

## SECTION 27 30 01

### TELEPHONE SYSTEMS

#### PART 1 - GENERAL

##### 1.01 SECTION INCLUDES

- A. PABX telephone system
- B. Emergency telephone (ET) system
- C. Fire telephone (FT) system
- D. Intercom system

##### 1.02 MEASUREMENT AND PAYMENT

- A. Measurement: Telephone systems will be measured for payment as a lump-sum unit acceptably installed and tested for compliance.
- B. Payment: Telephone systems, will be paid for at the Contract lump-sum price for telephone systems, or as part of the lump-sum price for Communications Work, as determined by the lump sum measurement specified above, as indicated in the Bid Schedule of the Bid Form.

##### 1.03 REFERENCES

- A. Bellcore:
  - 1. Pub 43720 Private Line Interconnection; Operational Features of Bell System Switch Terminations
  - 2. Pub RFC 890007 Electrical Characteristics of Bell System Network Facilities At The Interface with Voiceband Ancillary And Data Equipment
- B. Electronic Industries Association (EIA)
  - 1. EIA 464 Private Branch Exchange (PBX) Switching Equipment for Voiceband Applications.
- C. National Fire Protection Agency (NFPA):
  - 1. NFPA 72 Standard for the Installation, Maintenance and use of Protective Signaling Systems
- D. Rural Electrification Administration (REA):
  - 1. REA Form 528 General Specification For Private Automatic Branch Exchanges, Sections "a" through "e"
  - 2. REA Telephone Engineering and Construction Manual (TE & CM)

**1.04 DESCRIPTION**

- A. The Telephone Systems shall include the following:
  - 1. PABX Telephone System
  - 2. Emergency Telephone System
  - 3. Fire Telephone System

**1.05 SUBMITTALS**

- A. General: Refer to Section 01 33 00 - Submittal Procedures, and Section 01 33 23 - Shop Drawings, Product Data, and Samples, for submittal requirements and procedures.
- B. Functional description of each telephone system and purpose of all proposed test and diagnostic equipment.
- C. Top-down documentation for all PABX software and firmware. The documentation shall include structured formats or top-level flow charts, functional descriptions, program listings, detailed design descriptions of all algorithms, flowcharts, program design languages or pseudo-code, operating instructions, data base descriptions, program logic and data interface diagrams and descriptions, and hardware interfaces. The submittal shall include the following:
  - 1. A functional description and overview of the software
  - 2. An inventory of all software programs and modules, cross-indexed and characterized as standard, modified standard, or custom.
  - 3. A standard that software documentation released by the Contractor conforms to.
  - 4. Documentation on standard software.
  - 5. Documentation on modified standard programs.
  - 6. Functional requirements document, design and specifications document, and program source code for custom-designed software.
  - 7. Complete listing of the database documentation.
  - 8. Complete description of all display format.
  - 9. Memory map charts of application programs.
- D. Two PABX Software/Firmware modules shall be provided; one for in-service use, and one for spare.
- E. PABX Dial Plan.

**PART 2 - PRODUCTS****2.01 PABX TELEPHONE SYSTEM**

- A. A PABX system, Designated Matching Product, Northern Telecom's Meridian Option 11C or the latest compatible replacement model, shall be provided in each station, compatible with the existing Northern Telecom's Meridian Model 81C main PABX. The system shall provide PABX, courtesy, and emergency call box telephone services. Telephone sets shall be located in the station and wayside facilities including train control rooms, train control houses, switch interlocking locations, maintenance of way, traction power facilities, ventilation structures and other wayside facilities, as indicated. The location and types of telephone sets in each location shall be as shown on the Contract Drawings. The PABX system shall be a completely integrated package with the functionalities required to operate with the existing PABX system. Components including the telephone switch equipment and telephone sets shall be manufactured by a single manufacturer.
- B. PABX System Design:
1. The PABX system shall be designed for console-less operation, with dial-up service from PABX telephone sets, manual ringdown service from White Courtesy Telephone sets, direct trunk line 911 connection from Emergency Call Box (ECB) locations, and public address access from selected PABX telephone sets.
  2. The equipment shall be of digital solid-state, modular design, utilizing the same Intelligent Peripheral Equipment cards as the NT Meridian Model 81 with the latest hardware and software technologies available at the time of bid.
  3. The hardware and software design shall be such that incremental increases in station lines and trunks, and modifications of user data (adds, moves, or changes) may be easily accomplished without affecting service to any existing lines and trunks.
  4. Dial-up Service: The system shall provide station to station direct dialing, capable of processing calls to/from any point in the District's telephone system. PABX telephone users shall be able to go off-hook and dial any network number, regardless of location or serving PABX, and the system shall automatically complete the call to a system telephone set or route it over primary rate lines for switching by the existing main PABX at LMA, whichever is applicable.
  5. Courtesy Telephones: Courtesy telephones shall provide communications between patrons and the station agent's booth.
    - a. The telephone switch shall provide courtesy telephone service. These phones shall be installed to provide easy access to elderly and handicapped patrons in accordance with ADA requirements.
    - b. Calls made from courtesy telephones shall be directed to the PABX telephone in the station agents booth(s). If the station agent does not respond after 15 seconds or the line is busy, a 2-chime code call shall be broadcast over the Station Public Address System. The code call shall be repeated every 15-seconds until the call is acknowledged.

