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Specification for Installation of the Crew Activity Planning System Coaxial Cable Communication System

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G. S. Roman

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MITRE

MITRE Technical Report

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CONTRACT SPONSOR	NASA/JSC
CONTRACT NO.	F19628-79-C-0001 T5295F
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THE MITRE CORPORATION
HOUSTON, TEXAS

ABSTRACT

This report contains the specification used to install a broadband coaxial cable communication system to support remote terminal operations on the Crew Activity Planning system at the Lyndon B. Johnson Space Center. The system will support high speed communications between a Harris Slash 8 computer and one or more Sanders Graphic 7 displays.

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PART I

STATEMENT OF WORK

1. Description of Work: The work consists of furnishing all labor, materials and equipment not indicated as Government Furnished Equipment (GFE) that are necessary to perform all work in strict accordance with these specifications, schedules and drawings for a two-cable, two-way broadband Coaxial Cable Data Communications System at the Lyndon B. Johnson Space Center.

2. Location: This project is located in Buildings 4, 12 and 30 and connecting tunnels at the Lyndon B. Johnson Space Center, Houston, Texas.

3. Principal Features: The work to be performed includes the following principal features:

   3.1 Installation of dual trunk cables (aluminum sheath 0.412" OD) from the computer facility in Building 4 through the utility tunnels to Room 229 in the Mission Operations Wing of Building 30 and Room 258A of Building 12.

   3.2 Installation of the communications equipment listed on the attached drawings to provide a two-cable, two-way broadband cable communications system.

   3.3 Installation of conduits and messenger cables as needed to support the installation of the cable communications system.

   3.4 Installation of the mounting hardware as specified.

   3.5 The contractor will provide all necessary equipment, labor and installation material not supplied as GFE, whether specified or not, to provide a complete two-cable, two-way broadband coaxial cable communications system as described in this specification.

4. Contract Drawings and Specifications:

4.1 Drawings and specifications will be furnished to the contractor. These drawings will have the work to be performed in installing the broadband cable communication system overlayed. The work shall conform to the following contract drawings, all of which form a part of these specifications.

INSTALLATION OF COAXIAL CABLE
DATA COMMUNICATIONS SYSTEM
TO SUPPORT AT
LYNDON B. JOHNSON SPACE CENTER

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4.2 Omissions from the drawings or specifications, or the misdescription of details of work which are manifestly necessary to carry out the intent of the drawings and specifications, or which are customarily performed, shall not relieve the contractor from performing such omitted or misdescribed details of the work, but they shall be performed as if fully and correctly set forth and described in the drawings and specifications. The contractor shall check all drawings furnished to him immediately upon their receipt and shall promptly notify the Contracting Officer of any descrepancies before laying out the work. He will be responsible for any errors which might have been avoided thereby.

PART II

TECHNICAL SECTION

1. Applicable Publications: The publications listed below form a part of this specification to the extent indicated by references hereto:

   American National Standards Institute:

   C1 - National Electrical Code (1975)

   C2 - National Electrical Safety Code (1973)

2. Rules: All work shall be performed in accordance with the National Electrical Code (NEC); federal and municipal laws, codes and regulations; all applicable codes; and all ordinances. The heretofore stated codes, regulations and ordinances shall take precedence over the specifications in the event of a conflict. Nothing in these specifications shall be construed as a permit to violate the Code.

3. Coordination: If any conflicts occur necessitating departures from specified work schedules, details of departures and reasons therefore shall be submitted as soon as possible for written approval of the Contracting Officer.

4. Description of Work to be Performed: Column numbers included in this section refer to NASA drawings of the respective area. They are also included on the drawings which form a part of this specification.

   4.1 Install dual trunk cables from the computer facility in Room 273, Building 4 to Room 229 in Building 30. The system headend will be located at the designated equipment rack in Room 273 (Column 4.8, C.3); it is to be installed in accordance with Detail I. RG-11 flexible cable will be used in the construction of the headend and serve as the main conductor from the headend to a point adjacent to the riser to Room 272. There a pair of "F"-to-412 adaptors will be used to join the RG-11 to the 0.412" OD cables.

The cables will run beneath the raised floor from Room 273 into Room 272 as shown in Figure 1. The cables will then utilize an existing riser to the ceiling in Room 182A (Column 5.0, C.8). The run will continue along the ceiling to the area above the riser to the utilities tunnel (Column 5.9, C.7) as shown in Figure 2. The cables are to be run in cable trays in the utility tunnel as shown in Figures 3, 4 and 5. The 0.412" OD cables use the existing riser (Column 15.75, M) to enter Building 30 and run above the suspended ceiling to the riser to the second floor (Column 16,H.65) as shown in Figure 6. On the second floor of Building 30 the cables are mounted below the raised floor to Room 229 (Column 13.5, H.5) where they terminate as shown in Figure 7.

4.2 A second pair of 0.412" OD cables are to be run from the junction of the utilities tunnels serving Building 30 and Building 12 as shown in Figure 4. From there they proceed to the riser in Building 12. The riser is utilized to bring the cables to the ceiling of Room 138 (Column 2.6, C.4). The cables will then proceed along the ceiling of Room 138 and using existing conduit (if any) pass through the wall of Room 138 to the area above the suspended ceiling of the First Floor corridor (Column 2,C.4) as shown in Figure 11. From there they will proceed south along the corridor, then east to the ceiling of Room 109. (Column 5.9, E.4). Using existing risers in Room 109, the cables will run to the ceiling of Room 209 and then above the suspended ceiling to the area above Room 258A (Column 5.0,D.7) and terminate as shown in Figure 12.

4.3 Splices in the 0.412" cable not shown on the drawings, but necessary due to the length of cable pull, shall be approved by the Contracting Officer. All such splices will utilize universal splice connectors.

4.4 Install equipment listed in the Bill of Materials and connect cables as shown on drawings to provide a two-cable, two-way broadband cable communications system. The headend equipment shall be installed as shown in Detail I. The power supply should be installed on the rear of the rack. Amplifiers and directional couplers shall be installed at the junction of the utilities tunnels serving Buildings 12 and 30. The components shall be mounted on aluminum plates affixed to the cable trays as shown in Detail II. The taps of the directional couplers shall be connected to the cables serving Building 12 and the through output shall be connected to the cables serving Building 30. The outbound amplifier's output shall be connected to the input of the directional coupler and the inbound amplifier's input shall be connected to the input of the directional coupler as shown in Figure 4. The cables on the second floor of Building 12 shall each connect to a pair of four output multitaps, mounted as shown in Detail III, having 23 db attenuation to tap. The distribution cable outputs of the outermost taps shall be terminated with 75 ohm resistors with AC bypass capability. Similarly the cables in Room 229 of Building 30 shall connect to a pair of multitaps having 17 db of attenuation to tap as shown in Figure 7. All unused multitap ports shall be terminated with 75 ohm resistors using "F" fittings. A pair of directional couplers shall also be installed approximately 230 feet past the Building 12 junction under the Building 30 Administration Wing. The directional couplers shall have 3.0 db isolation to tap and the secondary taps shall be terminated with 75 ohm resistors with AC bypass capability. A pair of short cables (RG-11) shall be provided that will allow connection of the secondary taps of these directional couplers to the directional couplers on the TMS cables which are located in the same area.

4.5 Install conduits, cable straps and metal mounting plates. Conduit sleeves will be installed to protect cables where new penetrations of walls must be made to accommodate the cable.

5. Pull Plan: The contractor shall submit a pull plan which shall be approved by the Contracting Officer before any work starts.

6. Identification of Cables: Trunk cables installed by the contractor shall be color coded with a red band and an orange band 5 inches from each connector for the inbound cable and a red band and a green band 5 inches from each connector for the outbound cable. All parts shall have painted spots on outward facing surfaces of the installed parts: orange for parts mounted on the inbound cable and green for parts mounted on the outbound cable.

