SECTION 07 84 13

PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: through-penetration firestop systems for penetrations through fire-resistance-rated constructions, including both empty openings and openings containing penetrating items including but not limited to.

1. Penetration firestopping systems.
2. Penetrations in fire resistance rated walls.
3. Penetrations in horizontal assemblies.
4. Penetrations in smoke barriers.
5. Exposed penetration firestopping systems.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: Product Data: Technical data for each penetrating firestopping system including illustration of firestopping system and design designation.

B. Unlisted Firestopping Systems: Obtain an Engineering Judgment (EJ) from firestopping manufacturer where no UL, FM Approvals, or other listed assembly is available for particular firestop configuration. Follow International Firestop Council (IFC) recommended guidelines for evaluating firestopping systems in EJs.

C. Product Schedule: Submit schedule for each penetration firestopping system indicating location, illustration of firestopping system, and design designation of qualified testing and inspecting agency.

1. Engineering Judgments: Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping system, submit illustration, with modifications marked, approved by penetration firestopping system manufacturer's fire protection engineer as an engineering judgment or equivalent fire resistance rated assembly developed in accordance with current International Firestop Council (IFC) guidelines. Obtain approval of authorities having jurisdiction prior to submittal.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: Submit data for Installer.

B. Product Test Reports: Submit reports for each penetration firestopping system and for tests performed by a qualified testing agency.

C. Provide UL assembly information on each penetration indicating all materials.

1.5 CLOSEOUT SUBMITTALS

A. Installer Certificates: Submit certificates from Installer indicating that penetration firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.

1.6 QUALITY ASSURANCE

A. Installation Responsibility: Assign installation of through-penetration firestop systems and fire-resistive joint systems in Project to a single qualified installer.

B. Installer Qualifications: Entity having minimum 5 years documented experience that has been approved by FM Global according to FM Global 4991 Approval of Firestop Contractors or evaluated by UL and found to comply with UL's "UL Solutions Qualified Firestop Contractor Program" requirements and employs applicators with the required experience and training to perform the work.

1. Manufacturer's willingness to sell its penetrating firestopping system products to Contractor or to Installer does not confer qualification on buyer.

C. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements.

D. Manufacturer Qualifications: Entity that has received UL's "Firestop Movement Certification," which demonstrates that manufacturer's firestopping products designated with M-Ratings are based on exposure to cyclic movement and UL 1479 fire test evaluation when tested in accordance with ASTM E3037.

1.7 MOCKUPS

A. Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Build mockup of each penetration firestopping system type required for Project, including supporting construction substrates, attachments, and accessories.
2. Where one penetration firestopping system type may be used for different penetrating items or in different wall or floor constructions, install one assembly for each different combination.
3. Obtain approval of mockups from authorities having jurisdiction before proceeding.
4. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations by Change Order.
5. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 COORDINATION

A. Do not cover up through penetration firestop system installations that will become concealed behind other construction until each installation has been examined by Owner's inspecting agency and building inspector when required by authorities having jurisdiction.

1. Notify Owner's testing agency at least seven days in advance of penetration firestopping installations; confirm dates and times on day preceding each series of installations.

B. Coordinate construction of openings and penetrating items to ensure that penetration firestopping systems can be installed according to specified firestopping system design.

C. Coordinate sizing of sleeves, openings, core drilled holes, or cut openings to accommodate penetration firestopping systems.

1.9 PROJECT CONDITIONS

A. Environmental Limitations: Do not install penetration firestopping system when ambient or substrate temperatures are outside limits permitted by penetration firestopping system manufacturers or when substrates are wet because of rain, frost, condensation, or other causes.

B. Install and cure penetration firestopping materials per manufacturer's written instructions using natural means of ventilations or, where this is inadequate, forced air circulation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General: For penetrations through fire-resistance-rated constructions, including both empty openings and openings containing penetrating items, provide through-penetration firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated.

B. Fire Test Response Characteristics:

1. Perform penetration firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.
2. Test in accordance with testing standards referenced in “Penetration Firestopping Systems” Article. Provide rated systems complying with the following requirements:
    a. Penetration firestopping systems shall bear classification marking of a qualified testing agency.
        1) UL in its online directory “Product iQ.”
        2) Intertek Group in its "Directory of Building Products."
        3) FM Approvals in its “Approval Guide.”

C. Provide components for each penetration firestopping system that, upon curing, do not re-emulsify, dissolve, leach, break down, or otherwise deteriorate over time from exposure to atmospheric moisture, sweating pipes, ponding water, or other forms of moisture characteristic during and after construction.

