PART I - GENERAL

1.01 DESCRIPTION

A. Scope: Work under this Section shall include all materials and installation for Pneumatic Tube System as shown on the Drawings and specified herein.

B. Related Work Specified Elsewhere:

1. Division 1 – GENERAL REQUIREMENTS
2. Division 13, Section 13280 – ASBESTOS ABATEMENT and IN-PLACE MANAGEMENT

C. Section includes complete Pneumatic Tube System (PTS).

1. Furnish labor, materials, tools, equipment, architectural fees, permits, etc. to comply with all codes and regulatory agencies and perform all work and services necessary for or incidental to the furnishing and installation of a Design-Build completion/addition to the existing 4" Pneumatic Tube System as shown on the drawings and specified. Any work or services required to the existing even though not indicated is understood to be a part of this specification.

2. This is a continuation/completion of the 4" Rough-in PTS currently installed in the Tower and being installed in Tower II. When finished, these additional stations and the completion of the existing rough-in will become a functioning multi-zone system. The system provided shall be specifically designed for the handling of specimens, blood products, and Pharmacy items which fit into the carrier without damage e.g. hemolysis. Payload (material being transported) shall not exceed three (3) pounds.

D. Related Work:

1. Provide painting, patching and fire sealing for passage of all tubing through walls and floors.

2. Provide cutting, fittings repainting, patching and finishing of installed work. Include installed work of other sections where it is necessary to disturb such work to permit installation of PTS work. See Division 1.

3. Provide furring of enclosures for PTS equipment.

4. Provide access doors, panels and frames of the style, type and rating required for any mechanical/electrical component. Indicate all locations on submittals.

5. Provide all conduit, electrical wiring and connections to electrical panels for single phase power at each station, diverter and central controls and three phase power at each power unit (APU).

6. University's Representative reserves the right to approve all system designs, system routings, equipment and installation.
1.02 SUBMITTALS

A. Shop Drawings: Submit in accordance with Division 1. Show locations of all equipment, loads and all other pertinent data as may be required by the University’s Representative’s Consultant to determine compliance with the Contract Documents.

B. Submit one production carrier with insert for each style carrier proposed.

C. Manuals: Submit in accordance with Division 1 copies of Operating and Instruction Manuals 30 days prior to final inspection of the (**CONSULTANT TO SPECIFY**) system. Submit any changes prior to final inspection of that portion of work. The manuals shall contain complete operating, maintenance and repair instructions, including but not limited to the following:

1. Description of system components.
2. Special operating instructions.
3. Routine maintenance procedures and servicing information.
4. Wiring and control schematics.
5. Complete catalogued list of spare parts.
6. Recommended quantities of “parts on hand”.

D. Field Record Drawings: Submit in accordance with Division 1 one complete set of reproducibles indicating “as installed” conditions including all electrical/mechanical devices and access to same shall be furnished. The reproducibles will be made from the approved architectural shop drawings. The riser diagram shall be CAD generated and indicate all devices by Room Number and locate all electrical panel/circuit powering each device by floor and Room number. The Record Drawings shall indicate graphically all equipment locations in accordance with the identification decals.

E. Upon completion of all phases the Contractor shall put in escrow (at no cost to the University) a hard copy of the uncompiled software as well as a copy of the completed software (on CD ROM) compatible with the accepted system.

1.03 JOB CONDITIONS

A. Related Requirements:

1. Section 01310 – COORDINATION

B. Before submitting a bid proposal each Bidder shall carefully examine the project documents, fully inform himself of existing conditions, and limitations of the site. The previous installation is described in Tower 1 as-builts and Tower 7 renovation as-builts. The current Tower II installation is described in Tower II contract drawings and specifications. Bidder acknowledges the intent of utilizing existing tube runs and equipment locations. By submitting a bid, bidder agrees that they have independently determined and verified that the existing tubing will accommodate the carriers specified or if not usable provide new tubing or bends. Excess tube throughout the complex may be removed and relocated as necessary to meet the requirements.
C. Schedule and coordinate the work of this Section with the work of all other trades involved with the completion of the project; verify delivery and installation of all equipment with approved schedule for the project; provide all required items for a complete and operable installation so as to cause no delays.