7. 0.412" OD Cable: The bending radius of the cable shall not be less than 6 inches. All bends will be made using a tubing bender and care shall be taken to avoid repeatedly bending the cable at any point. Caution shall also be exercised in order to prevent excessive flexing of trunk cables when pulling through ducts or conduits.

8. Conduits: Electrical metallic tubing (EMT) shall be used for all conduits that must be installed to satisfy these specifications and conform to Federal Specifications WW-C-563. The conduit size shall be as directed by the Contracting Officer. Pull or junction boxes shall be provided where required for pulling cables due to excessive number of bends or length of conduit runs. Number of bends per run shall conform to NEC limitations. Inside radii of bends in conduits 1-inch size or larger shall not be less than 10 times the nominal diameter.

9. Testing of System: The contractor upon completion of the installation of the cable communications system shall verify the system is properly functioning.

   9.1 The system shall first be aligned as follows:

1. Each outbound amplifier gain and slope control shall be adjusted to obtain a +40 dBmV output at any television channel with a +20 dBmV input on that channel at the headend amplifier.

2. Inbound amplifier gain and slope controls are adjusted to obtain a +40 dBmV output at any television channel with a +50 dBmV input on that channel to an inbound tap port in Room 229 of Building 30.

9.2 The level at each outbound tap is to be recorded with a +20 dBmV input at 211.25 MHz (or other frequency designated by the Contracting Officer) at the headend. The level at the headend shall be recorded with a +50 dBmV input signal at 211.25 MHz (or other frequency designated by the Contracting Officer) at each inbound tap. The results of these measurements shall be presented to the Contracting Officer upon completion.

9.3 The connector will also perform measurements to certify RF radiation does not exceed:

15 μV/M below 54 MHz or above 216 MHz measured 100 feet from any point in the system.

20 μV/M between 54 MHz and 216 MHz measured 10 feet from any point in the system.

The contractor shall be responsible for locating and repairing all system faults due to equipment malfunction or equipment defect.

10. Warranty of Equipment: All equipment furnished by the contractor under this contract shall be warranted to meet all performance requirements outlined in the Parts Schedule and Specifications for a period of 90 days from the date of acceptance of the system by the Contracting Officer.

11. Repair of Existing Work: When it is necessary to cut, channel, chase or drill floors, walls, partitions, ceilings and other surfaces in order to properly install, support or anchor the conduit, cables or other electrical work, the work shall be carefully laid out in advance and then carefully completed. Any damage to the building or equipment shall be repaired by skilled workers of the trades involved, at no additional cost to the Government.

12. Spare Parts: Under this contract, spare parts listed in the Parts Schedule and Specifications will be returned to the Contracting Officer by the contractor.

13. Material and Workmanship: Unless otherwise specifically provided in this contract, reference to any equipment, material, article, or patented process, by trade name, make or catalog number, shall be regarded as establishing a standard of quality and shall not be construed as limiting competition; and the contractor may at his option, use any equipment, material, article or process which, in the judgment of the Contracting Officer, is equal to that named.

BILL OF MATERIALS (LIST)

Item	For Installation	Spares	Total
Line Extender Amplifier	4	0	4
Attenuation Pad for Amplifiers			
15.0 db attenuation	1	0	1
6.0 db attenuation	1	0	1
3.0 db attenuation	2	0	2
Directional Coupler			
9.0 db attenuation to tap	2	0	2
Splitter			
3.0 db attenuation to tap	2	0	2
Interchangeable Multitaps - 4 way			
17.0 db attenuation to tap	4	0	4
23.0 db attenuation to tap	4	0	4
35.0 db attenuation to tap	3	0	3
Coaxial Cable (0.412" OD)	4702	498	5200 (2 reels)
Coaxial Cable (RG-59-size)	0	1000	1000
Coaxial Cable (RG-11-size)	40	960	1000
Connector (0.412" OD cable)	28	20	48
Connector F-59 with ferrule	0	25	25
Connector F-11 with ferrule	19	6	25
Terminating Resistor	44	6	50
Adapter F-to-BNC	0	10	10
Adapter F-to-412	2	3	5
Adapter F-to-VSF	13	2	15
Terminating Resistor (AC blocking)	6	0	6
Power Supply 60 VAC	1	0	1
Power Combiner	1	0	1
Splice Connector (Universal)	10	0	10

Note: Bill of Materials includes only communications hardware to be furnished by the Government. Mounting materials, such as plywood backboards, brackets, messenger wire, conduit, etc., are not listed but are to be furnished under this contract by the contractor.

Line Extender Amplifier, Manual Gain Control, One-Way

Line extender amplifier shall be provided as required. Amplifiers shall be of modular construction and housed in a rugged cast aluminum enclosure. The unit shall be adequately weatherproofed to permit outdoor installation without additional protection. The housing cover shall be hinged and all hardware for cover fastening and unit mounting shall be stainless steel. All amplifiers shall be suitable for mounting as shown on attached drawings. Connection to the amplifiers shall be made with standard 5/8" threaded aluminum cable connectors.

The amplifier shall have minimum full gain of 28 db with a manual gain control range of 10 db. For cross-modulation not exceeding -57 db, output capability shall be +54 dBmV for 12 channels with 3 db block tilt and 3 db slope. Output capability shall be +49 dBmV for 35 channels with 6 dB slope. Frequency response shall be 5 to 300 MHz. Frequency response flatness shall be $\pm$ 0.5 db from 40 MHz to 300 MHz. The noise figure shall not exceed 11 db at channel W without equalizer.

Amplifier shall be cable-powered from AC input voltages from 20 volts to 60 volts with a maximum current requirement of 800 milli-amperes. Amplifier shall have built-in surge portection and a power disposition switch to stop or pass power.

Jerrold Model SLR-300 or approved equivalent

Attenuation Pad for Amplifier

Plug in attenuation pads designed for plug-in installation inside the line extender housing shall be available in values of 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 6.0, 9.0, 12.0, and 15.0 db. These pads shall provide flat-attenuation over a passband of 5 to 300 MHz.

Jerrold Model SXP-* or approved equivalent

*attenuation

Power Passing Splitter and Directional Coupler

Signal splitters shall be provided in the system as specified. These units will be housed in a rugged cast-aluminum housing, weather and radiation shielded, and be suitable for mounting along cable trays as shown on attached drawings. Connection to the unit shall be by aluminum cable connectors with standard 5/8" x 24 threads.

Signal splitters shall permit a maximum current of 10 amperes. Terminal match at any port shall be 20 db or better. Frequency passband shall be from 5 MHz to 300 MHz. Units shall be available in two models, one symmetrical signal splitter and one directional coupler with a normal tap attenuation of 9 db.

The symmetrical signal splitter shall have a maximum insertion loss of 3.9 db and isolation between output ports of 24 db.

The 9 db directional coupler shall have maximum insertion loss of 1.7 db and maximum tap attenuation of 9.2 db. Isolation between output ports shall be 24 db minimum.

Jerrold Model STC-3C Splitter or approved equivalent. Jerrold Model STC-8C Directional Coupler or approved equivalent

Interchangeable Broadband Directional Coupler Multitap (4 Outlets)

Taps provided for the system shall be four-output directional coupler types. Taps shall be contained in a rugged cast-aluminum housing and be suitable for mounting along cable trays as shown on attached drawings.

Feeder line connections shall be made by aluminum cable connectors with 5/8" x 24 threads. The center conductor connections shall be made by seizing with a screw. Tap connections shall be made by standard "F" connectors. Four-outlet taps shall be available in nominal attenuation values of 10, 14, 17, 20, 23, 26, 29, 32, and 35 db and have maximum insertion loss of 3.7, 1.8, 1.2, 0.8, 0.6, 0.5, 0.4, 0.4,

and 0.5 db respectively. Additionally, terminating taps with 7 db nominal attenuation shall be available. Frequency response of all tap ports shall be from 5 MHz to 300 MHz. Tap-to-tap isolation within the same unit shall be greater than 20 db from 5 MHz to 300 MHz and greater than 30 db from 10 MHz to 300 MHz. Taps shall be power-passing except at any of the tap ports, and shall be rated for at least 5 amperes maximum. Return loss at the input and output ports shall be 20 db or better. Return loss of the tap ports shall be in excess of 20 db from 10 MHz to 300 MHz. Circuit boards shall be interchangeable to alter attenuation and number of outlets without removing the housing from the cable.

