Strike Plate – A metal plate attached to or mortised into a door jamb to receive and hold a projected latchbolt and/or deadbolt in order to secure the door to the jamb.

3.11 Testing laboratory – An independent testing laboratory not associated with the manufacturer.

4.0 Significance and Use:

4.1 A major concern for detention and correctional administrative officials is the reliable operation of locks used in their facilities. These test methods aid in assigning a level of physical security and performance to locks for swinging door assemblies.

4.2 These test methods evaluate the resistance of a lock to attacks using battering devices, handguns up to and including .44 magnum, prying devices, and fires. These test methods also evaluate the performance of a lock under simulated operating conditions. These test methods do not provide a measure of the resistance or performance of a lock subjected to attack by corrosive agents, high powered rifles, explosives, sawing or other extreme methods of attack.

4.3 The primary purpose of these test methods is to approximate the levels of abuse and operating conditions to which locks are subjected in detention and correctional institutions. The result of their use provides a measure of assurance of protection to the public, and to detention and correctional personnel.

5.0 Prototype Selection, Construction and Size

5.1 Prototype Selection

5.1.1 Lock samples shall be representative of the types and styles intended for use in secure areas such as dayrooms, control rooms, cells and sally ports.

5.1.2 Prototypes for testing shall be selected at random from the manufacturers' finished stock.

5.1.3 The manufacturer shall permanently mark the test locks and retain them at the manufacturing facility for future reference. In lieu of retaining test locks, the manufacturer shall be permitted to contract with the testing laboratory to provide a certified procedure for the construction of tested assemblies with factory follow-up service (see paragraph 7.1).

5.2 Prototype Construction and Size

This section pertains to all tests requiring full-scale door assemblies consisting of doors, jambs, headers, and hardware.

5.2.1 The construction and size of the test door assemblies shall be representative of the application being simulated.

5.2.2 The door assembly support fixtures shall simulate the rigidity normally provided to a door assembly in a building by the ceiling, floor and walls. Refer to figure 1 for a minimum acceptable support fixture.

5.2.3 The test door assembly shall be prepared for the installation of locksets and hinges in conformance with the hardware manufacturer's instructions and templates.

6.0 Test Methods:

6.1 A test sample shall consist of a minimum of one lock. Perform each test described herein, on a previously untested lock unless otherwise specified. The test methods that follow consist of independent setups and procedures. They can be run exclusively or sequentially as deemed appropriate by the party ordering the tests.

The Scope, Significance and Use, Apparatus, Procedure and Test Termination and Conditions of Acceptance are specified explicitly except when other standards are being adopted as part of this standard.

6.2 Bullet Penetration Test

6.2.1 Test a lock assembly in accordance with the Ballistics Test provisions of UL 752. The weapon and ammunition shall be selected in accordance with the "Super-Small Arms" power rating. Any other sections, figures and/or tables cited in the Ballistics Test provisions of UL 752 are also adopted as part of this test method.

6.2.2 Testing individual components of the lock assembly is acceptable if each component test is conducted in accordance with the Ballistics Test provisions of UL-752.

6.2.3 Test Termination and Conditions of Acceptance
A test lock shall meet the penetration-resistance requirements specified in UL-752. Locks satisfying the above-stated conditions of acceptance, will be assigned the weapon resisting rating of super-small arms (Level 3): 44 Magnum.

6.3 Impact Test

6.3.1 Scope:
This test method is designed to evaluate the capability of a detention lock, to resist repeated impact forces at the designated area.

6.3.2 Significance and Use:
This test method is intended to simulate closely a sustained battering ram style attack and provide an evaluation of the capability of the lock to prevent, delay, and frustrate escape and/or access to unauthorized areas. The test results are intended to aid in assigning a level of physical security to various configurations of swinging door detention locks.

An impact test of this design performed on a detention lock evaluates the impact strength of the lock and its components as well as quality of fabrication techniques.

6.3.3 Apparatus: Impactor - The impactor shall be a pendular system with a mass capable of delivering horizontal impacts of up to 271.2 J (200 ft-lbf). The weight of the impactor shall be between 36.0 to 45.0 kg (80 and 100 lbs) inclusively. The striking nose of the ram shall be made from C1010-1020 carbon steel, the striking surface area of which shall be 0.00258 $m^2 \pm 25.8$ mm^2 (4.0 ± 0.04 sq in) (see figure 2).

6.3.4 Procedure
The lock shall be installed in a test fixture that closely simulates the door and frame to be used in actual detention or correctional facility construction. Using a prototypical door assembly and the test apparatus described in paragraph 6.3.3, deliver 400 impacts of 271.2 J (200 ft-lbf) each to the door lock on the push side of the door. The point of impact shall be on the centerline of the bolt, spaced a maximum of 152.4 mm (6 in) from the edge of the door (refer to figure 3).

6.3.5 Test Termination and Conditions of Acceptance
The lock shall remain in place and locked throughout the testing procedure. The lock being damaged to the extent that egress can be achieved constitutes failure. Upon completion of the impact series, an attempt shall be made to disengage manually the lock. If the lock will not disengage by key operation, it shall constitute failure.

6.4 Fire Test:

6.4.1 The door assembly with the required lock shall be subjected to Fire Endurance and Hose Stream tests in accordance with standard test methods ASTM E152, UL-10 (B), or NFPA 252.

6.4.2 Scope:
It is intended that the test lock maintain the fire door in a closed position for the duration of the fire endurance test.

6.4.3 Apparatus and Test Setup:
The lock shall be mounted in a door assembly which is representative of the classification rating desired for the lock design.

6.4.4 Test Termination and Conditions of Acceptance:
The acceptance criteria and criteria for assignment of fire ratings shall be in accordance with standards E 152, UL-10 (B), or NFPA 252.

6.5 Tool/Attack Pick Resistance Test:

6.5.1 The lock shall be tested for resistance to tool attack and forcing tests in accordance with test standards UL-1034 and UL-437.

6.5.2 Scope:
These test procedures are intended to help establish the level of resistance of locks to being opened by a concentrated static force or by manipulation with hand tools.

6.5.3 Significance and Use:
Locks are expected to remain locked while being subjected to relatively short-term attack by concentrated static force or by hand tools such as hammers, chisels, high-speed drill bits, adjustable wrenches, pry bars, punches, screwdrivers, picking tools and wires.

6.5.4 Test Termination and Conditions of Acceptance:
The acceptance criteria shall be in accordance with standards UL-1034 and UL-437. Testing individual components of the lock is acceptable if each component test is conducted in accordance with UL-1034 and UL-437. The level of performance shall meet the rating of small tool attack and forcing tests.

6.6 Environmental Performance Test:

6.6.1 Scope:
The procedures specified in this section are intended to help in measuring the performance attributes of locks when operating under extreme environmental conditions. Performance ratings shall be established for the following environmental tests:

Humidity Test

Temperature Test
Salt-Spray Corrosion Test
Rain Test
Dust Test

When locks are expected to function in harsh environmental conditions such as extremes of humidity and temperature, outdoor exposure or abnormally dust-borne areas, their performance shall be rated by one or more of the procedures enumerated in this section.

6.6.4 Procedure:
Perform all tests in accordance with test standards UL-1034 and UL-437.

6.6.5 Test Termination and Conditions of Acceptance
The acceptance criteria shall be in accordance with the standards UL-1034 and UL-437. The level of performance shall meet the rating of the testing as prescribed by UL-1034 and UL-437.

6.7 Electric or Pneumatic Lockbolt Retraction Force Test:

6.7.1 Scope:
This test method evaluates the capabilities of electric or pneumatic locks to function, under simulated operating conditions, while lateral force is applied perpendicular to the door face to prohibit lockbolt retraction.