D. Provide components for each penetration firestopping system that do not contain ethylene glycol.

E. Provide components for each penetration firestopping system that are sufficiently flexible to accommodate movement, such as pipe vibration, water hammer, thermal expansion, and other normal building movement without damage.

F. Provide components for each penetration firestopping system that are appropriately tested for the thickness and type of insulation utilized.

2.2 PENETRATION FIRESTOPPING SYSTEMS

A. Penetration Firestopping Systems: Provide Penetration Firestopping systems that resist spread of fire, passage of smoke and gases, and maintain original fire resistance rating of construction penetrated. Penetration firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.

1. Basis-of-Design Products: Subject to compliance with requirements, provide penetration firestopping systems listed in the Penetration Firestopping Schedule at the end of this Section by Hilti, Inc., or comparable systems by one of the following:
    a. 3M Building and Construction.
    b. FireShield; Fire Rated Solutions LLC.
    c. Grabber Construction Products, Inc.
    d. International Fireproof Technology Inc.
    e. NUCO Inc.
    f. Passive Fire Protection Partners.
    g. Roxtec Inc.
    h. Specified Technologies Inc.

B. Penetrations in Fire Resistance Rated Walls: Penetration firestopping systems with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg (2.49 Pa). Fire resistance rated walls include fire rated walls, fire barrier walls, smoke barrier walls and fire partitions.

1. F-Rating: Not less than the fire resistance rating of constructions penetrated.
2. Membrane Penetrations: Install recessed fixtures such that the required fire resistance will not be reduced.
3. M-Rating: Provide penetration firestopping systems meeting specified F-Rating after being tested in accordance with ASTM E3037

C. Penetrations in Horizontal Assemblies: Penetration firestopping systems with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg (2.49 Pa).

1. F-Rating: At least one hour, but not less than the fire resistance rating of constructions penetrated.
2. T-Rating: At least one hour, but not less than the fire resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.
    a. Those within the cavity of a wall.
    b. Floor, tub, or shower drains within a concealed space.
    c. 4-inch or smaller metal conduit penetrating directly into metal-enclosed electrical switchgear.
3. W-Rating: Provide penetration firestopping systems showing no evidence of water leakage when tested according to UL 1479.

D. M-Rating: Provide penetration firestopping systems meeting specified F-Rating, T-Rating, and W-Rating after being tested in accordance with ASTM E3037.Penetrations in Smoke Barriers: Penetration firestopping systems with ratings determined per UL 1479, based on testing at a positive pressure differential of 0.30 inch wg (74.7 Pa).

1. L-Rating: Not exceeding 5.0 cfm/sq. ft. (0.025 cu. m/s per sq. m) of penetration opening at and no more than 50-cfm (0.024-cu. m/s) cumulative total for any 100 sq. ft. (9.3 sq. m) at both ambient and elevated temperatures.
2. M-Rating: Provide penetration firestopping systems meeting specified L-Rating after being tested in accordance with ASTM E3037.

E. Exposed Penetration Firestopping Systems: Flame spread and smoke developed indexes of less than 25 and 450, respectively, per ASTM E 84.

F. Manufactured Piping Penetration Firestopping System: Penetration firestopping systems with ratings determined per ASTM E814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg (2.49 Pa).

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    a. ProVent Systems, Inc.
2. F-Rating: At least one hour, but not less than the fire resistance rating of constructions penetrated.
3. T-Rating: At least one hour, but not less than the fire resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.
4. W-Rating: Provide penetration firestopping systems showing no evidence of water leakage when tested according to UL 1479.
5. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast in place concrete slabs.
6. Stack Fitting: ASTM A48/A48M, gray iron, hubless pattern wye branch with neoprene O ring at base and gray iron plug in thermal release harness. Include PVC protective cap for plug.
7. Special Coating: Corrosion resistant on interior of fittings.

2.3 ACCESSORIES

A. Provide components for each penetration firestopping system necessary to install fill materials and to maintain ratings required. Use components specified by penetration firestopping system manufacturer and approved by qualified testing and inspecting agency for conditions indicated.

1. Permanent forming/damming/backing materials.
2. Substrate primers.
3. Collars.
4. Steel sleeves.

2.4 FILL MATERIALS

A. Cast in Place Firestop Devices: Factory assembled devices for use in cast in place concrete floors and consisting of an outer sleeve lined with an intumescent strip, a flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.