1. Bidder acknowledges that bid drawings are schematic in nature and allowances are included in the contract sum to accommodate minor routing changes.

2. Cause as little interference or interruption of existing utilities and services as possible.

1.04 WARRANTY

A. Related Requirements:

1. Division 1 – GUARANTEE, WARRANTY

B. Materials and workmanship of the pneumatic tube installation shall comply in every respect with Contract Documents. Unless due to ordinary wear and tear, or improper use or care by the University, correct defects which develop within one year as described under the Section.

C. Portions of the system will be brought on line before the total construction is complete. Each station/portion will be accepted according to this Section and warranty for each portion shall begin when the reliability criteria is met for that portion.

1.05 SPARE PARTS

A. Related Requirements:

1. Division 1 – SPARE PARTS and MAINTENANCE MATERIALS

B. The PTS Contractor shall include in his bid and allowance of $5,000 for spare parts for the 4” PTS and a list of same shall be submitted with his bid. These parts shall be derived from the “recommended quantities” in the parts manual.

PART II - PRODUCTS

2.01 PNEUMATIC TUBE SYSTEMS

A. Acceptable Contractors:

1. Based on prequalification, the only acceptable bidders are Pevco Systems International, Inc. and Translogic Corporation or equal.

2. Each Contractor shall stand solely first party responsible for design, installation and warranty for the equipment furnished.

2.02 SYSTEM OPERATION

A. Sending: To send a carrier through the system, the operator places the carrier in the station dispatcher, selects its destination code on the station control panel. The liquid crystal display (LCD) will display the destined station alpha/numerically for verification, e.g. “Sending to Lab station #10” if so designated. Once verified, the operator depresses the dispatch button placing the carrier in queue for dispatch to the designated station.
The LCD will display “Dispatch Request Accepted” and confirm the required sections of the network are functioning, assuring that the carrier will be delivered to its destination. The LCD will continue to display the selected station until the carrier has arrived at its destination or until canceled. After receipt of the accepted signal, the dispatching sequence shall be automatic, requiring no additional attention by the operator. Until the time the carrier leaves the dispatcher, the carrier may be manually removed and destination code canceled. Once the carrier has been given the dispatch command, the loader shall slide into position for release of the carrier into the system network. Loader shall return to normal and a second carrier may be placed in the dispatch sequence as previously described. If the second carrier is accepted into the network, the LCD will continue to display the selected station until the carrier has arrived at its destination. If two carriers are in transit from the same sending station, the LCD will display each destination until the carrier has arrived at its destination. If two carriers are in transit from the same sending station, the LCD will display each destination until all carriers have arrived at their respective destinations. Only a properly configured carrier shall be accepted and no foreign objects shall be accepted into the system. Once a clear path has been verified, the carrier shall travel via the shortest route (means turnaround capability at each diverter) under the vacuum/pressure mode to its destination. A light and audible pulse signal at the receiving station shall indicate only the arrival of an active carrier, not an empty carrier. A full station will cause the pulsing alarm to sound continuously until the condition is relieved.

B. Reject: If the carrier cannot be dispatch to its destination, a reject indicator shall appear on the Control Panel and the carrier shall not leave the dispatching station. The liquid crystal display shall separately indicate one of the following system conditions in English language:

1. Non-existing station selected.
2. Station filled to capacity.
3. Selected station shut down.
4. Station/system malfunction.

C. Malfunction: If the intended receiving station malfunctions after carrier is in transit, the carrier shall be: returned to sender or, if in the receiving loop, deliver at the nearest station, go into alarm condition and print out receiving station. All carriers in transit at time of power failure or turn-off shall continue to their selected destination upon restoration of power. System shall not contain any designated reject station. Should the malfunction be self-corrected internally, the computer will automatically cancel the alarm and not require manual restart.