6.7.2 Significance and Use:
This test method simulates the remote release (unlocking) of electric or pneumatic locks while being subjected to a perpendicular lateral force directed to stop lockbolt retraction.

A test of this design performed on an electric or a pneumatic lock evaluates the operating force characteristics and strength of the lock and its components as well as quality of fabrication techniques.

6.7.3 Apparatus:

6.7.3.1 The test fixture shall consist of a stationary frame and a hinged door. The fixture shall be constructed in accordance with figure 4 and must incorporate the lock manufacturer's recommendations for mounting the lock and strike, where a strike is furnished with the lock.

6.7.3.2 Test apparatus shall consist of a loading device, a gage for measuring force, a simulated control panel and a means of monitoring the electrical or pneumatic energy supplied to the lock.

6.7.3.3 A means shall be provided to adjust the electrical or pneumatic energy to the lock within the parameters specified in 6.7.4.3.

6.7.4 Procedure

6.7.4.1 Mount test lock and strike, where strike is supplied with the lock, in the test fixture in accordance with the manufacturer's recommended installation instructions.

6.7.4.2 Lubricate the lock in accordance with manufacturer's installation instructions. Do not lubricate the strike or lock bolt keeper.

6.7.4.3 Set electrical energy output of the control panel to minimum variation allowed by the manufacturer and electrical energy should be in compliance with UL-1034.

6.7.4.4 Before applying the load to the door, verify that the door and the lock are free from binding.

6.7.4.5 Apply the lateral load specified in Table I on the push side of the door. Apply the load on the centerline of the lockbolt at a distance of 152.4 mm (6 in) from the edge of the door as shown in figure 4.

6.7.4.6 Operate the lock five consecutive times while maintaining the specified perpendicular load.

6.7.5 Test Termination and Conditions of Acceptance:
If lockbolt fails to retract in any of the five attempts, this constitutes failure.

6.8 Mechanical Lockbolt Retraction Force Test:

6.8.1 Scope:
This test method evaluates the capability of a mechanical lock to function, under simulated operating conditions, while lateral force is applied perpendicular to the door face to prohibit lockbolt retraction.

6.8.2 Significance of Use:
This test method simulates the manual release (unlocking by key) of a lock while being subjected to a perpendicular lateral force directed to stop the lockbolt retraction.

A test of this design performed on a key-operated lock evaluates the operating force characteristics and strength of the lock and its components as well as quality and fabrication techniques.

6.8.3 Apparatus:

6.8.3.1 The test fixture shall consist of a stationary frame and a hinged door. The fixture shall be constructed in accordance with figure 4 and must incorporate the lock

manufacturer's recommendations for mounting the lock and strike, where a strike is furnished with the lock.

6.8.3.2 Test apparatus shall consist of a loading device and a gage for measuring force.

6.8.4 Procedure

6.8.4.1 Mount test lock and strike, where strike is supplied with the lock, in the test fixture in accordance with the manufacturer's recommended installation instructions.

6.8.4.2 After the lock is installed in the test fixture described in 6.8.3.1, engage the lock and check to be sure that it remains locked.

6.8.4.3 Apply the lateral load specified in table 1 on the push side of the door. Apply the load on the centerline of the lockbolt and at a distance of 152.4 mm (6 in) from the edge of the door as shown in figure 4.

6.8.4.4 While maintaining the specified test load, manually disengage the lock, allowing the door to operate to the extent permitted by the test fixture. Levers, wrenches or other similar devices are allowed to assist in increasing the mechanical advantage of the key. The key used shall be representative of the manufacturer's production.

6.8.4.5 Perform steps 6.8.4.3 and 6.8.4.4 five consecutive times while maintaining the specified perpendicular load.

6.8.5 Test Termination and Conditions of Acceptance

Inability to retract the lockbolt while maintaining the perpendicular load and or breakage of the key while attempting to unlock the door will constitute failure.

6.9 Remote (Electrical) Release Operation Cycle Test:

6.9.1 Scope:

This test method evaluates the capabilities of electrical and pneumatic locks to continuously function under normal operating cycles.

6.9.2 Significance and Use:

This test method is intended to closely simulate repeated operation of the lock as it undergoes a a cycle of remote unlocking and the slam relocking.

This cycle test evaluates the wear characteristics and fatigue strength of the lock's components as well as quality of fabrication techniques.

6.9.3 Apparatus:

6.9.3.1 The test apparatus shall consist of a fixture as shown in figure XXX (figure of setup not yet available). The test apparatus must comply with the mounting requirements listed in the manufacturer's installation literature.

6.9.3.2 The test apparatus shall have a means to open the door to 60 ± 5 degrees. A door closer shall be used to close the door.

6.9.3.3 The door panel of the test fixture shall weigh between 113.5 and 136.2 kg (250 and 300 lb).

6.9.3.4 A control device with a means to adjust the voltage to the lock shall be provided and a calibrated voltage measuring device shall be provided to measure voltage to the lock under load. The control device shall include a means to monitor any auxiliary limit switches that are actuated during the normal electric operation of the lock.

6.9.3.5 A counting device actuated by the hinged test panel shall be provided.

6.9.3.6 Indication of locked and unlocked status, when available in the lock under test, shall be monitored.

6.9.4 Procedure:

6.9.4.1 The test lock shall be mounted in a test fixture incorporating the recommendations provided by the manufacturer's installation instructions.

6.9.4.2 The lock is to be lubricated before and during the test in accordance with the manufacturer's recommendations.

6.9.4.3 Set operating voltage to the lock under load to the midpoint of the voltage range specified by the manufacturer to within ± 10% of the range.

6.9.4.4 Duration of the test shall be in accordance with table 1. Set counter and cycle the lock once every three to ten seconds. Inspect the lock for damage or failure and record findings at 25,000-cycle intervals for the first 100,000 cycles. Inspect the lock at 50,000-cycle intervals thereafter.

6.9.5 Test Termination and Conditions of Acceptance:

Locks completing a specified number of cycles without failure and only periodic lubrication and adjustment in accordance with the manufacturer's recommendations shall

be deemed to have passed the test. This shall include all auxiliary limit switches included as part of the test lock.

6.10 Mechanical Release Operation Cycle Test:

6.10.1 Scope:
This test method evaluates the capability of the lock to continuously function, by key, under normal operating cycles.

6.10.2 Significance and Use:
This test method is intended to closely simulate continuous or long-term usage of the locking mechanism by repeatedly operating the key release (unlocking) of the mechanism.

A cycle test of this design performed on a lock evaluates the wear characteristics and fatigue strength of the lock's key release and other lock components as well as the quality of fabrication techniques.

6.10.3 Test Apparatus:
Mechanical Cycle - This cycle, utilizing the key, moves the latch bolt through its locked and unlocked positions of the latch bolt. The degree of rotation both clockwise and counterclockwise shall be independently adjustable. Indication of locked and unlocked status, when available in the lock under test, shall be monitored. Cycle initiation and monitoring shall be accomplished by independent sensing of the latchbolt position. A typical configuration is shown in figure 5.

6.10.4 Procedure:
The lock will be taken through a complete cycle of locking and unlocking utilizing the apparatus described in 6.10.3. The total number of cycles shall be determined in accordance with table 1.

The completion of a cycle will be determined by sensing the proper movement and position of the latchbolt and the proper indication sequence when the lock normally includes such features.

6.10.5 Test Termination and Conditions of Acceptance:
Locks completing the number of cycles shown in table 1 without failure and only periodic lubrication and adjustment in accordance with the manufacturer's recommendations shall be deemed to have passed the test. This shall include all auxiliary limit switches included as part of the test lock.