B. Latex Sealants: Single component latex formulations that do not re-emulsify after cure during exposure to moisture. Provide water resistant materials for all floor penetrations.

C. Firestop Devices: Factory assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.

D. Intumescent Composite Sheets: Rigid panels consisting of aluminum foil faced intumescent elastomeric sheet bonded to galvanized steel sheet.

E. Intumescent Putties: Nonhardening, water resistant, intumescent putties containing no solvents or inorganic fibers.

F. Intumescent Wrap Strips: Single component intumescent elastomeric sheets with aluminum foil on one side.

G. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.

H. Silicone Foams: Multicomponent, silicone based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

I. Silicone Sealants: Single component, silicone based, neutral curing elastomeric sealants.

J. Thermal and Endothermic Wraps: Flexible, insulating, and fire-resistant protective wraps tested and listed for up to 2-hour fire ratings in accordance with ASTM E814 or UL 1479; for protecting membrane penetrations of utility boxes, critical electrical circuits, communications lines, and fuel lines, and for thermal barrier and circuit integrity protection in accordance with ASTM E1725 or UL 1724.

K. Fire-Rated Cable Sleeve Kits: Complete kits designed for new or existing cable penetrations through walls which accept standard accessories.

L. Fire-Rated Cable Pathways: Single or gangable device modules composed of a steel raceway with integral intumescent material and requiring no additional action in the form of plugs, twisting closure, putty, pillows, sealant, or otherwise to achieve fire and air-leakage ratings.

M. .

1. Products: Subject to compliance with requirements, provide one of the following based on initial cable volume installed, plus 20 percent additional capacity:
   a. Hitli Firestop Speed Sleeve (CP 653). Use in conjunction with CFS-SL GP Gang Plate where more than one device is required in the same partition or other application.
   b. Hilti CFS-SL Series Firestop Gangplate – Utilize when existing cables require firestop device; select for specific installation requirements.
   c. Specified Technologies Inc; EZ Path.

2. Fire-rated cable pathway devices are the preferred product for data, video, and communications cable penetrations. Install these devices in locations where frequent cable moves, add-ons, and changes will occur. Such devices must be:

   a. Capable of retrofit around existing cables.
   b. Designed so that two or more devices can be ganged together.
   c. Maintenance-free so no action is required to activate the smoke- and fire-sealing mechanism.

3. Where fire-rated cable pathway devices are not practical, openings within walls and floors designed to accommodate data, video, and communications cabling must be provided with re-enterable products specifically designed for retrofit, such as retrofit devices for cable bundles, firestopping putty, plugs, or pillows.

N. Retrofit Device for Cable Bundles: Factory-made, intumescent, collar-like device for firestopping existing over-filled cable sleeves and capable of being installed around projecting sleeves and cable bundles.

O. Wall-Opening Protective Materials: Intumescent, non-curing putty pads or self-adhesive inserts for protection of electrical switch and receptacle boxes.

P. Fire-Rated HVAC Retaining Angles: Steel angle system with integral intumescent firestopping gasket for use around rectangular steel HVAC ducts without fire dampers.

Q. Firestopping Plugs: Flexible, re-enterable, intumescent, foam-rubber plug for use in blank round openings and cable sleeves.

R. Fire-Rated Cable Grommet: Molded two-piece grommet made of plenum-grade polymer and foam inner core for sealing small cable penetrations in gypsum walls up to 1/2 inch (13 mm) in diameter.

S. Closet Flange Gasket: Molded, single-component, flexible, intumescent gasket for use beneath a water closet (toilet) flange in floor applications.

2.5 MIXING

A. Penetration Firestopping Materials: For products requiring mixing before application, comply with penetration firestopping system manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the work.

B. Proceed with installation after correcting unsatisfactory conditions.

3.2 PREPARATION

A. Surface Cleaning: Before installing penetration firestopping systems, clean out openings immediately to comply with manufacturer's written instructions and with requirements:
   1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of penetration firestopping materials.
   2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with penetration firestopping materials. Remove loose particles remaining from cleaning operation.
   3. Remove laitance and form release agents from concrete.

B. Prime substrates where recommended in writing by manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

C. Masking Tape: Use masking tape to prevent penetration firestopping from contacting adjoining surfaces that remain exposed on completion of the work and would otherwise be permanently stained or damaged by contact or by cleaning methods used to remove stains. Remove tape as soon as possible without disturbing firestopping's seal with substrates.

3.3 INSTALLATION

A. General: Install penetration firestopping systems to comply with manufacturer's written installation instructions and published drawings for products and applications.