- c. Telephones in the elevators shall initiate the PA-code call without time delay. These calls shall be redirected to Central Control via the Emergency Telephone System if the Station Agent does not respond to the call within 90 seconds. The interface card for the PABX with the ET system shall be as specified herein. The PABX shall accept 17 to 40 ma as quiescent (on-hook) loop current, and 40-60 ma loop-current in the off-hook condition. Loop and supervision currents shall be provided by the ET system.
  - d. Courtesy telephones shall be designed for hands-free speaker phone operation. A permanently affixed sign shall be provided at each telephone location indicating public phones to be used in case of emergencies if the Station Agent does not respond to courtesy telephone call.
6. Emergency Call Box Telephones: The PABX switch shall be designed to provide the functions for emergency call box telephones as follows:
    - a. The telephone circuits shall be loop supervised through the PABX equipment.
    - b. Lifting the handset in the Emergency Call Boxes shall initiate the PABX switch to direct the call to BART Police emergency 911 operations.
  7. Power supply to the PABX system shall be from the negative (-) 48V dc power supply system.
- C. PABX Telephone Switch Equipment: The telephone switch shall meet the following requirements:
1. Rack mountable inside a communication equipment cabinet. Alternative mounting arrangements are acceptable subject to District approval. Physical dimensions, construction, mounting data (wall and/or floor), and enclosure locking mechanism shall be submitted.
  2. Employ a four or five-digit dial plan compatible with the existing NT Meridian Model 81C PABX switch. The software shall have an automatic routine that performs number analysis to the third digit. The software must determine if the number dialed is within the PABX or must be sent to a BART designated PABX switch over a Primary Rate Interface, and perform the necessary routing functions. No access level (e.g. "9") shall be required to dial any network number. "0" shall be automatically routed to the LMA Central PABX Attendant's console(s) via T1 lines.
  3. Performance: Traffic handling shall comply with the requirements of REA Form 528 and shall meet the following requirements:
    - a. Traffic Parameters:
      - 1) On seizure by a station line, the dial tone delay shall be such that no more than 1.5 percent of the calls are delayed more than 3 seconds.

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2) The grade of service with reference to terminating calls shall be no worse than P = .03.

3) Holding times of calls shall be as specified herein. The holding time values do not include machine setup and release times.

b. Average Subscriber Dialing Holding Times (time used to dial digits):

	<u>DIGITS DIALED</u>	<u>PUSHBUTTON SEC.</u>
Subscriber Response to:		
1) Dial Tone	--	2.6
2) Dialing Time per Digit	--	0.8
	1	3.4
	2	4.2
	3	5.0
	7	8.2
	8	9.0
	9	9.8
	10	10.6
	11	11.4

c. Average Incoming Register Holding Times for Direct Inward Dialing (DID):

	<u>BASIC SEC.</u>	<u>TIME/DIGIT SEC.</u>
1) DTMF or MF Receiver	1.0	0.14
2) Dial Pulse (DP) Receiver (10 PPS) Senderized Central Office	0.6	1.50

d. Average Sender Holding Times: DTMF Senders - Basic-1 Second, Plus 0.14 Seconds Per Digit using DP Senders:

- 1) With overlap pulsing (out pulsing starts after receipt of third digit): 9.1 seconds holding time for up to 6 digits, and 1.8 seconds for each additional digit.
- 2) Without overlap pulsing: 4.6 seconds holding time for up to 4 digits, and 1.2 seconds for each additional digit.