7.0 Certification Reports:

7.1 Certification - The manufacturer shall be permitted to contract with the testing laboratory to provide the manufacturer with a certified procedure for the construction of tested assemblies with factory

follow-up inspection service as an option to retaining the original test specimens.

7.2 Reports - Test reports shall contain the following information:

7.2.1 Name and address of testing laboratory.

7.2.2 Date laboratory completed tests.

7.2.3 Name and address of door assembly and lock manufacturers.

7.2.4 Description of identifying markings on all components of test assembly.

7.2.5 Location of testing equipment.

7.2.6 Diagrams, details and photographs of testing equipment.

7.2.7 Specifications and details of components of test assembly including test assembly drawings, door and frame component drawings, hardware templates and instructions, wall specifications, and details on anchoring devices.

7.2.8 All test data including graphs and tables.

8.0 Key Words:

Detention Security
Hollow Metal
Door
Impact Test
Bullet Penetration Test
Battering Ram
Fire Test
Physical Security
Swinging Door Assemblies
Correctional Facility
Detention Facility
Frame
Hardware
Locks
Hinges

TABLE 1 – PROPOSED PRODUCT CLASSIFICATION AND TESTING CRITERIA
OF DETENTION LOCKS FOR SWINGING DOORS

TESTING CRITERIA

GENERIC LOCK TYPE	LOCK MOUNTING	CYLINDER TYPE	USAGE ELECTRIC	(CYCLES) BY KEY	IMPACT FT/LBS	IMPACT COUNT	RETRACTION BOLT LOAD BY KEY	RETRACTION BOLT LOAD BY EL or PU	GRADE LEVEL	USAGE LEVEL
EMJC	2" JAMB MORT.	C	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
EMJM	6" JAMB MORT.	M	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
EMJP	12" JAMB MORT.	P	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
ESJC	2" JAMB MORT.	C	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
ESJM	6" JAMB MORT.	M	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
ESJP	12" JAMB MORT.	P	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
ESDC	DOOR MORTISE	C	TBD	TBD	TBD	TBD	TBD	N/A	TBD	TBD
ESDM	DOOR MORTISE	M	TBD	TBD	TBD	TBD	TBD	N/A	TBD	TBD
MKDC	DOOR MORTISE	C	N/A	TBD	TBD	TBD	TBD	N/A	TBD	TBD
MKDM	DOOR MORTISE	M	N/A	TBD	TBD	TBD	TBD	N/A	TBD	TBD
MKDP	SURF. MTG. PL.	P	N/A	TBD	TBD	TBD	TBD	N/A	TBD	TBD
PCJC	2" JAMB MORT.	C	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
PCJM	6" JAMB MORT.	M	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
PCJP	12" JAMB MORT.	P	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD

EM – ELECTRIC, MOTOR OPERATED
ES – ELECTRIC, SLOLENOID OPERATED
MK – MANUAL, KEY OPERATED
PC – PNEUMATIC, CYLINDER OPERATED

J – JAMB MOUNTED
D – DOOR MOUNTED

C = COMMERCIAL
M = MOGUL
P = PRISON

TBD – TO BE DETERMINED

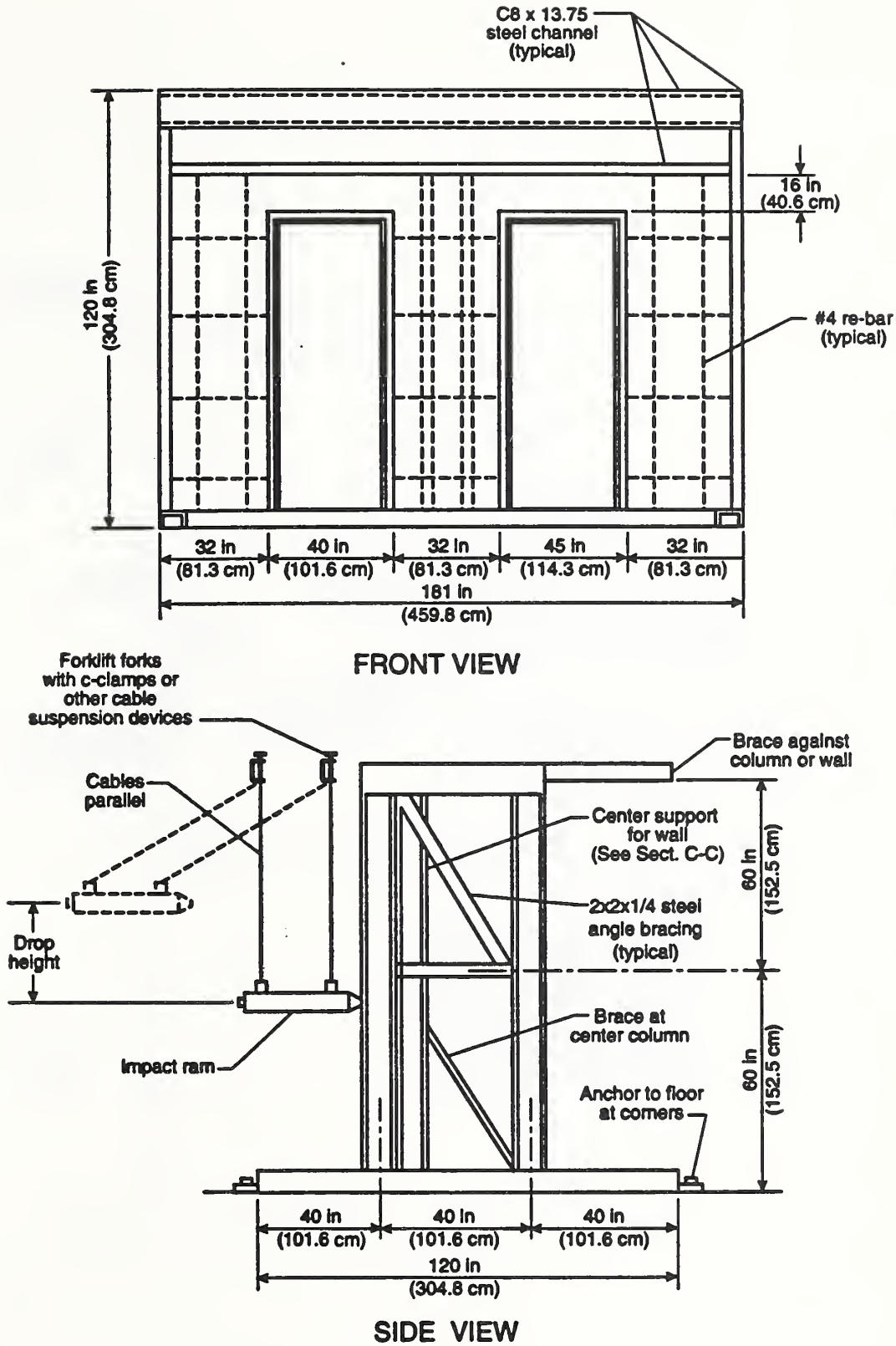
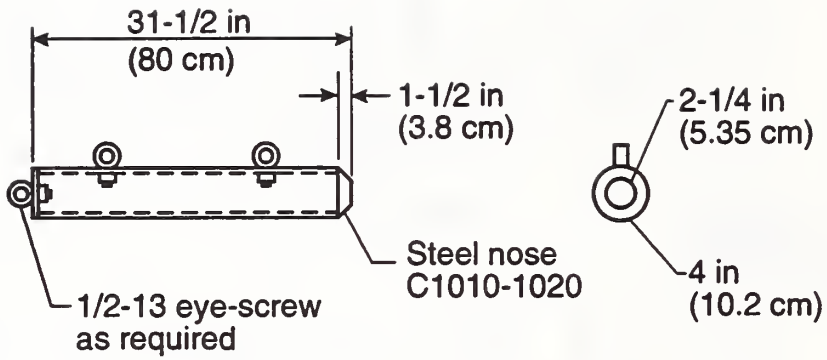