Jerrold Model FFT4 - *or approved equivalent
*Attenuation

Coaxial Cable Connectors

Coaxial cable connectors shall be used to connect to equipment as required. Connectors shall be solderless, 75-ohm impedance and be designed for the specific type of cable used. Splices in any coaxial cable line are not acceptable, unless splice connectors specifically designed for the purpose are available. All connectors for 0.412" cable shall have integral radiation sleeve.

Jerrold Model	Cable Type
F-59	RG-59/U Size
VSF-412S	0.412" OD Aluminum
F-11	RG-11/U Size

or approved equivalent

Terminating Resistor

Terminating resistors with 75-ohm impedence shall be installed at unused ports and feeder line ends. Terminating resistors shall be designed to cover the frequency range from 5 MHz to 300 MHz with minimum return loss of 30 db across the VHF band.

Jerrold Model TR-75F ("F" connector) or approved equivalent

Jerrold Model STR-75C (power blocking) or approved equivalent

Remote Amplifier Power Supply

Remote power supply for cable powering of amplifiers shall be provided. The power supply shall be enclosed in a rugged metal housing.

Line input voltage shall be from 95 to 130 VAC for an output voltage within ± 2 percent of rated at full loading. Output voltage shall be 60 VAC with maximum current of 14 amperes. Line regulation shall be ± 1 percent from nominal over the rated input voltage at full rated current. Load regulation shall be +2 percent, -0 percent from 28 percent load to full load. Surge protection shall be provided with a striking voltage of 145 volts, non-polarized.

Jerrold Model SPS-60B or approved equivalent

Power Combiner

Power combiners shall be provided as required. Unit shall be housed in a rugged cast aluminum case adequately weatherproofed to permit outdoor installation and shielded against radiation. The unit shall insert 60 volts AC from a power supply into a coaxial cable for remote powering of amplifiers. The power combiner shall have an RF bandpass from 5 MHz to 300 MHz with an impedance of 75 ohms at all terminals. RF insertion loss shall not exceed 0.4 db. The unit shall be rated to carry 10 amperes on each leg with a maximum current of 14 amperes on each leg with a maximum current of 14 amperes on the common leg. The unit is to be fused on each of the two output legs.

Jerrold Model SPJ-3C or approved equivalent

Universal Splice Connector

Devices which accept cable to housing connectors for a 90- or 180-degree splice shall be provided as part of this contract.

Jerrold PBA-Series or approved equivalent for 90° and 180° splices

Coaxial Cable 0.412" OD

Coaxial Cable (0.412" OD, 75 ohm, aluminum-sheathed with black polyethylene jacket 0.034" thickness, with 0.092" solid copper clad aluminum center conductor, and polystyrene foam dielectric.

Times Wire and Cable Company JT-2412J or approved equivalent

Coaxial Cable (RG-59/U Size)

Coaxial Cable (0.237" OD, 75 ohm, aluminum braid and tape) with black polyethylene jacket, 0.032" copper clad steel center conductor.

Times Wire and Cable Company 2045 or approved equivalent

Coaxial Cable (RG-11/U Size)

Coaxial Cable (0.407" OD, 75 ohm, aluminum braid and tape) with black polyethylene jacket.