3) Average call holding times (HT):

<u>TYPE OF CALL</u>	<u>H. T. SEC.</u>
Intra PBX	100
City (Local)	120
City (Toll)	300
Tie Trunks	100

e. Traffic Ratios:

- 1) Intra-system - 21%
- 2) Incoming - 41%
- 3) Outgoing - 38%

- 4. Provide 20% wired spare capacity.
- 5. Stored Program Control (SPC), computerized digital switching system, with a battery backed non-volatile RAM for customer data.
- 6. Employ the North American Standard 8x8 (64Kb) □255 PCM companding algorithm.
- 7. Time Division matrix shall have at least 128 time slots for use by both trunks and telephone sets.
- 8. Function of Electronic Key Feature sets shall reside in the switch equipment and not the telephone set. Firmwares, such as EPROM and/or microprocessors that are specific to the model of set, may reside in the telephone set. The use of key system equipment not integral to the switch is not permitted.
- 9. Interfaces:
  - a. Trunk Interfaces: Two 1-MB lines connections to the telephone utility. One 1-MB line shall be connected as trunk line, while the other shall be connected through a modem for remote maintenance access.
  - b. Telephone Set Interfaces:
    - 1) Analog line cards.
    - 2) Public Address/Audio Paging via a 2-wire interface.
  - c. Data Interfaces: Serial port data interfaces shall be provided, complying with EIA/RS-232D, for the following functions:

- 1) The telephone switch shall have the capability to perform internal diagnostics automatically and on manual command. Exception reports from automatic testing and the results of manual testing shall be output via a serial port that operate asynchronously at a data rate of 300 - 9600 bps.
  - 2) A separate serial port shall be used for traffic monitor terminal interface. The interface shall forward real-time data of off-hook conditions of the White Courtesy Telephones to the Station-level computer. ASCII asynchronous format shall be used. Real-time data shall include trunk and station identification codes.
- d. Primary Rate Interface: The PABX shall be provided with Primary Rate Interface, ISDN, for routing to a BART designated PABX switch.
10. Telephone Switch Equipment Features:
- a. Call Park, Call Hold, and Call Waiting.
  - b. Conference, three party.
  - c. Call Forward for all calls, busy and Don't Answer. This feature shall be user-programmable. Don't Answer time-delay shall be 0 to 90 seconds.
  - d. Ten classes (minimum) of service with customer-definable restrictions. Three classes of service shall be used as follows:
    - 1) PA Access.
    - 2) Courtesy Telephone pick up.
    - 3) Outside line restriction.
  - e. System Speed Call.
  - f. Call hunting by Group.
  - g. Group call-pickup.
  - h. Directed call pickup.
  - i. Automatic and manual Night Bell.
  - j. User-defined ringing cadence:
    - 1) PABX Telephones - 1 sec. on, 2 secs. off.
    - 2) Courtesy Phones - 1 sec. on, 1 sec. off.
    - 3) ECB Telephones and Network Trunks - 1 sec. on, 2 secs. off.

- k. Trunk Answer From Any Station (TAFAS).
  - l. Trunk Queuing with Automatic callback.
11. Power for all telephony and display functions shall be directly supplied by PABX talk-battery/station line voltage. The use of AC transformers is not permitted.
- D. Telephone Sets.
- 1. Telephone types shall be as specified herein. Wall jacks shall be IBM Type 2, or standard type RJ 45. Plugs shall be RJ-type. Locations of telephones along with the type of telephone and wall jacks to be installed in each location are as shown in the Drawings. Telephone sets installed at interlocking locations shall be housed in a stainless steel NEMA 4X enclosure.
  - 2. Electronic Key-Feature Telephone Sets:
    - a. Single model, either wall-mounted or desktop type, as indicated.
    - b. DTMF or vendor-proprietary digital dial signaling.
    - c. Seven (minimum) direct-select buttons for the following functions:
      - 1) Direct trunk select - 5
      - 2) Direct Public Address select - 1
      - 3) Line Hold - 1
    - d. Fifteen character (minimum) LCD, LQD, or LED Alphanumeric Display showing the following information:
      - 1) Calling Station or trunk identification number.
      - 2) Time and date.
    - e. Telephone sets in the station agents booths shall be equipped with an integral "Busy Lamp Field." The lamps shall be initiated by the PABX through the same telephone line connecting the telephone with the switch equipment to indicate the location of incoming calls.
    - f. Telephones in the station platform shall be installed in lockable enclosures.
    - g. Utilize four-pair Category 3 type station wire for telephony and display functions.
    - h. Line cords for desktop models shall be modular. Plugs shall be located in close proximity to the telephone set to limit line cord length to a maximum of 10 feet.