Figure 1 - Test wall and support assembly



Weight: 80 - 100 lb (36.3 - 45 kg)

Note:
Any material applied to or inside the ram to satisfy weight requirement shall be rigidly attached to prevent its shifting during test procedures

Figure 2 - Impact Ram

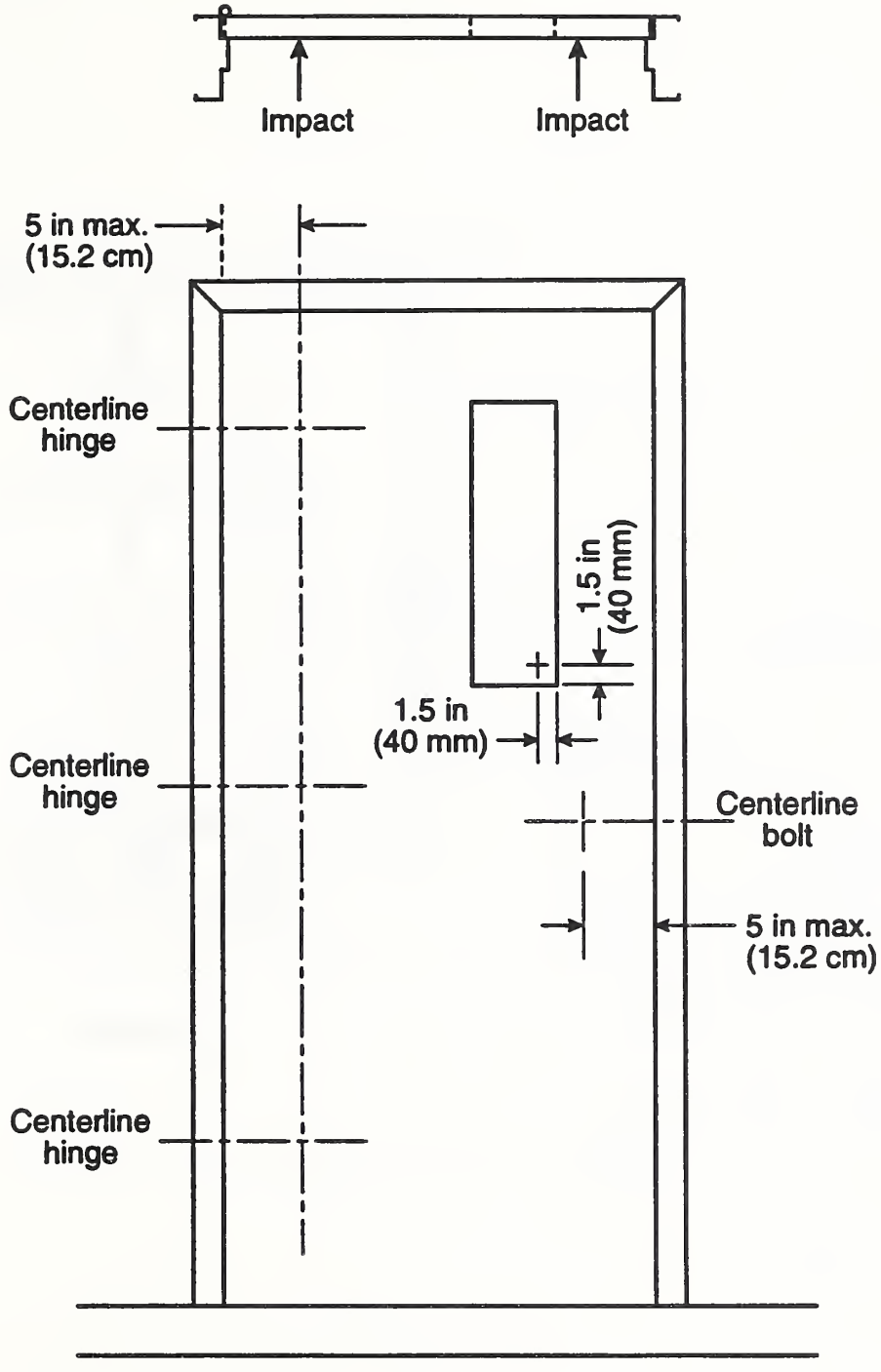


Figure 3 - Location of impact point for lock impact test

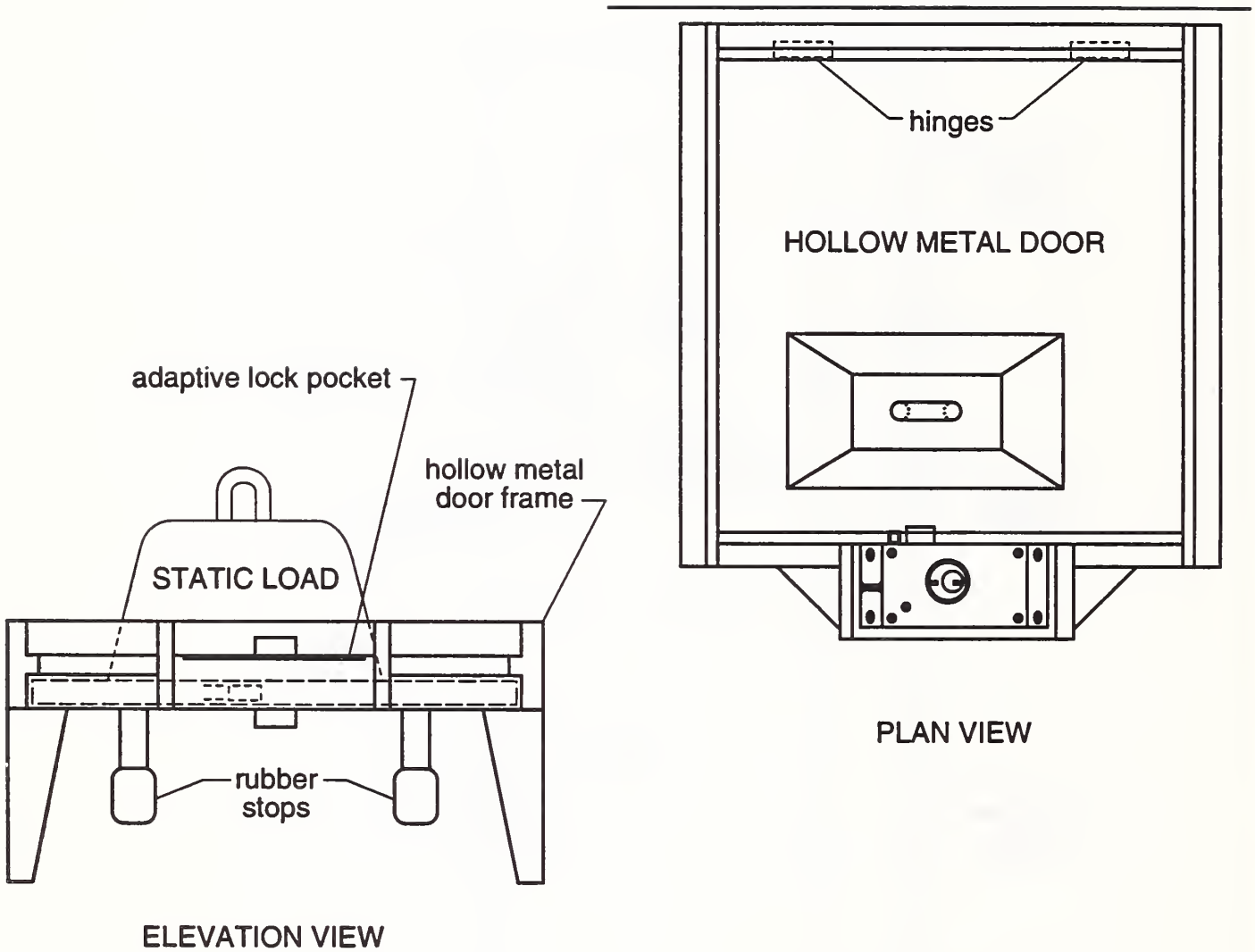


Figure 4 - Setup for lockbolt retraction test

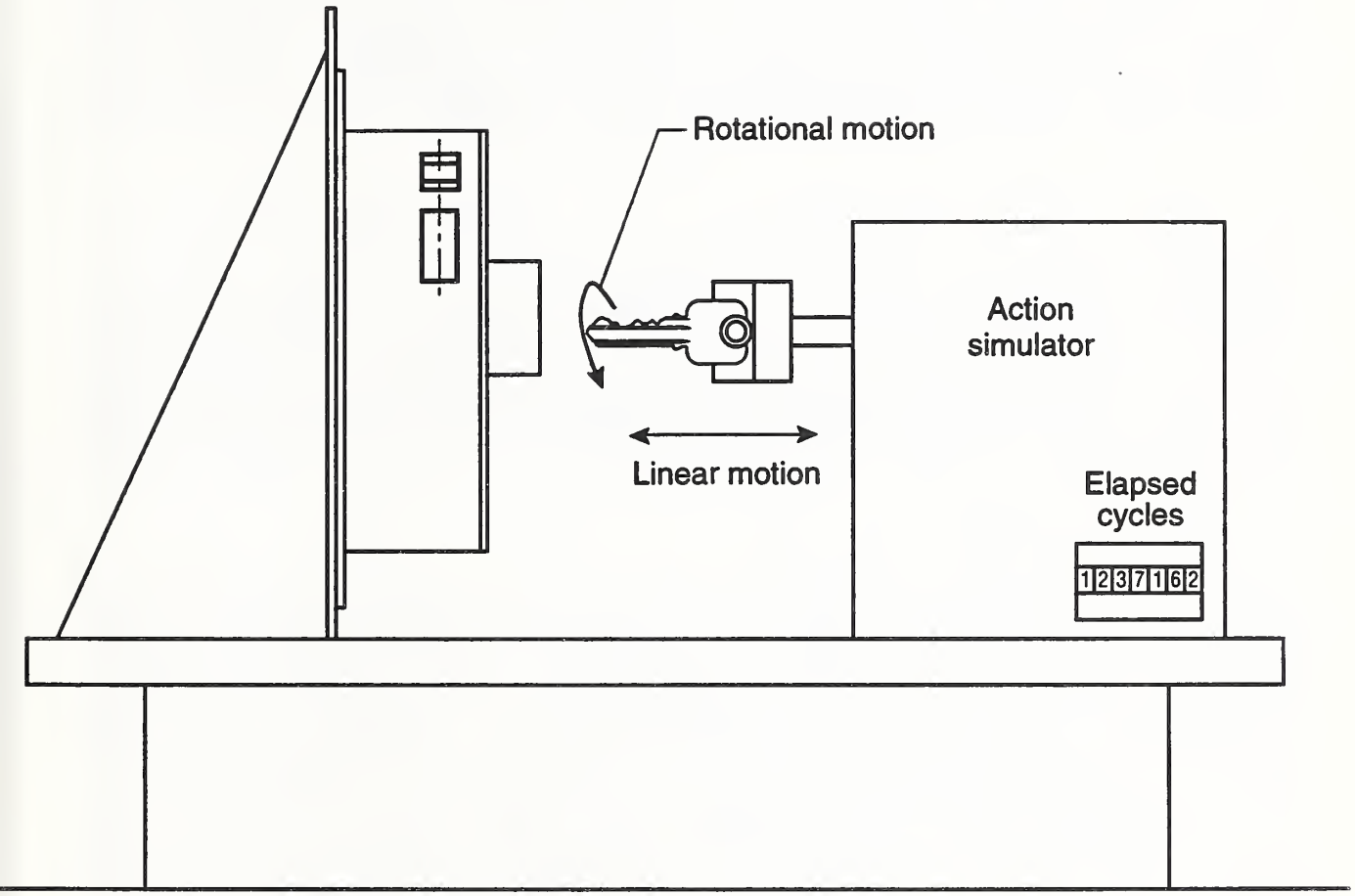


Figure 5 - Typical setup for mechanical operation cycle test

V. RECOMMENDED RESEARCH PROGRAM

V.1 Problem Definition

The evaluation of locking systems for detention and correctional facility application requires that performance standards be established. Before performance standards can established, it will be necessary to quantify the forces and displacements associated with different modes of physical attack and to achieve a consensus among lock manufacturers and users on security performance levels for various products. Thus, the first stage of a research program should focus on developing and/or conducting standardized laboratory procedures for assigning security grades or levels to electrical, mechanical and pneumatic locking systems. A parallel activity should be the investigation of forces and displacements associated with different modes of physical attack in minimum, medium, and maximum security penal institutions.

The standards summarized in Section III were developed primarily for locks installed in residential and commercial building applications. Moreover, some of the standards do not contain sufficient details (e.g. apparatus, setup and procedure) to constitute a standard test method. These facts notwithstanding, these standards can provide the framework for performance standards and test methods specifically aimed at locks installed in detention and correctional facilities. Before standards such as the pushing, torque or tool attack tests of UL 1034 can be adapted, laboratory testing must be devoted to establishing the apparatus, test setup and procedures applicable to detention and correctional facility locks.

V.2 Technical Approach