D. Release: Carriers may be simultaneously positioned in any or all station dispatchers and destination selection encoded into each station control panel. Carriers shall then be released from the dispatchers in a variable sequence by the control program of the computer, which shall assure the maximum operating efficiency of the system.

E. Program: PTS shall be provided with standard operating program that treats all stations on an equal priority basis. Once the system has been in operation, analysis of the activities (print out) may indicate that certain stations require priority of dispatching or receiving. Such priorities may then be incorporated through the keyboard with capabilities of separate dispatch and receive priorities which are time adjustable through the computer time clock.
F. Empty Carriers: System shall be provided with the capability which permits automatic
distribution of empty carriers. The system shall be programmed with a predetermined
quantity of carriers assigned to each station. The quantity shall be maintained by the
computer when empty carriers are dispatched into the system through the empty code.
The empty carrier shall travel to the nearest station below quota with priority given to
those stations farthest below quota. An arriving empty carrier shall not actuate any signal
device at the receiving station.

G. Carrier Forwarding: It shall be possible to assign a secondary destination for any
shutdown or disabled station through the keyboard. This attribute will allow for continuity
of operation by automatically selecting a 24 hour function transfer, e.g. Main Pharmacy
will become the forwarding station when other Pharmacy stations are shut down.

H. Priority Dispatch: PTS shall be provided with a priority scheme that allows certain
transactions to enter the system ahead of others. Each station shall have an assigned
dispatch priority level which is based on projected needs. This feature is adjustable
through the computer keyboard.

I. STAT Dispatch: Local feature at the station level that overrides the central computer’s
priority scheme. If the need for a STAT transaction is required, the sender may enter her
authorization code to enter the dispatch. A STAT dispatch always has the highest priority
level.

J. Secured Transaction: Allows the dispatching station to enter an assigned code prior to
dispatching a carrier into the network. When the carrier arrives at its destination, it will be
held on the slidegate until an assigned security code is entered whereupon the carrier will
drop into the receiver.

K. CRT Tracking: Displays, records and monitors all system transactions and traffic flow.
The transaction printouts shall depict both send/receive times and wait times while carrier
is in queue. The trace capability will use a visual display to determine carrier routing and
fault location in event of component/system failure. Each carrier in the system shall be
identified by origin and destination as it passes through each intermediate diverter,
interzone diverter and arrival at station.

L. Air Power Unit (APU): Each APU, for energy conservation, shall automatically turn off
during periods of non-usage.

M. Automatic Station Shutdown: will be provided for each station on the network. This
feature automatically turns the send and/or receive function of each station on/off at
predetermined time for each day of the week.

N. System Management Reporting: is based on storing specified information in a data base.
The CCC shall be capable of storing all P.T. transactions including, but not limited to
hangtime, dispatch and arrival times, alarm conditions and duty cycles of all mechanical
equipment to a log file. Software shall be capable of downloading the log file to either a
magnetic tape, hard disk or a floppy disk in individual file sizes not greater than 320,000
bytes. Downloaded files shall be in a format that can be readily imported for use by
standard software packages such as Microsoft Excel, etc. The manufacturer may use his
own system software to produce Management Reporting in addition to downloading of
files. Management Reporting is defined as the ability to printout reports summarizing/quantifying interzone, interstation send/receive transactions depicting peaks
including 15, 60, 240 minute and 24 hour intervals. These printouts shall indicate rank
order of the stations being evaluated. Also reports shall depict, at a minimum, alarm
summaries, equipment malfunctions and maintenance schedules based on malfunctions as well as periodic maintenance.

2.03 RUNNING MATERIAL

A. Transmission tubing and bends: 4" galvanized, steel tubing especially manufactured for PTS systems. Bends shall be formed into a minimum radius of 48". Air lines shall be the same material and size as tubing specified. All joints shall be made with a sleeve or bell connection and sealed air tight with a mastic and vinyl tape. Joints occurring out of doors shall be welded air and water tight.