B. Install forming materials and other accessories of types required to support fill materials during application and in the position needed to produce cross sectional shapes and depths required to achieve fire ratings.

1. After installing fill materials and allowing to fully cure, remove combustible forming materials and accessories not forming permanent components of firestopping.

C. Install fill materials by proven techniques to produce the following results:

1. Fill voids and cavities formed by openings, forming materials, accessories and penetrating items to achieve required fire resistance ratings.
2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.
4. Install firestop devices for telecommunications and other cabling in accordance with manufacturer's tested assemblies and UL ratings. Follow all recommendations by the manufacturer for preparation, installation and rating to match that of surrounding construction.

3.4 IDENTIFICATION

A. Wall Identification: Permanently label walls containing penetration firestopping systems with the words "FIRE AND/OR SMOKE BARRIER - PROTECT ALL OPENINGS," using lettering not less than 3 inches (76 mm) high and with minimum 0.375 inch (9.5 mm) strokes.

1. Locate in accessible concealed floor, floor-ceiling, or attic space at 15 feet (4.57 m) from end of wall and at intervals not exceeding 30 feet (9.14 m).

B. Penetration Identification: Identify each penetration firestopping system with legible metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches (150 mm) of penetration firestopping system edge so labels are visible to anyone seeking to remove penetrating items or firestopping systems. Use mechanical fasteners or self adhering type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:

1. The words "Warning - Penetration Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
2. Contractor's name, address, and phone number.
3. Designation of applicable testing and inspecting agency.
4. Date of installation.
5. Manufacturer's name.
6. Manufacturer's product and UL assembly number.
7. Installer's name.

3.5 FIELD QUALITY CONTROL

A. Owner will engage a qualified testing agency to perform tests and inspections according to ASTM E 2174.

B. Where deficiencies are found or penetration firestopping system is damaged or removed because of testing, repair or replace penetration firestopping system to comply with requirements at no additional cost to Project.

C. Proceed with enclosing penetration firestopping systems with other construction only after inspection reports are issued and installations comply with requirements.

3.6 CLEANING AND PROTECTION

A. Clean off excess fill materials adjacent to openings as the work progresses by methods and with cleaning materials that are approved in writing by penetration firestopping system manufacturers and that do not damage materials in which openings occur.

B. Provide final protection and maintain conditions during and after installation that ensure that penetration firestopping systems are without damage or deterioration at time of Substantial Completion. If, despite protections, damage or deterioration occurs, immediately cut out and remove damaged or deteriorated penetration firestopping material and install new materials to produce systems complying with specified requirements.

3.7 PENETRATION FIRESTOPPING SCHEDULE

Concrete Floors		
Type of Penetrant	**F-Rating (Hr)**	**Hilti Basis-of-Design UL System**
Circular Blank Openings	1 or 2	F-A-0006, C-AJ-0055, C-AJ-0090
	3	F-A-0006, C-AJ-0055, C-AJ-0086
Single Metal Pipes or Conduit	1 or 2	C-AJ-1226, C-AJ-1291, F-A-1028, F-A-1017
	3	C-AJ-1155, C-AJ-1226, F-A-1017
	4	C-BJ -1037, C-BJ-1034
Single Non-Metallic Pipe or Conduit (i.e. PVC, CPVC, ABS, FRP, ENT)	1	F-A-2053, F-A-2025, C-AJ-2109
	2	C-AJ-2098, C-AJ-2167, C-AJ-2371, C-AJ-2342, C-AJ-2567, C-AJ-5301
	3	F-A-2054, C-AJ-2109, C-AJ-2098, C-AJ-2371, C-AJ-2342
	4	C-BJ-2016, C-AJ-2017
Single/Cable Bundles	1	F-A-3007, C-AJ-3095, C-AJ-3180, C-AJ- 3283
	2	F-A-3085, F-A-3087, F-A-3089, C-AJ-3095
	3	F-A-3007, C-AJ 3095, C-AJ-3285
Cable Tray	1, 2, or 3	C-AJ-4034, C-AJ-4035
Single Insulated Pipes	1 or 2	F-A-5015, F-A-5017, C-AJ-5090, C-AJ- 5091
	3	F-A-5016, C-AJ-5090, F-A-5018
	4	C-BJ-5006
Electrical Busway	1 or 2	C-AJ-6006, C-AJ-6017, F-A 6042, C-AJ- 6036
	3	C-AJ-6006, C-AJ-6017
Non-Insulated Mechanical Ductwork without Dampers	1, 2, or 3	C-AJ-7046, C-AJ-7051
Insulated Mechanical Ductwork without Dampers	N/A**	N/A**
Mixed Penetrants	1 or 2	C-AJ-8099, C-AJ-8056, C-AJ-8143
	3	C-AJ-8099, C-AJ-8056
	4	C-AJ-8095