To effectively address the objectives of the research program, a Detention Lock Research Facility would be established. There is no known facility in the U.S. dedicated to establishing standard test methods for locks and locking devices. It is not intended that such a laboratory be engaged in testing activities more appropriately conducted by commercial laboratories or by lock manufacturers. The initial setup of the research facility would incur some one-time expenditures such as: 1) constructing test frames (reaction frame and wall panels), 2) fabricating impactors, 3) purchasing and installing door panels to accomodate the locks, 4) purchasing hydraulic jacks, devices for applying torque and deformation measuring instruments, 5) constructing test fixtures for impact testing, 6) building a jig for conducting the mechanical release operation and mechanical lock bolt retraction tests, and 7) obtaining a prototypical electrical control panel. Because of the need for purchasing equipment to set up the facility, the program's expenses would be somewhat front-end loaded.

The facility would be established in concert with related work at the National Institute of Justice, and the standards-development activities of ASTM Committee F33. As a mininum capacity, the facility would be capable of performing most of the tests mentioned in Section IV - including impact, lock bolt retraction, torque and cyclic operation - on prototype locks obtained from various manufacturers. It is envisioned that existing fire and ballistics test methods and test facilities can be adapted to detention facility locks whenever research in these areas would be required.

V.3 Research Program Plan

V.3.1 Overview

It is recommended that a primarily laboratory-based research program be undertaken to fulfill several objectives: 1) to quantify performance levels of commercial detention locks, 2) to provide a technical basis for the establishment of a security classification system for locks, 3) to validate proposed standard test methods for detention locks, and 4) to develop test methods in gap areas. The order in which these objectives are fulfilled is somewhat problematical in that objectives 1) and 3) are intertwined. Before finalizing the plans for this program, it would be desirable to form an expert advisory panel consisting of lock hardware manufacturers, architects and/or engineers and corrections professionals. The projected output from this testing effort would be technical data to serve as a basis for a National Institute of Justice standard on detention and correctional facility locks.