B. Hanging material: hangers shall be spaced not more than 12’ on centers. Each bend shall be supported by two hangers on each end. Individual galvanized clamps or row clamps with plated rods shall be screwed into appropriate anchors. Vertical tubing shall be supported at each floor level. Sway bracing shall be installed where required. Diversers shall be supported at four (4) points and side braced when hanger length is greater than 12". All hangers shall meet seismic requirements.

C. Diversers/transfer units shall be silent operating electro/mechanical devices and shall be valveless. Each unit shall be designed into a sheet metal enclosure with removable access panels fastened with Zeuss type fasteners; or keyhole type with captive machine screw. Sleeve connections to the tubing shall be made with bolted split sleeves. The motor shall be fused or otherwise protected from seizing due to obstructions.

D. Markings: All transmission and air lines shall be marked (stenciled) with identification decals not less than 2" high to denote both trunk and branch. Distance between decals shall not be greater than 30’ with decals also installed on each tube at the diverter locations. All diversers shall be similarly labeled and clearly visible when accessed. The as-built drawings, riser diagrams, and manuals shall indicate graphically all equipment locations in accordance with the identification decals.

2.04 CARRIERS

A. Acceptable Manufacturers:

1. Goldston Red Latch Carriers, or equal. Shall be side opening type capable of being dispatched either end first and preclude dispatching unless properly closed. Riding bands shall preclude fishtailing.

B. Payload portion: constructed of transparent plastic or one side transparent and one side opaque. Riding bands shall be of sound absorbing material and readily replaceable.

C. Quantities:

1. Two hundred fifty (250) carriers of manufacturer's standard design and be able to convey x-ray films rolled to 14-1/2" long.

2. Forty (40) inserts for carrying lab specimens. Unit shall be capable of carrying 10 vacutainers.

3. Fifty (50) inserts for carrying Central Supply items.

4. Fifty (50) inserts for carrying Pharmacy items. Carrier shall be capable of carrying a 1-litre IV bag with additive.
D. Carrier Serial Numbers: each carrier shall have a serial number clearly indicated for purpose of control by maintenance.

2.05 STATION EQUIPMENT

A. Materials

1. Terminals shall consist of a self-supporting “rough-in” enclosure sound deadened with a sheet form AQUAPLAS DS-125, or equal, no known equal.

B. Appurtenances and Finish:

1. Various operating and decorative components are added after the adjacent walls have been finished and located where shown on the drawings. The receive bin shall be capable of receiving/storing a minimum of 3 carriers prior to overload shutdown.

2. The carrier storage compartment shall be integral with the station and provide storage for a minimum of 3 carriers.

3. Sheet metal surfaces shall be factory painted with a polyurethane/polyvinyl scuff resistant finish. Finish trim frame for stations mounted flush in finished wall shall be manufacturers approved standard. Submit details and finishes for approval prior to installation.

4. Load shelf shall be integral and easily fold down when use not required.

C. Control Panels:

1. Each station shall be equipped with a modular designed control panel which can be interchanged with any other panel. All circuitry will be on a removable printed circuit board. The panel shall be hinged and key operated to obtain access. The panel will provide necessary encoding devices for the operator/systems interface which shall translate the operator’s inputs to system signals and provide transaction status indicators.

2. Major Controls Indicators contained on the panel shall be:

   a. Operating instructions.

   b. 2 Keypad for destination encoding.

   c. 48 character (minimum) LCD for indicating status of stations/system.

   d. Carrier receive/arrival light (may be mounted separately).

   e. Dispatch enter button.

   f. Cancel/clear button.

   g. Five or more special destination keys labeled in English indicating, e.g. “Lab”, “Rx”, etc.

   h. Audible enunciator as described for PRI.
i. Station directories (may be mounted separately).

D. Remote Destination Signaling:

1. Certain stations shall have multiple designations for purposes of signaling a particular department/area for which an arriving carrier is intended. The remote signal shall be activated by the arrival of its carrier and shall cause a flashing light to illuminate and continue flashing until such time as the operator depresses his designation cancel switch at the station which shall cancel only his designation. Locations are indicated elsewhere.