Times Wire and Cable Company 2062 or approved equivalent

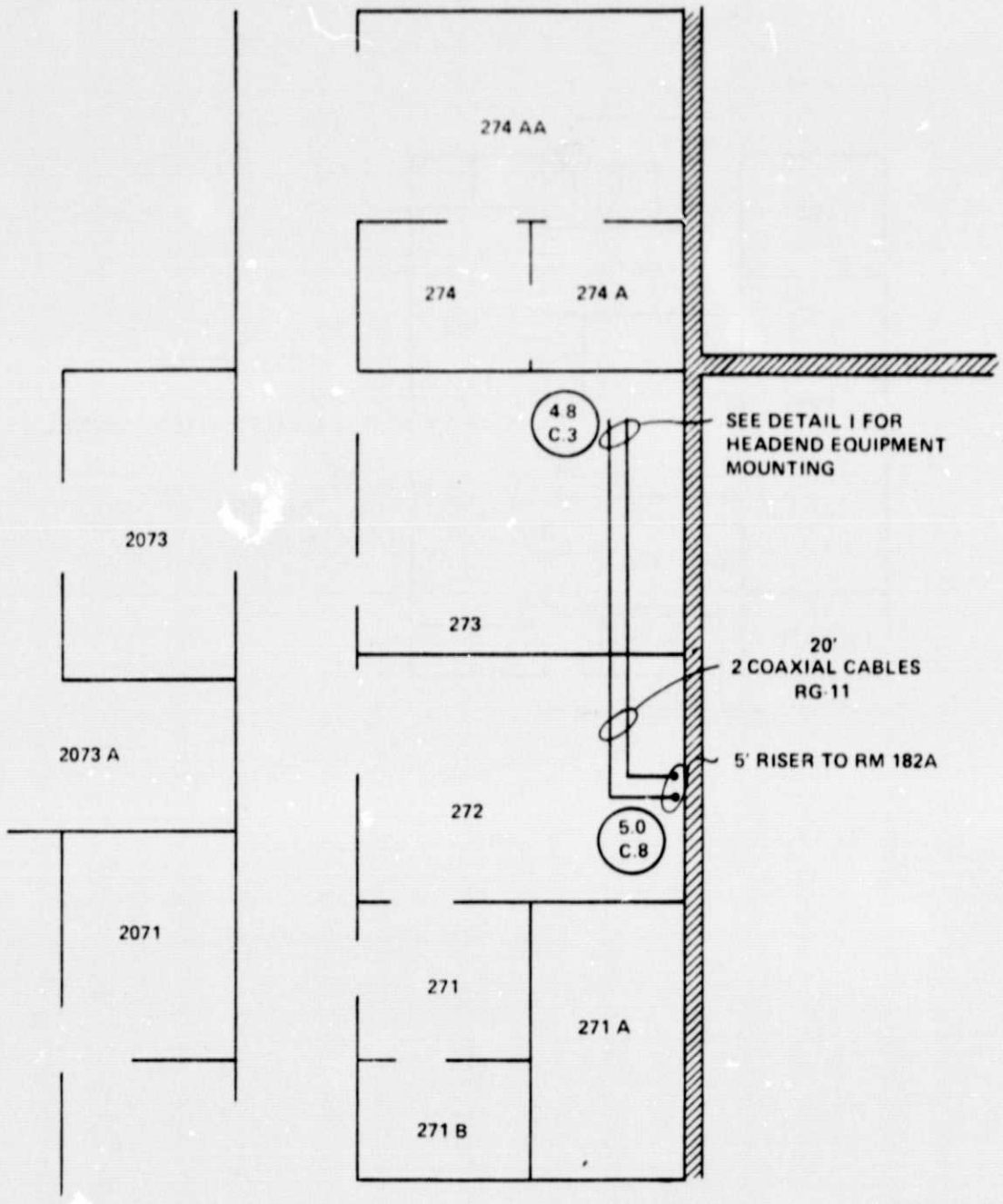


Figure 1. Building 4 Second Floor

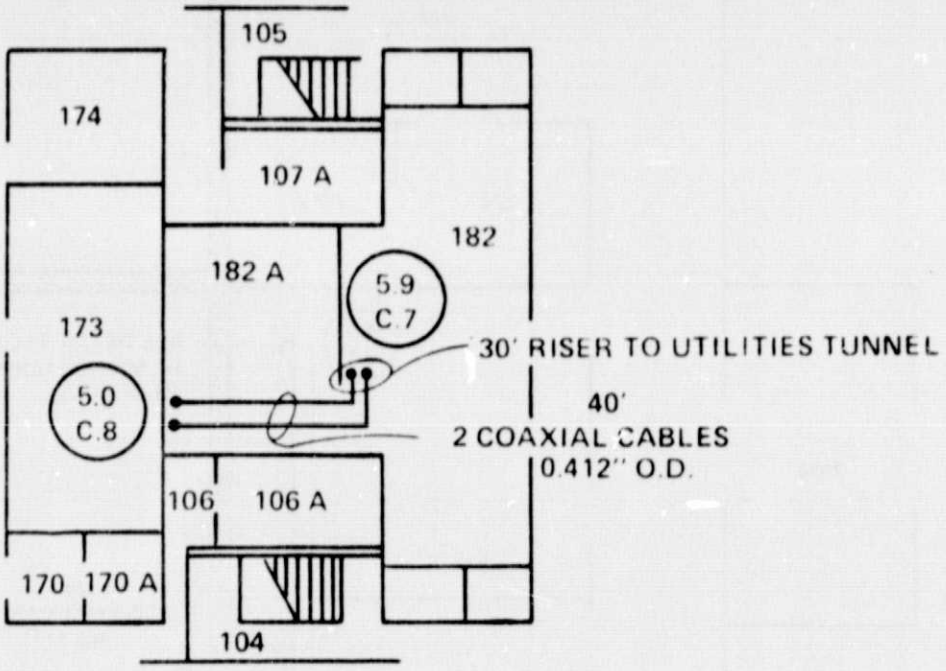


Figure 2. Building 4 First Floor

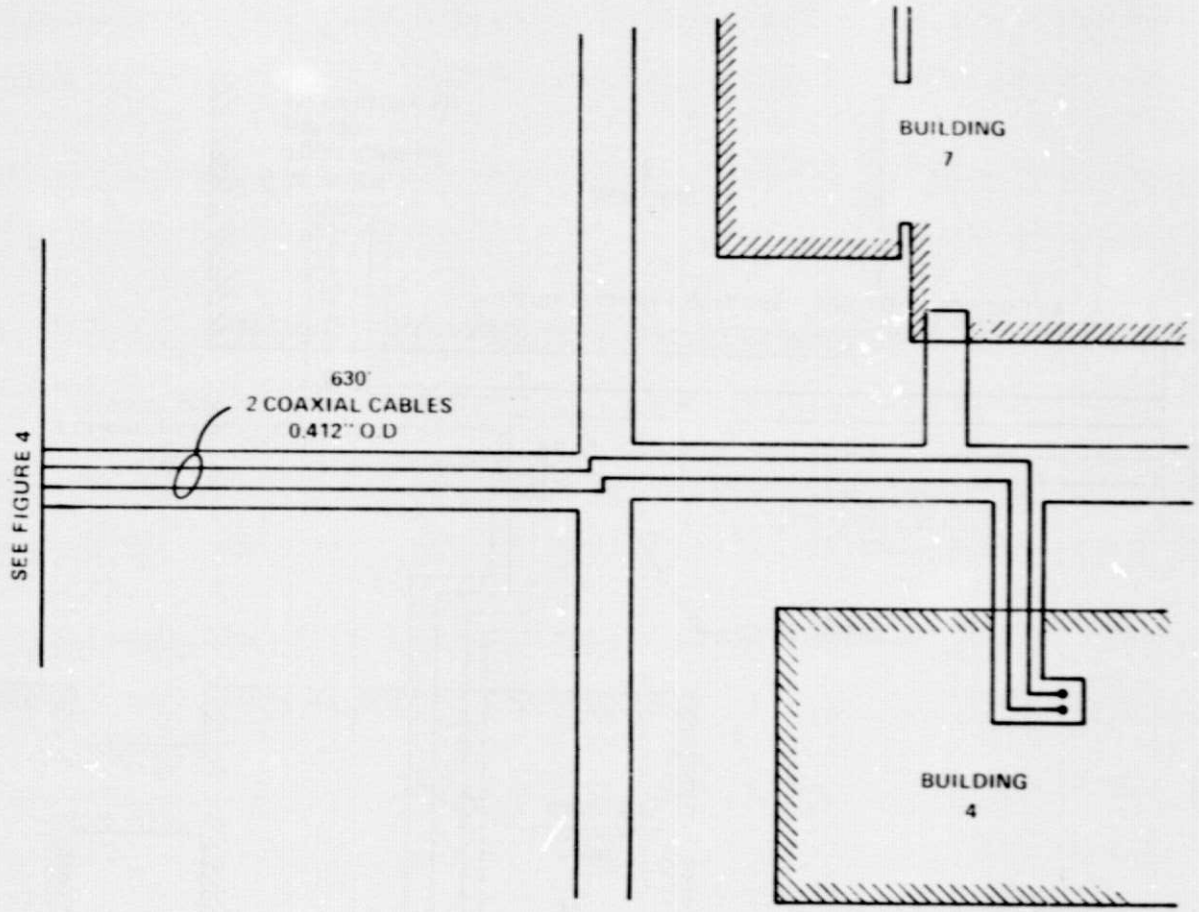


Figure 3. Tunnel System Plan E-T-22