V.3.2 Scope of Investigation

The research program would be conducted over a three-year period by a team of four investigators: a principal engineer, a structural engineer or physicist, a lead technician with electronic and mechanical skills and a second technician with principally mechanical skills. It is not envisioned that the research team would devote full time to the program for the entire three-year period. Rather, there would be periods of concentrated experimental effort, followed by data analysis, report writing and critique by the expert advisory panel.

The process of performance standard and test method development would likely be an iterative one in that a set of test methods must be adopted initially to assist in quantifying performance levels for different types of locks. Some features of the initial test methods could change significantly based upon subsequent research results. The research program would consist of three major components: 1) testing to quantify lock performance levels, 2) investigating the adaptation of industry residential/commercial lock test standards to detention/correctional lock requirements, and 3) development of new test methods in identified gap areas. The details of the third component are not addressed here as a priority list of new test needs should first be compiled by a panel of lock industry experts. Immediately following are brief descriptions of recommended testing comprising the first two components.

V.3.2.1 Testing for Quantification of Lock Performance Levels

1) Electrical Release Operation Cycle Tests
The draft test method presented in Section IV requires electric locks to be subjected to a specified number of test cycles duplicating normal operation, inability to do so constituting failure. This performance requirement should be examined by conducting a standardized test procedure on a sample of locks from various manufacturers. The number of cycles required to fail each lock prototype would be recorded. Thus, the range of life expectancy, in terms of cycles of operation, would be established. Durability grades would be established to reflect the range of performance levels observed during testing. The number of cycles of operation in the standard test method would be specified in accordance

with agreed upon durability grades.

2) Lockbolt Retraction Test
A key feature of the lockbolt retraction test is the application of a concentrated load directed perpendicular to the face of the door near the lock. This test load simulates the action of inmates attempting to jam the lockbolt to prevent its retraction. It is recommended that a sample of detention locks be tested for lockbolt retraction over the range of possible perpendicular forces. In this manner, performance levels can be established for this mode of physical attack.

3) Impact Test
Table I of the draft test method presented in Section IV will specify minimum numbers of impact and the associated impact energy for the various lock types. Limiting values cannot be assigned until after performance data is collected. It is desirable to first define the range of energy absorption capacities of detention/correctional locks for the purpose of assigning security (grade) levels. This objective can be accomplished by employing the test setup described in the draft test method and varying both the impact energy and the number of impacts. The impact test method development task will include establishing impact energy levels and blow counts for the several grade levels envisioned for Table I.

V.3.2.2 Adaptation of Industry Residential/Commercial Standards

Several of the standards summarized in Section III.1 appear to be adaptable to detention/correctional facility locks, but laboratory investigation is required before such a transition can be made. Items to be investigated include: force and torque magnitudes, weights and sizes of test equipment, test setup details, test procedure and acceptance criteria. Following is a preliminary list of specific test standards that are recommended for the investigation.

1) Pushing Test - UL 1034

2) Hand Tool Attack Test - UL 1034 & UL 437

3) Knob Torque Test - UL 1034, ASTM F 476, ANSI A156.2

4) Axial Load Test - ANSI A156.2

5) Vertical Load Test - ANSI A156.2

6) Bolt Strength Test - ANSI A156.2, ASTM F 476

7) Cylinder-Core Tension Test - ASTM F 476

8) Cylinder-Core Torque Test - ASTM F 476

Some of these test standards are primarily intended for mechanical locks and others are applicable to all types of locks. The priority ranking for the list of standards to be studied should be assigned after input by industry experts.

V.3.3 Yearly Summary of Activities

Following is a summary of the activities to be conducted in each of the three years:

1st Year
Funding Level - $185K

Scope of Activities
- Establish an expert advisory panel
- Define the scope of the laboratory setup
- Design facility layout
- Design the test frames and support system
- Purchase test equipment (hydraulic jacks, tranducers, electrical control panel, counters, etc.)
- Construct support system and test frames
- Purchase door panels
- Purchase lock hardware
- Begin performance testing of locks
- Begin testing for validation of proposed standard test methods
- Prepare report on results from performance testing

Commentary
Notwithstanding the fact that some manufacturers and commercial laboratories perform tests on locks, no facility is presently equipped to serve as the recommended detention lock research laboratory. The extent to which the laboratory facility would be initially equipped depends on several factors: the recommendation of the expert advisory panel, programmatic and funding constraints imposed by the sponsors. It is projected that some of the lock and door hardware could be obtained gratis from manufacturers, given the projected benefit to the lock industry. Some items would be purchased at random to maintain a degree of objectivity.

The population of swinging door locks can be divided into five categories: 1) Mechanical, 2) 24-Volt DC Electro-mechanical, 3) 115-Volt or 120-Volt AC Electro-mechanical, 4) Auto Electronic, and 5) Pneumatic, Electro-mechanical. The 24 VDC and 115 or 120 VAC categories are subdivided to distinguish between the means of activation, solenoid and motor. Among the five major detention lock manufacturers in the U.S., there are approximately 70 different models (not including variations in keying, knobs and material finish) comprising the potential test population. It would be unrealistic to include the entire lot in the research program. It is anticipated that with the help of the expert advisory panel, the lock sample can be limited to about 35 models.

A detailed budget would be dependent on the final decision about the scope of the research facility and the agreed upon range of experiments to be conducted over the three-year period. Following is a preliminary breakdown of the first year's expenditures:

Obtaining recommendations regarding the test facility from the advisory panel - $30K

Establishing preliminary classification matrix - - - - - - - - - - $10K

Designing test frame, facility layout, equipment procurement - - $35K

Cost of equipment - $40K

Setup test facility - $15K

Purchase Hardware - $ 5K

Laboratory testing & report writing - - - - - - - - - - - - - - - - - $50K

Total budget - - - - - - - $185K

Products
Preliminary recommended classification matrix for detention locks
Detention Lock Research Facility

2nd Year
Funding Level - $150K

Scope of Activities
- Complete testing for performance level calibration
- Continue testing for validation of proposed standard test methods
- Prepare final report on performance level calibration
- Prepare report containing selected test method recommendations
- Finalize plans for new test method development

Products
Final recommended classification matrix for detention locks
Selected test method recommendations

3rd Year
Funding Level - $125K

Scope of Activities
- Complete testing for validation of proposed standard test methods
- Prepare recommendations for modifications to proposed standard test methods
- Perform testing necessary for new test method development
- Prepare report containing all recommended standard test methods

Products
Standard test method recommendations for detention locks

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6. NIJ Standard-0316.00, "Physical Security of Window Units," U.S. Department of Justice, August 1980.

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VII. APPENDICES

APPENDIX A - PRELIMINARY PERFORMANCE CRITERIA FOR LOCKS AND LOCKING SYSTEMS

This appendix contains preliminary requirements and criteria for locks and locking systems. Among topics covered are: locking devices, key operated locks, door/lock controls, key control, installation, maintenance, and training. The criteria presented below has been extracted from Chapter 14 of NISTIR 89-4027 ("Preliminary Performance Criteria for Building Materials, Equipment and Systems Used in Detention and Correctional Facilities.")

Since locks and locking systems "secure" the moveable penetrations (doors and gates) located in the various facility barriers (walls and fences), they are very important elements in the overall security of the facility. In so far as possible, the security and durability of the locks and locking systems should be comparable with that of the doors/gates in which they are installed.

A.1 Requirement

General. Locks and locking systems should provide a level of performance consistent with the level of security, control, safety, and durability required, and the type of surveillance utilized.