2.06 SYSTEM CONTROL & SUPERVISORY FUNCTIONS

A. The PTS shall be supervised by an integrated electronic network which shall be centrally controlled through a personal computer (CCC) with alpha/numeric and graphic displays. The CCC shall include not less than the following:

1. PC type computer with 233MHz Pentium based microprocessor, 1 gigabyte cache RAM, 40 gigabyte hard drive, 3.5" 1.44 Mbyte diskette drive, 1 quad CD Rom, 1 28.8K bps phone modem all mounted in a minitower.

2. 17" flat panel LCD monitor, enhanced PC/AT 101 key keyboard and mouse.

3. Inkjet printer with minimum 600 x 600 dpi and continuous roll feed.

4. Uninterruptable power supply with 15 minute battery backup.

B. Portable computer with modem, for remote operation of the System; fully compatible with the CCC.

1. Acceptable manufacturer: Toshiba, Satellite 100CS, or equal.

C. The CCC shall provide operational functions and system management information for efficient system operation and monitoring. All user and system configuration programming shall be entered through the keyboard.

1. Functions which shall be provided in the program are:

   a. Logic to provide all system control functions.

   b. Logic to provide Monitor/Recorder functions.

   c. Logic for diagnostic/fault locating cap-abilities.

   d. Detect alarm conditions.

   e. Station shut-down allowing stations to be automatically shut down at specific times and returned to service at specific times. Changes will be made through the keyboard and "real" time clock.

   f. Transaction counts for stations, loops, and system. System counts shall be recorded hourly on the printer with stations and loops printed at midnight.
g. Automatic “Empty Carrier” redistribution with quantities altered through the keyboard.

h. Carrier forwarding.

i. Maintenance code access with three discrete levels of entry.

j. Priority send/receive with parameters altered through the keyboard.

D. Monitor/Recorder:

1. Display, record and monitor all system transactions and traffic flow. The transaction printouts shall depict both send and receive times. The printout of all system transactions shall be capable of being turned off and printed on demand through keyboard.

2. Trace capability with visual display to determine carrier routing and fault location in event of component/system failure. Each carrier in system shall be identified by origin and destination as it passes through each intermediate diverter, interzone diveters, and arrival at station. Display dispatch and arrival times.

3. Operate system in a semi-automatic mode via keyboard entry of the program commands for maintenance operations.

4. Automatically print out the nature of any alarm condition including time of occurrence, probable cause, component malfunction, location of malfunction, and printout alarms which are automatically canceled.

5. Display station status indicating on-line, filled to capacity, or non-existing.

6. Display all stations shutdown and time segments assigned on a single display.

7. Display all carriers assigned and available at each station on a single display.

8. Display active stations with cumulative transaction counts on a single display.

9. Display station status for send/receive priorities on a single display.

E. Priority Program: shall provide the capability of altering station and/or loop priorities through the keyboard. Each station shall have both send and receive priorities with different time frames for each 24-hour period and for each 7-day period.

F. Maintenance Program:

1. Access any loop which is in the off position. Other loops shall continue to operate normally when maintenance program is being used for one or more loops.

2. Through keyboard, set or reset electro-mechanical or pneumatic devices which are under computer control and/or stations and manually cycle all components of loop/station at required intervals and analyze operations.

G. CPU shall be protected by a constant voltage transformer which will prevent loss of program due to line spikes, supply current fluctuation or low voltage and have a self-contained uninterruptable power supply.
2.07 POWER UNIT PACKAGE

A. One power unit (APU) of the regenerative type shall be provided for each zone to generate sufficient air pressure/vacuum and CFM to maintain an average fully loaded carrier velocity of 25 fps and shall run only on demand.