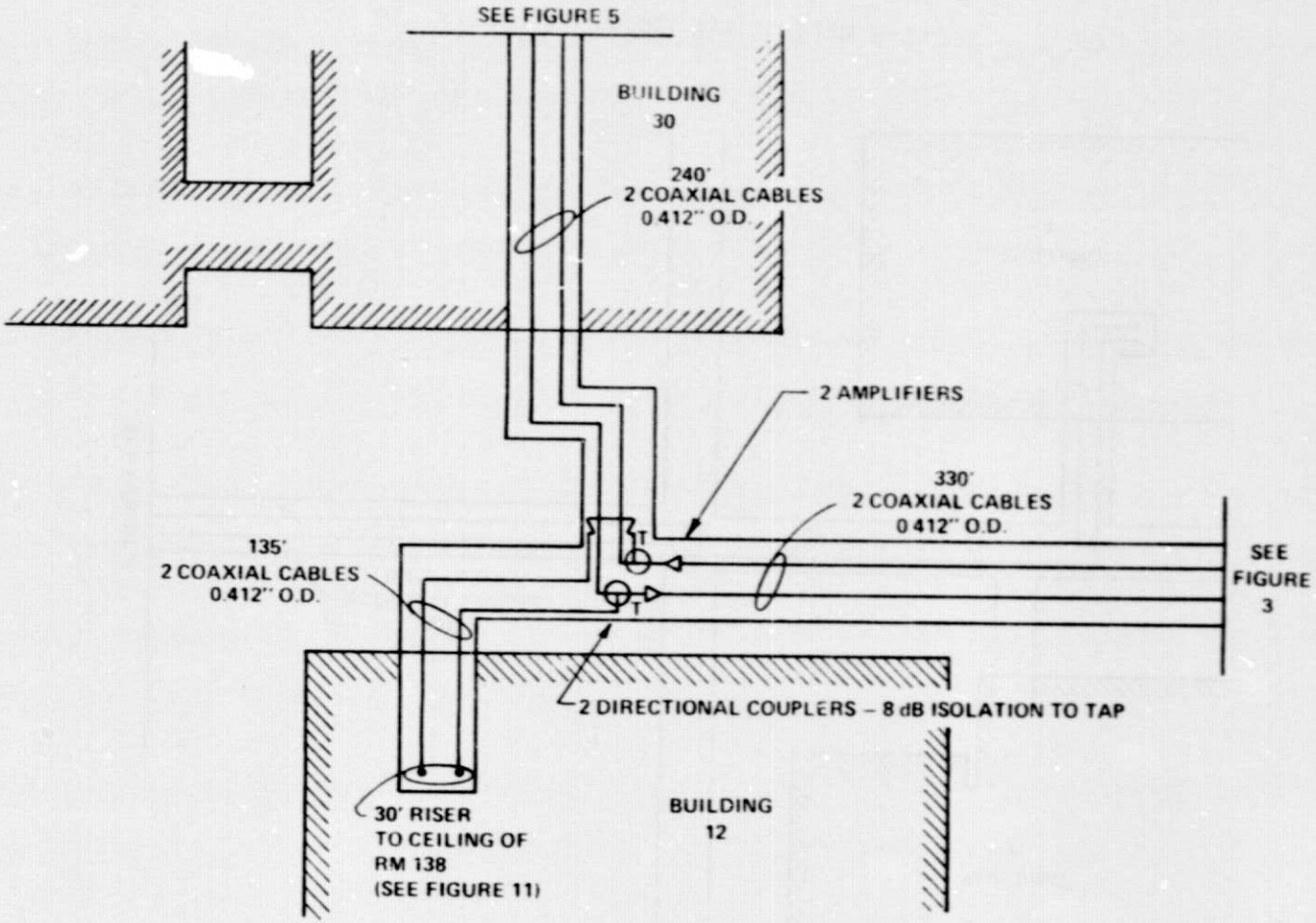


Figure 4. Tunnel System Plan E-T-21

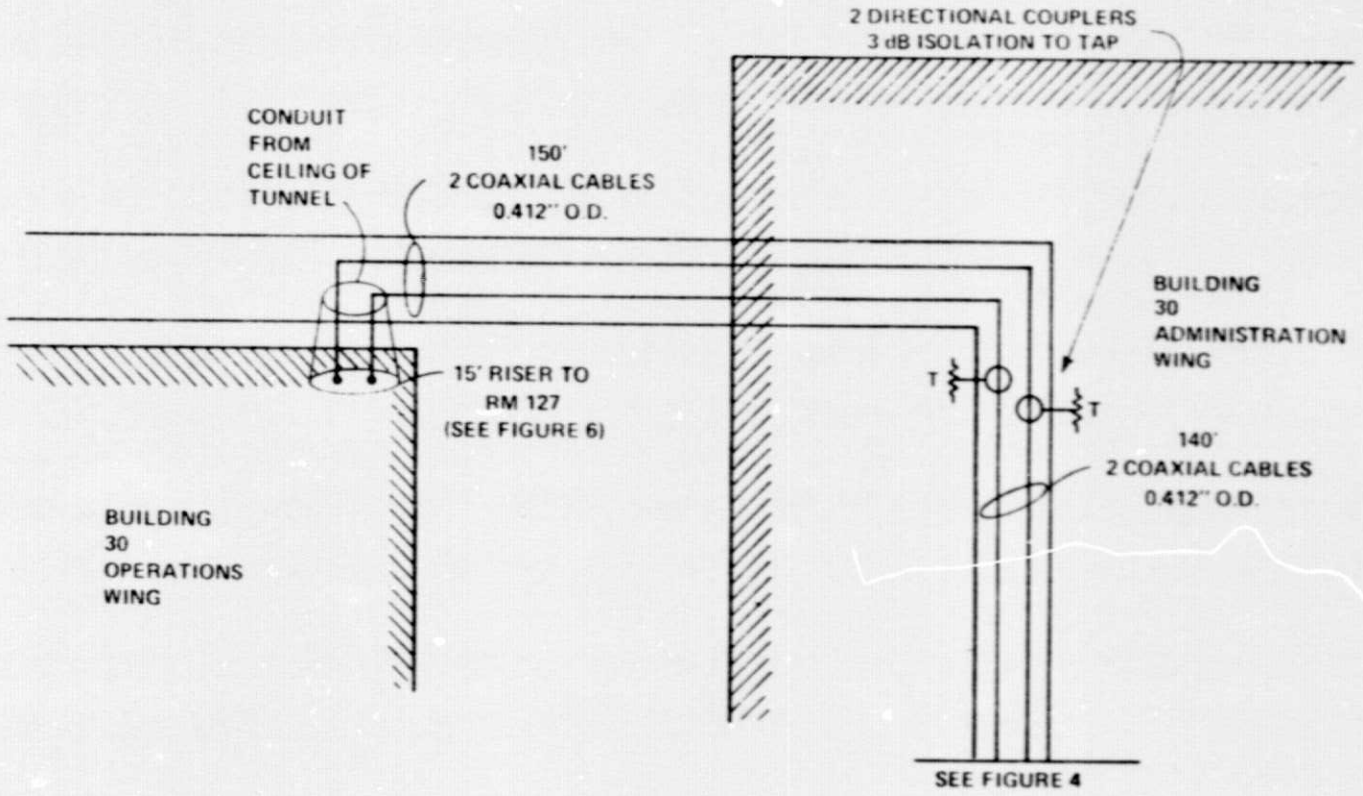


Figure 5. Tunnel System Plan E-T-17

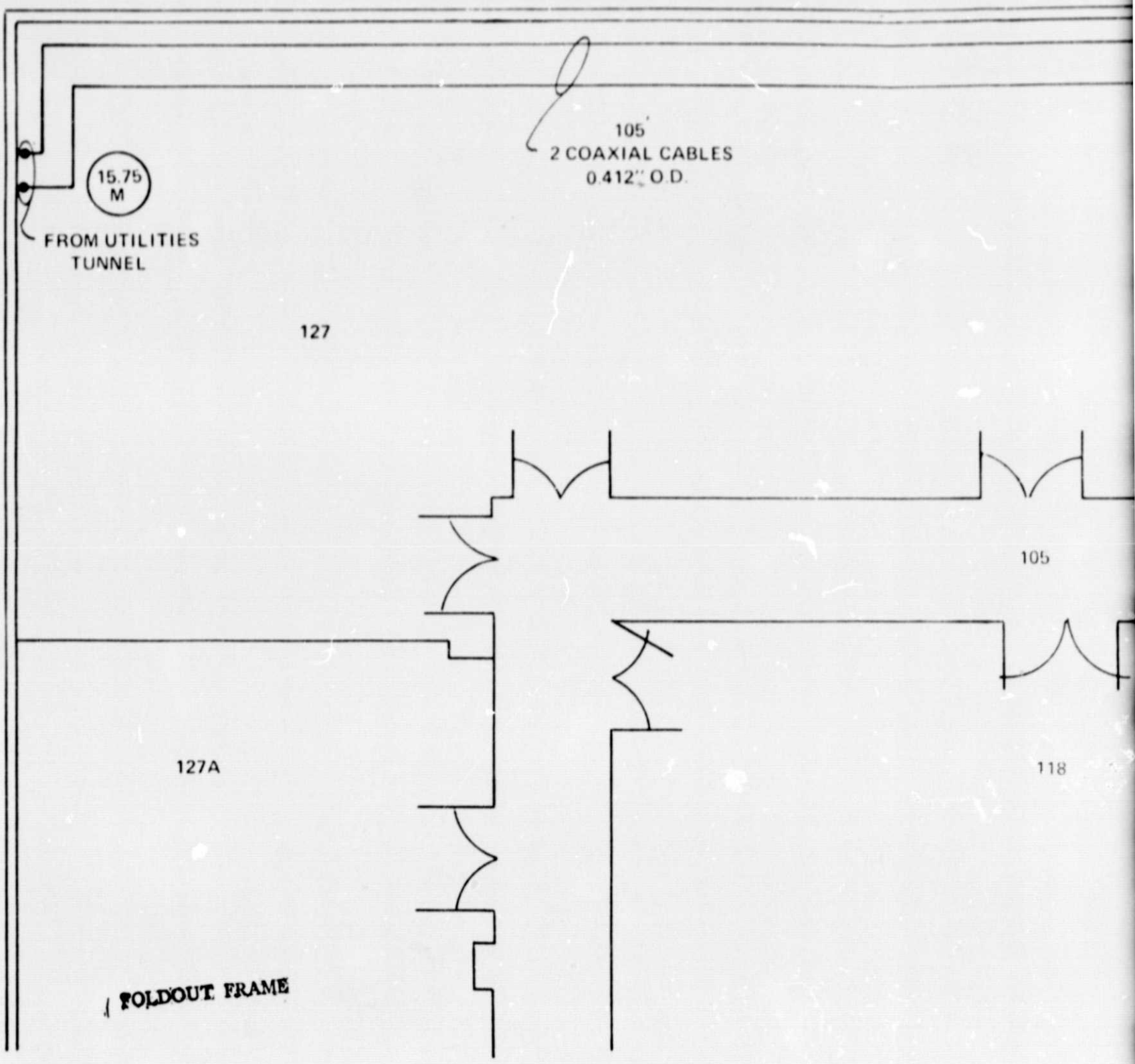
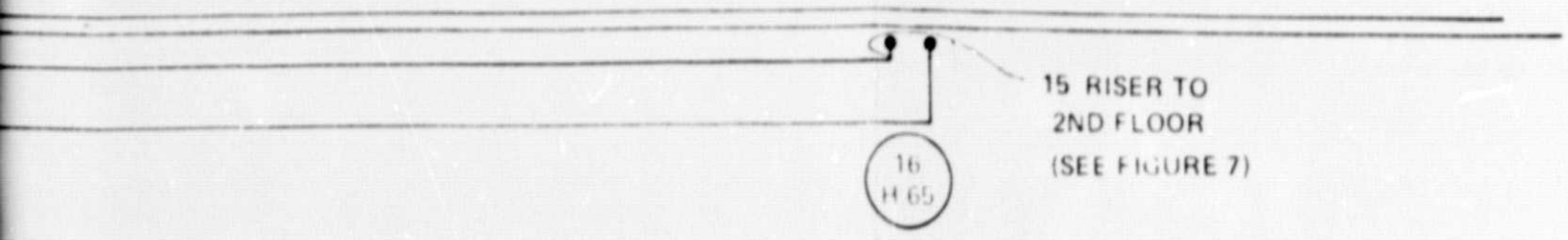
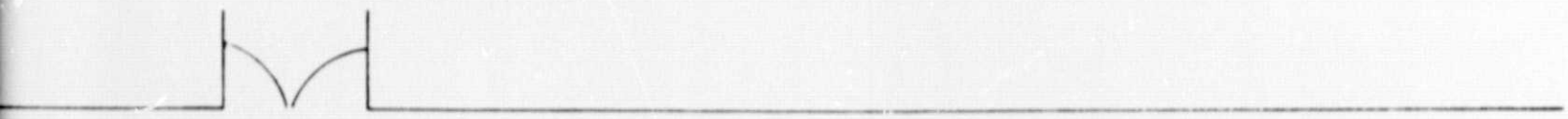