Commentary

The design and selection of locks and locking systems requires the consideration of a number of factors including: (1) the level of security and control required; (2) fire safety (inmates and staff); (3) type of surveillance; (4) operational convenience and simplicity; (5) durability; (6) flexibility to meet changing facility needs; and (7) cost.

A.2 Requirement

Locking devices. Where a high degree of security and door control is required, sliding door locking devices should be provided. Such devices should be capable of being operated from a secure control station.

Commentary

Locking devices are mechanisms or series of mechanisms used to control a door/gate or group of doors from a remote location. Accordingly, locking devices offer several advantages over key operated locks (i.e., doors are controlled from a protected position; locking components are inaccessible to inmates).

A variety of sliding door/gate locking devices are available -- rack and pinion, chain drive, pneumatic, hydraulic, and mechanical linkage. In rack and pinion devices, an electric motor drives a gear system that moves a rack above the door, unlocks the door and moves the door open or closed and relocks the door. In chain drive devices, an electric motor drives a gear system that moves a chain connected to the door system, etc. In pneumatic devices, the sliding door is unlocked, moved open or closed and relocked by pneumatic pistons and assemblies. In hydraulic devices, a pump forces a fluid through hoses or tubing to a hydraulic motor. Wheels connected to these motors then drive a rail connected to a door or gate. Mechanical linkage devices operate by the movement of mechanical devices, i.e., a wheel, a crank or levers, which unlock, open or close and relock the sliding doors.

Rack and pinion, pneumatic, hydraulic, and mechanical linkage devices have an advantage over chain drive devices in that they can be stopped (from a control station) during travel and the door can not be moved manually until it is mechanically released. In chain link devices with a clutch assembly, an inmate can block a door and then push it open or closed without it being mechanically released.

Mechanical linkage devices have a disadvantage compared to other devices in that blocking of the any door can stop movement of all doors which are grouped together. In addition, blocking of the door with a strong object can result in considerable damage to the door.

A.2.1 Criterion

Maximum/medium security. Where maximum or medium security is required (i.e., cell doors, sally port doors, and entrance doors in maximum or medium security housing units), fully controllable or manually operated sliding door locking devices should be used.

Evaluation

Review of plans and specifications.

Commentary

Fully controllable locking devices (i.e., capable of locking, unlocking, opening and closing from a control station) are generally used for maximum security applications. Manually operated devices are used in medium security applications as well as some maximum security applications. In manually operated devices, the door is unlocked or released (by either an electric motor operating a linkage, by pneumatic assemblies, or by the movement of mechanical devices) and a spring opens the door a few inches. At this point, further opening or closing of the door is done manually. In fully controllable devices, convenient adjustments should be provided for increasing or decreasing the door movement pressure.

At present, there are no standards relating to the performance of locking devices. Accordingly, the selection of such devices has to based primarily on satisfactory long-term performance under similar in-use conditions.

A.2.2 Criterion

Vehicle sally port gates. Vehicle sally port gates should be capable of being operated and locked from a remote location. Provisions for manual operation and locking should be available when power is off.

Evaluation

Review of plans and specifications.

Commentary

Vehicle sally port gates should be operated by a mechanism which unlocks the gate(s), moves it open, and closes and relocks it. A variety of locking devices are available; see Requirement 14.2.

A manual operating system should be part of the assembly. One such system is a manual or crank operation from an emergency column secured with a prison deadlock. Where subject to freezing temperatures, some devices may have to be equipped with electric heating elements to ensure proper operation.

A.2.3 Criterion

Interlock circuitry. Sally port gates or doors shall be provided with interlock circuitry to prevent the opening of more than one gate or door simultaneously. Where appropriate, all sally port gate or door locks should be operable by key from two sides.

Evaluation

Review of plans and specifications.

Commentary

Sally port gates/doors shall unlock, open, by the person accessing the gate/door and relock when closed by the gate/door closer or the person at the gate/door by the snap lock feature of the lock. Interlock circuitry may also be useful in other gate/door arrangements to improve the circulation of personnel while maintaining security.

A.3 Requirement

Key operated locks. Lock operation and size of lock bolt shall be compatible with the frequency of operation, the construction of the door and frame, the level of security required, and the type of surveillance utilized.

Commentary

Similar to locking devices, there is a large variety of key operated locks (mechanical, electro-mechanical, and pneumatic) available for applications requiring different levels of use and security. Mechanical locks are usually mounted on swinging doors and provide for deadlocking or slam-locking with automatic deadlocking. Electro-mechanical locks are generally jamb mounted and provide for slam-locking and remote, electric unlocking. Pneumatic locks provide features similar to those of electro-mechanical locks.

A.3.1 Criterion

Maximum security. Where maximum security is required, lever tumbler locks should be used. Such locks shall be capable of a high frequency of operation per day.

Evaluation

Review of plans, door schedules, and specifications.

Although current standards do not specifically address the type of heavy-duty locks used in maximum security areas, such locks should meet the applicable performance requirements set forth in UL Standards 437 [1] and UL 1034 [2].

Commentary

Lever tumbler locks should be used in high security areas such as holding cells, segregation cells, secure storage and utility room doors. The bolt is retracted by a paracentric key. These locks can be keyed alike or keyed separate; master keying is not available. Normally, there are five levers in the lock. Six levers are available for higher security applications. Lever tumblers should have anti-pick notches.

Where doors are scheduled to be keyed from two sides, the locks may require shimming. The shank of the cylinder plug

must extend into the escutcheon at both sides to assure that the key can be inserted from both sides. A key should not be left in a lever type lock since any turning device inserted into the cylinder plug from the opposite side can operate the lock. It is also important that the locks be installed right side up. If a lever type lock is installed upside down and a spring breaks, the lever drops and the key will not work. If the lock is right side up and a spring breaks, the lever tumbler can generally be fished with a key and the lock will continue to operate. In a correct installation, the keyway of the cylinder plug should align with the bottom of the lock bolt. Also when lever locks are installed upside down, the key rotates in the opposite direction. In such cases, the officer, from the habit of turning the key in the same direction, could be unlocking a lock that was intended to be locked.

A.3.2 Criterion Medium security. Where medium security is required, lever tumbler or mogul cylinder locks should be used. Such locks shall be capable of a high frequency of operation per day.

Evaluation Review of plans, door schedules, and specifications. Although current standards do not address the type of heavy-duty locks used in maximum or medium security areas, such

Commentary In mogul cylinder locks, the bolt is retracted by mechanical action of the cam on the cylinder plug by the turning of a (mogul) key. The keys and cylinders for these locks are larger and more durable than normal cylinder locks. These locks can be master keyed, keyed alike or keyed separate. They are often used to operate electric locks for manual override.

Normal cylinder locks, and commercial or institutional hardware are generally used in minimum security applications, administration buildings, etc.

A.4 Requirement Controls. Controls shall be provided to operate the locks and locking devices in the required modes.

Commentary The switches, relays and other devices should make up a control system compatible with the locks and locking devices and should be capable of providing the switching necessary to satisfy all desired operational modes.

A.4.1 Criterion Control console/panel. A control console or panel should be provided to operate locks and locking devices.

Evaluation Review of plans and specifications.

Commentary A control console/panel should be designed to display all switches to the operator. Normally installed in a secure area, i.e., an officers' control station, the console should be equipped with a switch for each door, a group switch for each wing of the building and switches for the corridor gates, which control access to those wings. There should also be a power cut-off switch to deactivate the console whenever the officer must leave his station.

A.4.2 Criterion Status indication. The status of sally port and cell doors shall be indicated on the control console or panel.

Evaluation Review of plans and specifications.