1. Acceptable Manufacturers: Rotron Model No. DR707D89X; FUJI Model No. VFC704A-7W, or equal.

B. Vibration and Sound Control: Provide, if required, vibration eliminating bases to permit not more than 10% of the vibrations to be transmitted into the structure. Provide each power unit with an intake/exhaust sound attenuator which shall have characteristics to effect a noise reduction down to a range from 70 to 75 decibels when measured 5' from the outlet and 45 off center. A sound enclosure shall be installed, if required, to meet this dB level.

2.08 SOUND CONTROL

A. It is the responsibility of the Contractor to maintain clearances from other systems including partition studs, building systems, and other devices wherever sound would be transmitted through physical contact.

B. All new horizontal tube runs not in mechanical rooms shall be isolated from the clamps with dampeners.


C. All station rough-in frames, supports and receive bins shall have applied sound dampening sheet. The station will be isolated from the floor through use of waffle/Isomode pads.


D. The described treatment for sound control is based on normal noise emanation from pneumatic tube lines and equipment. The Contractor will perform what additional treatment is necessary such that the noises created by his system will not be greater than 10 dBA above ambient level.

E. If tube runs occur over sensitive/patient rooms which require sound wrap, it shall be wrapped with 1-½ x 1-½ glass fibre insulation with an overwrap of 1 lb. Acoustilead and taped joints and wired. Dampener sheet form with adhesive backing and overlap joints is an acceptable substitute for glass fibre and lead.


2.09 SMOKE/FIRE DETECTION

A. The exhaust air line that each APU shall be fitted with a smoke detector which will cause that zone to shut down if any smoke enters the line at any location within that zone and is detected at the APU. The zone shutdown shall immediately place the system into alarm and indicate on the System Control Center.
B. A set of isolated electrical contacts shall be provided with each APU smoke detector for future connection to the facilities Fire Alarm Monitoring System.

PART III - EXECUTION

3.01 INSPECTION

A. Prior to beginning the installation of equipment, examine the site and verify that no irregularities exist that would affect quality of execution of work as specified. Do not proceed until irregularities are corrected and approval is received from the University's Representative.

3.02 INSTALLATION

A. The Contractor shall install the equipment in a workmanship manner according to the best practices and codes governing this type of installation.

1. Cut all ends of tubing square, file and mandrel when cutting tube. All transmission lines will be installed with flash on top.

2. No compound offsets will be allowed without 12" of straight between. All bends and offsets will have a new production carrier passed through prior to installation or closure of walls and ceilings.

B. The Contractor shall organize his work and maintain orderly/clean conditions relating to the installation. At final completion of installation work all equipment shall be cleaned, refinished as required and be delivered in perfect and unblemished condition to the University.

3.03 FIELD QUALITY CONTROL & ADJUSTMENTS

A. Upon completion of installation, the Contractor shall provide all personnel and devices required for adjusting, and preoperational testing of the system. This testing shall be completed prior to presenting the system to the University's Representative for acceptance.

B. Each station on the system shall simultaneously and randomly dispatch a carrier to every other system station until all dispatches/receives are complete; “simultaneous” for purposes of this test is construed to mean an interval not over 5 minutes between the time a carrier leaves the dispatcher and another carrier is entered into the dispatch sequence. Number of transactions to accomplish total test, start/completion time, number of transactions, and summary/number of malfunctions/ alarms shall be recorded.

C. The system will be considered ready for acceptance testing when the total number of mechanical/electrical failures due to equipment mal-function does not exceed ½%.

D. The Contractor shall furnish all personnel required for the testing and present the printouts indicating the error ratio is within the range described.
3.04 TESTING AND FINAL ACCEPTANCE

A. Final testing for acceptance shall not begin until printouts from preoperational testing demonstrate that malfunctions do not exceed one half of one percent (0.5%) of the number of transactions required to conduct such tests. Prior to scheduling acceptance testing, the Contractor shall submit for approval, a detailed plan describing how each Operational Criteria as specified shall be demonstrated.

B. Workmanship and equipment shall then be examined by the University and the University's Representative prior to conducting the operational test. Any deficiencies will be corrected before performing the test.