Figure 6. BUILDING 30 MISSION OPERATIONS WIN





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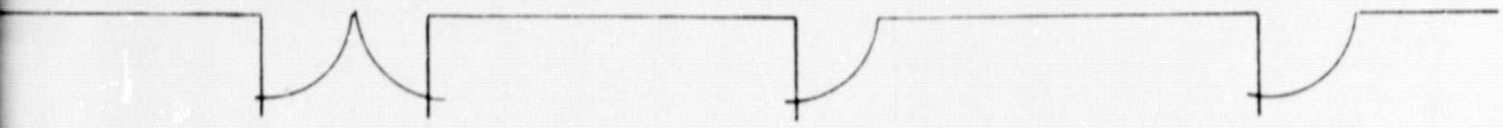

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2 FOLDOUT FRAME

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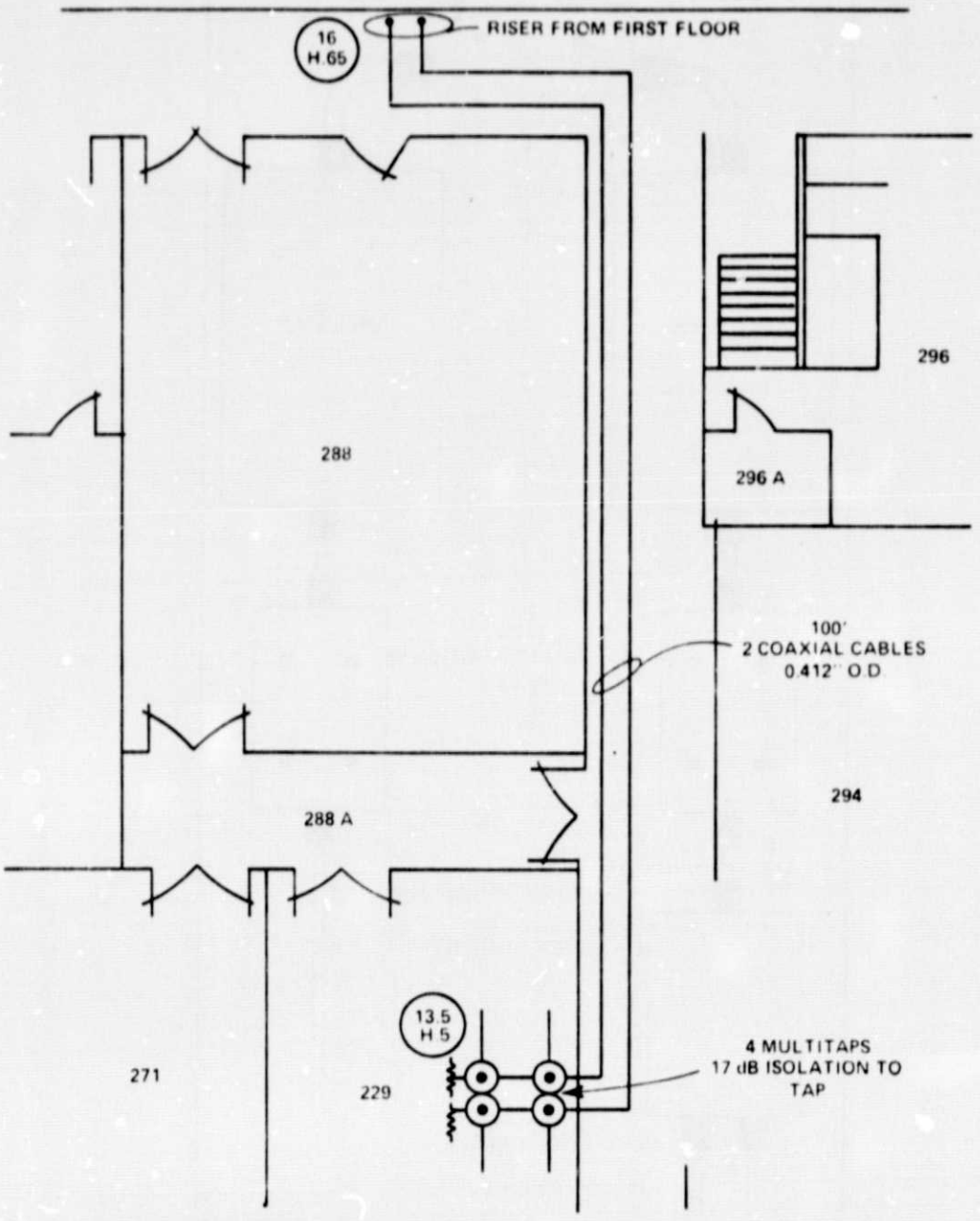