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- i. Handsets shall be of one-piece modular construction, equipped with a hearing-aid compatible receiver and electret transmitter. Handset cords shall be fully modular, retractile type. Length shall be 12 feet, fully extended.
  - j. Color shall be ash or ivory.
  - k. Audio gain control shall be provided in accordance with the Americans with Disabilities Act, as follows:
    - 1) Gain range: +8 to +12 dBA
    - 2) Gain control may be handset-mounted thumbwheel or a front panel control on the telephone set faceplate.
3. Analog Telephone Sets:
- a. General Requirements:
    - 1) One-piece G6 type handset with hearing-aid compatible receiver and noise-canceling transmitter;
    - 2) Non-modular, 3 feet length, vandal-resistant, low-risk exposure handset cords;
    - 3) Dual-gong, electromechanical ringer; and
    - 4) Audio gain control, with a range of +8 to +12dBA, via a handset-mounted thumbwheel.
  - b. Telephone Sets:
    - 1) Color: Ash
    - 2) Models:
      - a) Wall-mounted Type 2006
      - b) Desk Set Type 2008
      - c) Weatherproof Panel Set, Type 2000 Series
  - c. Courtesy Telephone Sets:
    - 1) Color: White.
    - 2) Model: Gai-Tronics Model No. 297, ADA Compliant.
- E. The Contractor shall develop and implement a Network dial plan that shall update the PABX systems currently in service and incorporate those which are being supplied as part of this Contract. This plan shall also integrate the new equipment with the current Direct Inward

Dialing (DID) and BART Telephone Network Dial Plan. The proposed Plan shall be approved by the District prior to implementation.

- F. Systems conforming to the above requirements shall be compatible with Northern Telecom's Meridian Model 81 switch.
- G. BART shall be placed on the PABX supplier's mailing list to receive announcements of the discovery, documentation, and solution to software problems, new software releases, and other improvements that could be made to the software furnished with the PABX systems. This information shall be made available for 15 years after final acceptance.

## **2.02 EMERGENCY TELEPHONE (ET) SYSTEM**

### **A. Existing System Description:**

1. The ET system consists of telephone sets installed in stations; wayside facilities including train control houses, ventilation structures, and traction power facilities; along the trackway in Emergency Trip Stations. Emergency telephone sets in the Station shall be installed in or near the Platform Trip Stations, and in the Emergency Management Panel Room.
2. Lifting the handset at any emergency telephone location places the caller on an immediate connection with the LMA operator at Central Control and in the station agent's booth of the covering passenger station. Location of the calling party is displayed on the visual display at Central Control, and magnetic tape recordings are automatically made of the entire conversation.
3. Lifting the handset initiates one-way inbound signaling to Central Control and the station agent's booth. The calling party receives a "ringback" tone to indicate that the call to Central Control is ringing. The Central Control operator answers the call by depressing the flashing console selector button after lifting the red emergency telephone (ET) handset from its console hook. The ringback tone is removed when Central Control answers.
4. The station agent in the passenger station also has access to the emergency telephone system via a telephone set, including as part of its circuit a console-mounted "call in progress" light. The station agent can also initiate a call to Central Control over the emergency telephone system.

## **2.03 FIRE TELEPHONE (FT) SYSTEM**

### **A. Existing System Description:**

1. The FT system consists of telephone sets installed in 14 below grade Passenger Stations, at the middle of each platform, at mezzanine near the fire alarm panel, at emergency exits, and at street level Command Post. Jackboxes are installed at a Fire Radio Call Box, at cross passages in below grade wayside tunnels (Berkeley Hills Tunnel and Transbay Tube), and at fire hose or standpipe locations.
2. The FT system provides audio communication and visual signaling between handsets located at street level and on each side of platform level below ground and on each

jackbox location. The system is a dedicated closed loop design where all handset and jackbox locations on the "party line" can communicate with each other up to six (6) handsets simultaneously.