C. The Testing for Final Acceptance shall consist of 2 phases. The first phase (Phase I) is the actual test described in 3.4.D, performed in presence of the University's Representative and for compliance with the contract documents. The second phase (Phase II) is a successful performance during a monitoring period described in 3.4.E.

D. The following Phase I requirements shall have been satisfactorily completed, without limitations:

1. Criteria as described under Article 2.3 "System Operation" are met.
2. Verification of satisfactory performance related to the proper functioning of the following but not limited to:
   a. Dispatch/receive sequence.
   b. Central Controls/CRT Printer.
   c. Deliberate interruption and synthesizing of malfunctions to test safety features, all alarm conditions, and system monitoring including tracking capabilities.
   d. Test carriers shall be inspected for nicks, cuts, and other marks which indicate a faulty installation.
   e. Sound controls.

E. The following Phase II requirements shall have been satisfactorily completed, without limitations:

1. When reliability of the system has been demonstrated for a period of 30 consecutive days of operation (after beneficial occupancy by the University) in which the total mechanical/ electrical failures due to equipment malfunction do not exceed one for every thousand transactions and the total downtime due to equipment malfunction does not exceed one hour in every thousand operating hours for the number of stations in the system, or both. The University's maintenance will log all malfunctions which appear on the printer, their cause, and what corrective measures were taken to place the system back on-line. Malfunctions/alarms not properly logged will not be charged against the total. Malfunctions occurring due to improper use of the equipment by operating personnel will not be considered a malfunction chargeable to the 30-day demonstration period.
2. The application for final payment may be submitted after Reliability has been demonstrated. The guarantee will begin concurrently with the 30 consecutive day demonstration period which meets the defined demonstration period.

3.05 TRAINING AND MAINTENANCE

A. Related Requirements:

1. Division 1, Section 01780 – CLOSEOUT SUBMITTALS

B. Training: The University's Representative shall be notified two weeks prior for appointment of representative(s) to be instructed in the proper operation and maintenance of the equipment.

1. Operational Training: The System Contractor shall perform a minimum of 40 hours training. This training program shall be accomplished at both the completion of Tower I and at the completion of Tower II. It shall be broken into several segments such that Users have been instructed in the use and operation of the system. Initial System training shall be done in a Classroom environment using a commercially prepared video describing the System, its capabilities and how to use the System. Included will be a review of information and standards regarding regulation of OSHA, CDC, etc. for safe transport of hazardous materials. A preprinted handout describing the protocol will be furnished to each attendee. Development of this protocol will be done with the assistance of the University's Representative. This training shall be done for 3 groups. Following the completion of this Classroom training session, individual instruction will be given at each tube station and will be coordinated with the University's Representative such that all shifts are covered.

2. Maintenance Training: Ten days prior to system start-up the System Contractor shall perform 32 hours of training which shall be broken into two segments. The first segment shall consist of 16 hours to be performed in a Classroom environment which shall consist of on-the-job type training with actual components being used and the maintenance manual being used as a guide. To insure all maintenance personnel assigned by the University's Representative receive training, the 16 hours will be segmented to cover all shifts. The second segment consisting of 16 hours will occur during the first 15 days of operation after start-up and will be scheduled with the University's Representative.

3. The System Contractor will spend a minimum of 20 working days observing the system in operation. This 15 days will be broken into two periods, the first 15-day period will occur after start of operation for Tower I and 5 days after start of operation of Tower II. The System Contractor will not leave the site until the system has run without failure for (3) consecutive days of operation for each Tower. This is construed to mean the last (3) days after the 15-day period for Tower I and the 5-day period for Tower II.

C. Breakdown Maintenance: The University's Representative will assume responsibility for system or any part thereof from the time that portion is placed in operation and the Reliability period as defined is met.

D. Preventative Maintenance: The System Contractor will provide inspection and maintenance on all equipment for a period of one year after operation and acceptance of the system.
1. This service will consist of one 8-hour day (during regular working hours) each month at a time agreeable to both the University's Representative and the System Contractor. This period shall also be used as a continuing education program in maintenance.

END OF SECTION 14580