Figure 7. Building 30 Mission Operations Wing Second Floor

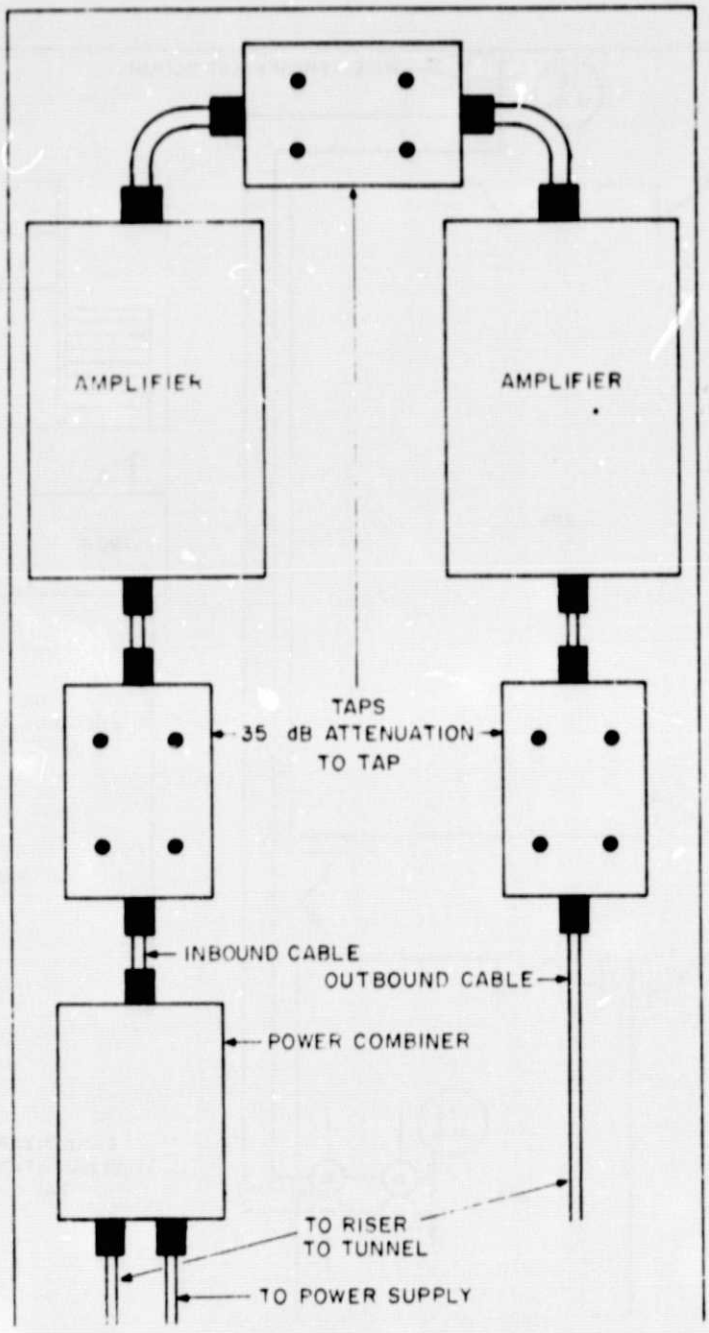
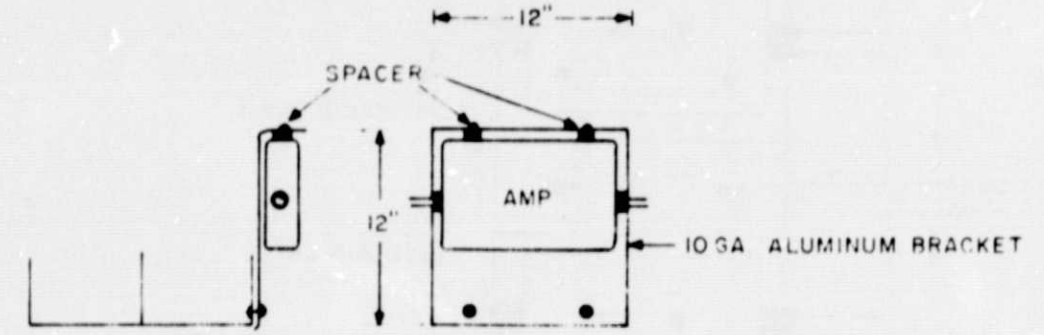
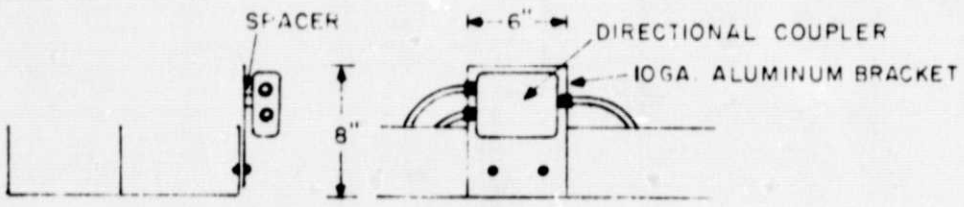


Figure 8. Detail I: Equipment Mounting in Headend (Building 4)