Concrete or CMU Walls		
Type of Penetrant	**F-Rating (Hr)**	**Hilti Basis-of-Design UL System**
Circular Blank Openings	1 or 2	C-AJ-0055, C-AJ-0090
	3	C-AJ-0055, C-AJ-0086
Single Metal Pipes or Conduit	1 or 2	C-AJ-1226, W-J-1067, W-J-1020, W-J-1248
	3	C-AJ-1226, W-J-1041, W-J-1068
	4	C-BJ-1034, C-BJ-1037, W-J-1041, W-J-1042, W-J-1068
Single Non-Metallic Pipe or Conduit (i.e. PVC, CPVC, ABS, FRP, ENT)	1 or 2	C-AJ-2109, C-AJ-2098, C-AJ-2167, C-AJ-2371,C-AJ-2342, C-AJ-2630
	3	C-AJ-2109, C-AJ-2098, C-AJ-2371, C-AJ-2342
	4	W-J-2057, W-J-2091
Single/Cable Bundles	1	W-J-3036, C-AJ-3095, C-AJ-3180, W-J-3060, W-J-3167
	2	W-J-3036, C-AJ-3095, W-J-3277, W-J-3278, W-J-3167, W-J-3189, W-J-3279
	3	C-AJ-3095, C-AJ-3180, W-J-3167
	4	W-J-3050
Cable Tray	1 or 2	W-J-4027, C-AJ-4034, C-AJ-4035
	3	C-AJ-4034, C-AJ-4035
	4	W-J-8007
Single Insulated Pipes	1 or 2	C-AJ-5090, C-AJ-5091, C-AJ 5061, W-J-5042
	3	C-AJ-5090, C-AJ-5061
	4	C-BJ-5006, W-J-5028
Electrical Busway	1 or 2	C-AJ-6006, C-AJ-6017, C-AJ-6036
	3	C-AJ-6006, C-AJ-6017
Non-Insulated Mechanical Ductwork without Dampers	1 or 2	C-AJ-7046, C-AJ-7051, W-J-7021, W-J-7022
	3	C-AJ-7046, C-AJ-7051
Insulated Mechanical Ductwork without Dampers	1	W-J-7029, W-J-7124
	2	W-J-7091, C-AJ-7095, W-J-7112, W-J-7124
Mixed Penetrants	1 or 2	C-AJ-8099, C-AJ-8056, W-J-8007, C-AJ-8143
	3	C-AJ-8041, C-AJ-8056, W-J-8007, C-AJ-8099
	4	C-AJ-8095, W-J-8007

Gypsum Board Partitions		
Type of Penetrant	**F-Rating (Hr)**	**Hilti Basis-of-Design UL System**
Metal Pipes or Conduit	1 or 2	W-L-1054, W-L-1058, W-L-1164, W-L-1175, W-L-1410, W-L-1412, W-L-1467
	4	W-L-1110, W-L-1111, W-L-1165
Non-Metallic Pipe or Conduit	1 or 2	W-L-2078, W-L-2075, W-L-2128, W-L-2284
	4	W-L-2184, W-L-2245
Single or Bundled Cables	1 or 2	W-L-3481, W-L-3482, W-L-3483, W-L-3484, W-L-3065, W-L-3111, W-L-3112, W-L-3334, W-L-3414, W-L-3396
	3	W-L-3385, W-L-3277, W-L-3334
	4	W-L-3139, W-L-3334
Cable Tray	1 or 2	W-L-4011, W-L-4019, W-L-4060, W- L-4081, W-L-6019
	4	W-L-8014
Insulated Pipes	1 or 2	W-L-5028, W-L-5029, W-L-5047
	4	W-L-5073

Non-Insulated Mechanical Ductwork without Dampers	1 or 2	W-L-7040, W-L-7042, W-L-7121, W-L-7155, W-L-7159
Insulated Mechanical Ductwork without Dampers	1 or 2	W-L-7059, W-L-7153, W-L-7156, W-L-7151
Mixed Penetrants	1 or 2	W-L-1095, W-L-8013
	4	W-L-8014

END OF SECTION