3. Lifting a handset from the hookswitch or plugging into a jackbox location turns on a normally off strobe light located above the telephone set, this in turn would begin to strobe at all locations on the system. The light continues to strobe until all parties hang-up and remove handset from jackbox.
4. The handsets and strobe lamps are connected by a single communication cable providing conductors for both audio and signaling.
5. The fire telephone system and strobe lamps are battery powered under constant charge. In the event of loss of AC power, the batteries will have enough capacity to operate the system for 200 hours. The batteries and chargers are located in the Train Control Room.

B. FT System Requirements:

1. The fire telephone system shall be designed in accordance with the technical and operational requirements of the existing FT as described above.
2. Fire Telephone handsets shall be provided in underground stations as indicated. Jackboxes shall be provided in subways and tunnels as indicated.
3. Major components and devices for the FT system shall include the following:
  - a. Telephone handsets with hookswitch and portable handsets shall be of rugged and durable construction and intended for emergency applications. Handsets installed in station premises shall be either pole or wall mounted units. Portable handsets shall have a shoulder strap carrying case. The handsets shall be a push-to-talk amplified unit with an armored cord.
  - b. Jackboxes shall be yellow in color and shall contain one standard telephone jack (tip, ring and ground sleeve). The box shall be weather resistant with a spring loaded or gravity-drop door. The jacks shall have corrosion resistant contacts (gold plated) and wired to a four position terminal strip in the box.
  - c. The batteries shall be sealed lead-calcium type designed with a life expectancy of twenty years. The battery charger shall be current limited with short circuit protection for 120 VAC input and filtered DC output. The battery shall be sized to provide full operation at room temperature for ninety minutes after loss of normal power.
  - d. Telephone enclosures shall be weatherproof and constructed of die-cast aluminum. The enclosure shall be lockable with yellow color and mark with "TELEPHONE" on the door. All hardware, including straps for pole mounting shall be stainless steel.
  - e. The strobe lamps with a yellow colored dome shall be designed for surface or pole mounting. The housing shall be aluminum die-cast or stainless steel with stainless

steel hardware. The flash rate of the lamp shall be 80 flashes per minute rated at 1,000 effective candlepower with a peak candlepower of 75,000.

- f. Other miscellaneous materials including cables, conduit and fittings, pull boxes and termination blocks shall be as specified in Section 20 70 26 - Common Materials and Methods for Electrical Systems, and Section 20 50 13 - Raceways for Facility Services
4. A connection shall be provided at each passenger station such that monitoring (recording) shall be possible at the LMA Central Control.

## **2.04 INTERCOM SYSTEM.**

- A. An intercom system shall be provided at end-of-line Stations.
- B. The intercom system shall provide communications between the Supervisor's Booth and the Employee Lounge/Break Room.
- C. Communications between room locations shall be hands-free after initially pushing a call button.
- D. The intercom unit in the Supervisor's Booth shall be provided with volume control adjustment.
- E. The intercom unit in the Supervisor's Booth shall be a Desk-type, and in the Employee Lounge/Break Room shall be a wall-mounted unit.

## **PART 3 - EXECUTION**

### **3.01 INSTALLATION**

- A. Station wiring for all telephone systems shall be four-pair telephone cables. Station and feeder cables shall not be spliced together.
- B. The power source for all telephone systems (except for the fire telephone system) shall be -48V dc fed from the DC distribution power panel.
- C. Quantity and approximate locations of telephone system equipment are shown on the Contract Drawings.

### **3.02 TESTING**

- A. Testing shall be performed in accordance with the requirements specified in Contract Specifications Section 01 45 24 - Testing Program Requirements. The following tests shall be performed on each telephone system, as applicable.
  - 1. Station to station calling.
  - 2. Station to trunk calling.
  - 3. Trunk to station calls.

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4. Initiate traffic to/from the system that shall activate the various progress and signaling signals/tones generated by the respective system:
  - a. Dial tone.
  - b. Station busy tone.
  - c. All trunks busy (congestion) tone.
  - d. Ringback tone.
  - e. Station ringing.
  - f. Distinctive ringing.
  - g. Delayed ringing at LMA Central (90 seconds for Elevator intercom to ET system).
  - h. Maintenance and Administration data is received, accepted, and transmitted in accordance with District and manufacturer's specifications.
  - i. Transmission and signal levels across all interfaces with other systems and subsystems.

**END OF SECTION 27 30 01**