AMPLIFIER MOUNTING



DIRECTIONAL COUPLER MOUNTING

Figure 9. Detail II: Hardware Mounting on Cable Trays in Tunnels

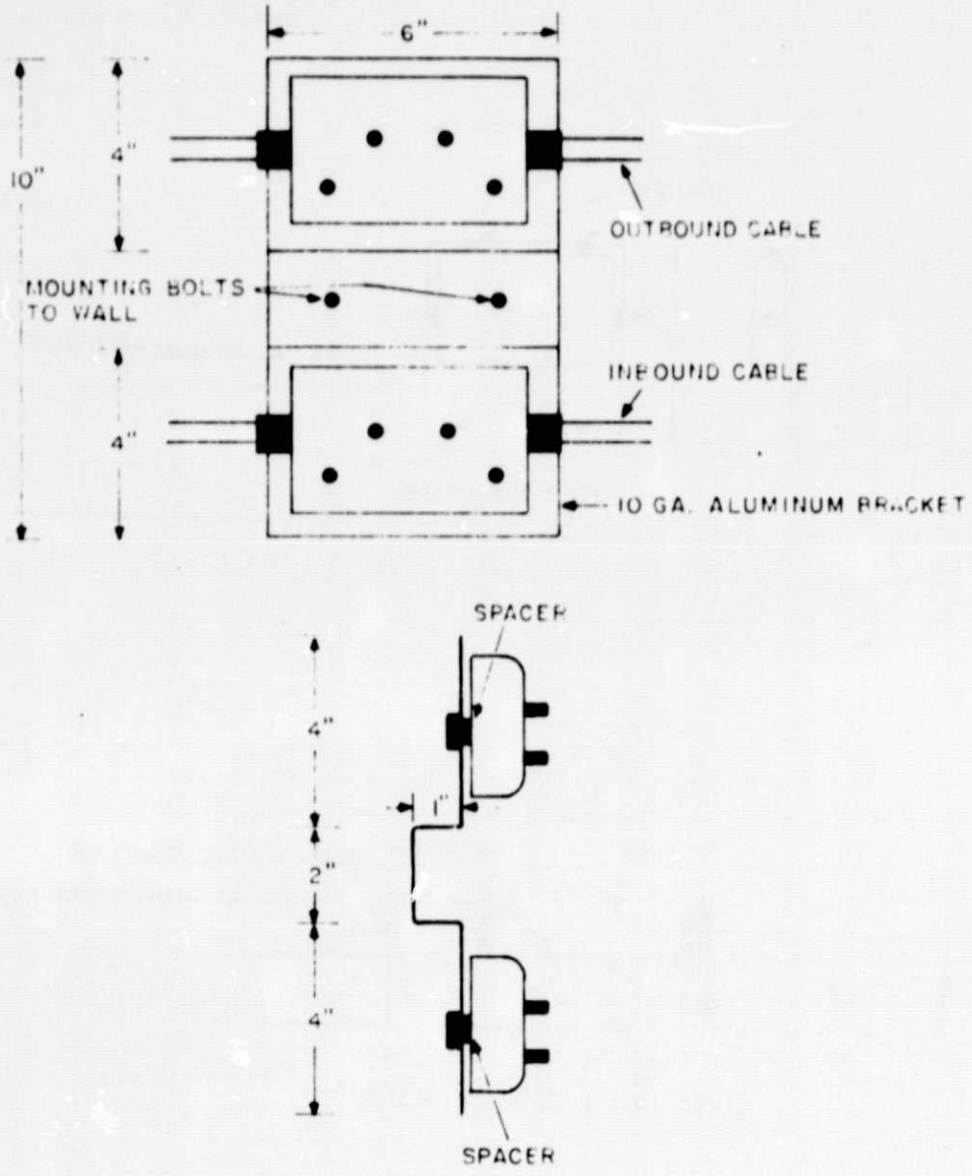


Figure 10. Detail III: Multitap Mounting

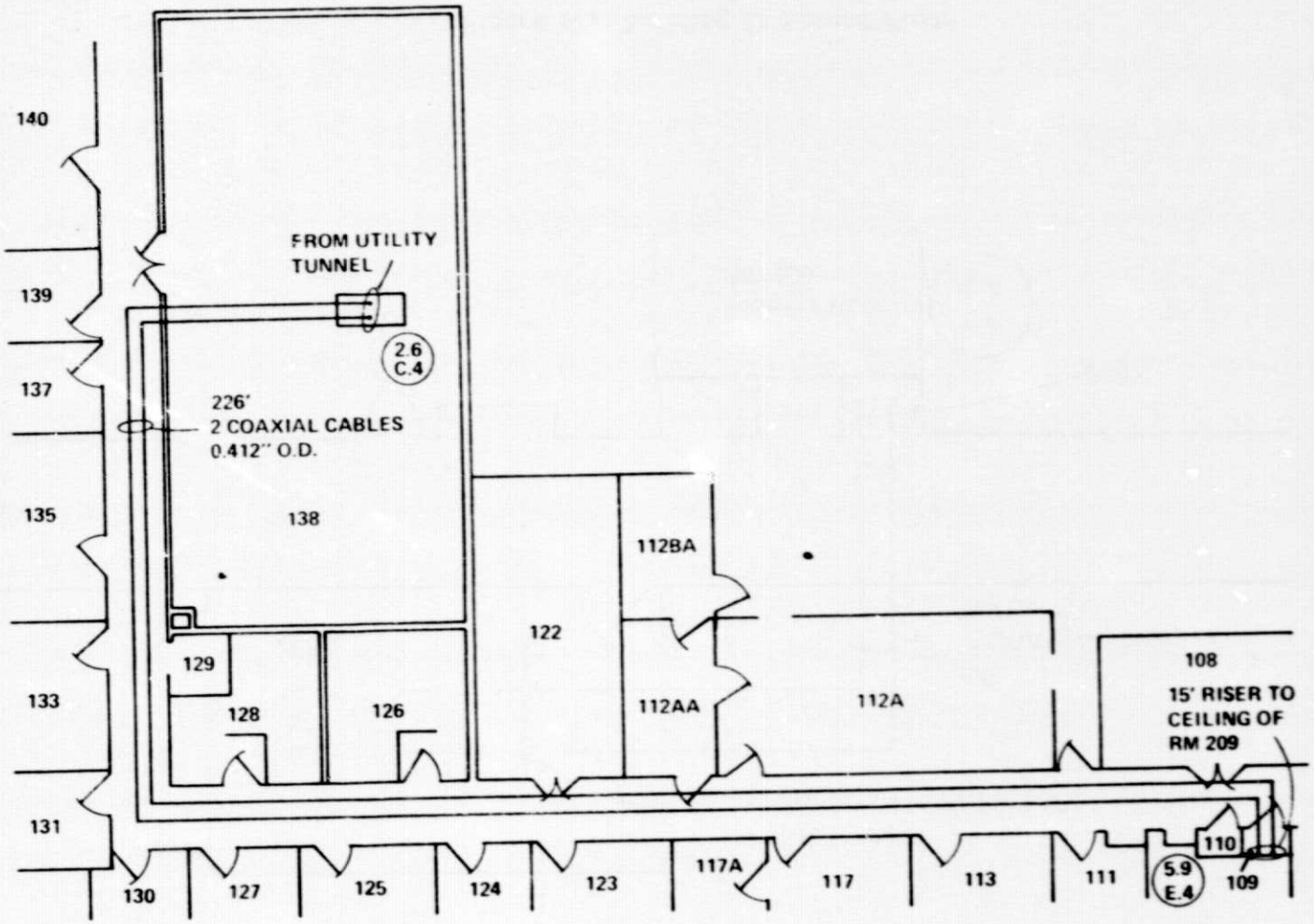


Figure 11. Building 12 First Floor

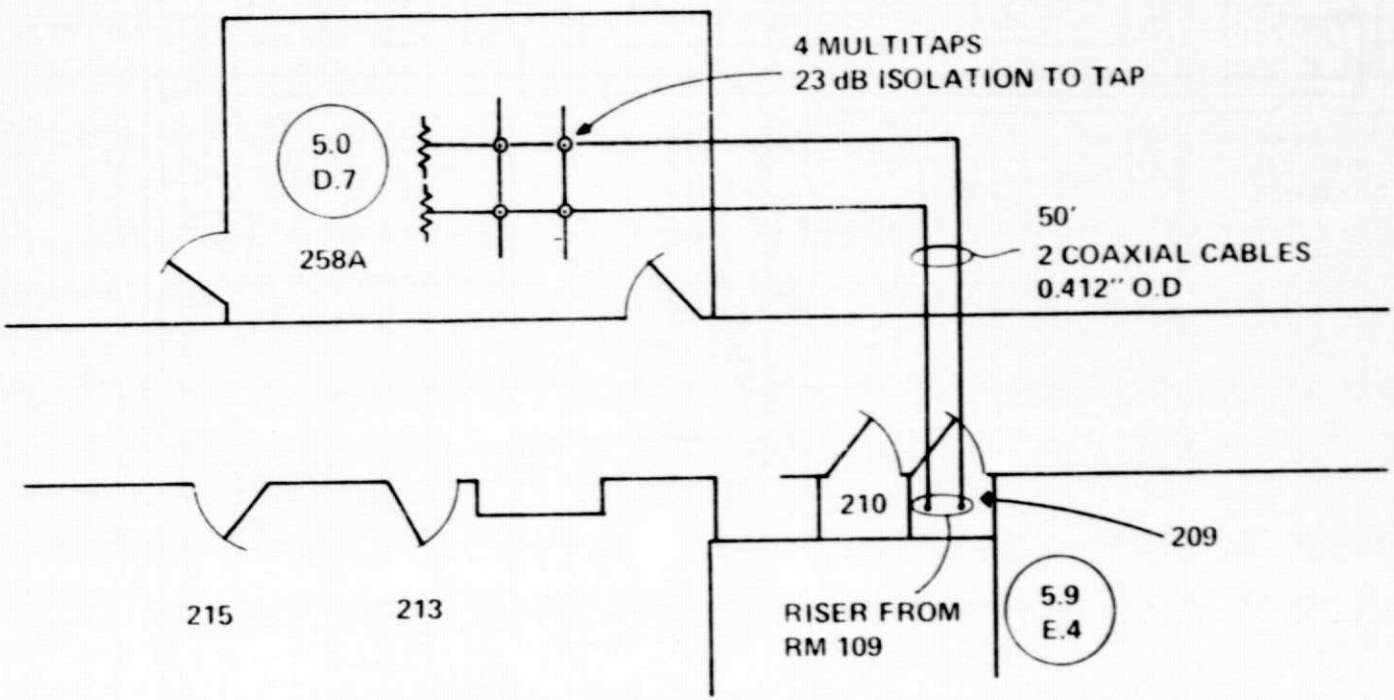


Figure 12. Building 12 Second Floor