Commentary Status indication shall indicate the closed and locked position of the gate/door. On sliding gates/doors, it shall indicate the dead locked position of the gate/door and the locked position of the front or rear locking bar. On swing gates/doors with jam mounted electric release locks, the status indication shall sense the closed position of the gate/door, the projected position of the lock bolt and the depressed position of the dead lock roller bolt. In many facilities, status indication consists of a green and red light system. A green light indicates a closed and locked condition, and a red light indicates all other conditions.

A.4.3 Criterion Control functions. In the event of power failure, the locking systems should be fail-secure.

Evaluation Review of plans and specifications.

Commentary A fail-secure locking system is held locked mechanically and only releases with electric or mechanical functions. Fail-secure is recommended for use in correctional and detention facilities so inmates do not cause a power outage to their advantage and escape.

A.4.4 Criterion Control cabinets. In areas accessible to inmates, closed, lockable cabinets should be used to house switches and manual controls of a locking system.

Evaluation Review of plans and specifications.

Commentary The security level of a control cabinet is normally high since inmates often pass within arms reach of the cabinet. For maximum security, 3/16-in. steel plate doors and housings secured with a heavy-duty lock are often used. Lighter construction and a normal cylinder lock can be used for minimum security. The cabinet lock should be keyed to a master key system.

A.5 Requirement Emergency release. Provisions shall be made for unlocking or gang release of cell doors in case of fire or other emergencies.

Evaluation Review of plans and specifications. Locking and release of cell doors should be in conformance with NFPA 101-88 [3] or other applicable life safety requirements.

Commentary ACA Standards for adult correctional and detention facilities require written policy and procedures for the release from locked areas in case of an emergency [4,5].

One type of emergency release is some form of mechanical linkage, chain or cable system, or an assembly of all of the above connected to each cell which, when activated, will release all doors. Individual, selective release of doors is available, but the cost of these systems is greater. An alternate emergency release system requires a supervisor to go to each door and operate a key to release that door. Master keying can be used on pin tumbler locks but not on lever tumbler locks.

A.6 Requirement Key control. A key control system shall be established for each facility. See Requirement 15.10.

Commentary ACA Standards for adult correctional and detention facilities require written policy and procedures governing the control and use of keys [6,7].

A.6.1 Criterion General. The key control system shall ensure an accounting of the location and possessor of each key.

Evaluation Review of operating policies and procedures.

Commentary One suggested approach is the use of a keyboard with hooks on the keyboard identified by a letter and number combination (i.e., vertical rows being alphabetical and the horizontal rows being numerical). Each key ring should have two tags, one to identify the ring number and the second shall state the total number of keys on that ring. The original key should be kept in a secure key room for a pattern key to cut duplicates from. The pattern keys should never be issued. Fire (or emergency) key rings should be tested on a scheduled basis to assure that they work. Keys should have stamped numbers for identification only and should not in any way identify the combination of the key.

A.7 Requirement Manuals and instructions. Manuals and instructions shall be provided for the installation, operation and maintenance of the facility locks and locking systems.

A.7.1 Criterion Installation. Locks, locking systems and controls shall be installed in accordance with the project drawings, specifications and manufacturer's recommendations.

Evaluation Review plans, specifications, and installation instructions.

Commentary Doors and frames - Alignment of the frame is most critical to the performance of a door and lock. On lever locks, assure that the lock is installed properly; see Criterion 14.3.1. The bolt must align with the keeper.

A.7.2 Criterion Field testing. After installation, each door and lock and locking system should be field tested to ensure satisfactory operation.

Evaluation Sliding doors - Test for smooth operation and desired closing pressure of the door. Run the door a number of times to assure it does not go out of adjustment.

Swing doors - Test for smooth operation. Door should swing free throughout its entire swing to assure there is no binding at the hinges. Door should align with the frame with all spaces between the door and frame equal. Door should align vertically with the frame at both hinge side and lock side. Lock bolt should engage the keeper without binding or play.

A.7.3 Criterion Maintenance. The facility should establish a plan for preventative maintenance or emergency repairs.

Evaluation Review of maintenance plans, manuals, and instructions.

Commentary ACA Standards for adult correctional and local detention

facilities require a written plan for preventative maintenance of the physical plant with provisions for emergency repairs or replacement of equipment [8,9].

Maintenance manuals shall contain information on adjustments, lubrication, electrical and mechanical trouble shooting, and ordering of spare or replacement parts.

General suggestions pertaining to maintenance are as follows:

1. Adjustments - Follow manufacturer's recommendations. All adjustments should be made with provisions for future adjustments to compensate for wear. The use of stop nuts and/or cotter keys is desired where adjustments are frequent and to assure the adjustments do not loosen through use.

2. Lubrication - Follow manufacturer's recommendations. Moving parts should be lubricated to reduce wear. Lubricant should reduce friction, but not collect dirt and cause an increase in wear. Lubricant should stay where put and not run causing damage to electrical components or danger to passers-by. Lubricants used for exterior applications in freezing temperatures must retain the lubrication ability through a wide range of temperature changes such as minus 50 degrees to plus 120 degrees.

3. Electric troubleshooting - Use proper test equipment and test circuit by circuit using manufacturer's and installer's wiring diagrams. Test circuits for continuity. Terminations are most causes of loss of continuity. Testing should be performed by a qualified electrician or electronic technician.

4. Mechanical troubleshooting - Test for smooth operation. Check for burrs on devices which contact each other and for proper engagement of gear assemblies. Test cable assemblies for binding when operated.

A.8 Requirement

Training program. The facility should establish a staff training program for the operation of locks/locking systems under normal and emergency conditions.

A.8.1 Criterion

General. Training should be provided to all facility staff who have responsibility for the operation and maintenance of locks and locking systems.

Evaluation

Contract documents covering the installation of new locks and locking systems should include provisions for adequate training of facility staff by the equipment manufacturer or other appropriate party. Ongoing training should be included in the facility operating policies and procedures.

Commentary ACA Standards for adult correctional and local detention facilities require written policies and procedures for training and staff development [10,11].

References for Appendix A

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11. ABSTRACT (A 200-WORD OR LESS FACTUAL SUMMARY OF MOST SIGNIFICANT INFORMATION. IF DOCUMENT INCLUDES A SIGNIFICANT BIBLIOGRAPHY OR LITERATURE SURVEY, MENTION IT HERE.)

Draft test methods are presented for evaluating locks installed in detention and correctional facilities. The methods have been developed by ASTM (American Society for Testing and Materials) Committee F 33 on Detention and Correctional Facilities and are drafted in ASTM standard test method format. The NIST contribution to this effort is to assist the F 33 Committee in drafting, balloting and obtaining consensus approval for these test methods. Existing standards for residential and commercial locks have been reviewed to determine their applicability to the evaluation of locks subject to the abuse common to detention and correctional facilities. Synopses of relevant standards are presented in this report.

A case is made for performing laboratory tests on prototype locks to quantify current performance levels and to establish a classification system for detention facility locks. Gaps in the knowledge base are identified and recommendations are advanced for performing a series of cyclical operations, impact and lockbolt retraction tests. The results from the recommended laboratory test program would be used to prepare a minimum performance standard for promulgation by the National Institute of Justice (NIJ). To ensure broad application of the NIJ standard, the test results would feed directly into standards-making activities of ASTM Committee F 33.

12. KEY WORDS (6 TO 12 ENTRIES; ALPHABETICAL ORDER; CAPITALIZE ONLY PROPER NAMES; AND SEPARATE KEY WORDS BY SEMICOLONS)

Building Technology; bullet resistance test; detention and correctional facilities; fire resistance test; impact test; lockbolt retraction test; locks

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