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Modernization of Existing Underground Heat Distribution Systems

Guidance for Manhole Rehabilitation in Army Underground Heat Distribution Systems

by
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Field inspections at many military installations have shown that deterioration of components in manholes is one of the main reasons for loss of efficiency and lowered service life of underground heat distribution systems. Periodic inspections and repairs are therefore considered essential for ensuring reliable, economic system operation. However, no guidance has previously been available specifically addressing manhole inspection and remedial action.

To provide this guidance, the U.S. Army Construction Engineering Research Laboratory (USACERL) has developed step-by-step instructions intended to help facilities engineers perform effective inspections and determine what repair work should be scheduled. Information includes guidance for conducting a typical inspection, with a standard checklist provided for field use; sampling procedures required to meet current regulations when asbestos-bearing insulation may be present; and for preparing contract documents to procure the repair work.

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FOREWORD

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GUIDANCE FOR MANHOLE REHABILITATION IN ARMY UNDERGROUND HEAT DISTRIBUTION SYSTEMS

1 INTRODUCTION

Background

Over the past 20 years, most underground heat distribution systems for Army facilities have used steam or high-temperature water (HTW) as the heating medium (nominal 100 psi* for steam and 400 °F for HTW). During this period, conduits for these systems were required to be prefabricated and designed for pressure testing, drainage, and drying capability due to flooding of the annulus between the conduit and carrier pipe (commonly designated as Class A type). For these systems, manholes were required to be installed at vertical changes in direction, at valves and takeoffs, and along straight runs at distances not to exceed 500 ft.

The condition of manholes and their internal components is critical to maintaining reliability, efficiency, and longevity of the system. However, most operations and maintenance (O&M) programs ignore regular inspection and maintenance of manholes; instead, the tendency is to wait until a component fails and then repair the damage. This practice is not cost-effective because allowing certain components to deteriorate to the point of failure can, in some cases, damage other parts of the system, requiring expensive replacement or repair at some point.

To facilitate manhole inspections, installations need guidance for evaluating manhole internals and determining what repair work should be scheduled. Depending on whether the repairs will be contracted outside or performed by in-house staff, guidance also is needed for developing a repair plan.

A factor complicating many inspections is the potential presence of asbestos-bearing materials in the conduit insulation. Due to the health hazards associated with asbestos, both the physical work environment and the type of renovation required are regulated closely by Federal agencies. Thus, the Directorate of Engineering and Housing (DEH) also needs guidance for dealing with manholes suspected of containing asbestos materials in accordance with Federal legislation.

Objective

The objective of this work is to provide installation DEHs with guidance for (1) performing a typical inspection of underground heat distribution system manholes, (2) inspecting and specifying remedial action for manholes suspected of having asbestos-containing insulation, and (3) preparing contract documents to procure repair work.

*A metric conversation table is shown on page 39.

Approach

Guidance was developed by interviewing experts in the field (Government and private sector) who have established effective manhole inspection and maintenance programs. In addition, applicable Army criteria documents were consulted to ensure the guidance would be in accordance with regulations for the different areas of inspection and repair. Similarly, Federal legislation pertaining to asbestos handling was reviewed.

All information was analyzed and that considered most beneficial to the DEH combined to form comprehensive, step-by-step guidance.

Scope

This information was developed specifically for Class A conduit systems. However, due to the similarity in manhole designs, much of the guidance could apply to other conduit system classes.

Mode of Technology Transfer

Information collected in this study will impact the revision of Naval Facilities Engineering Command Guide Specification (NFGS) 02694B, *Underground Heat Distribution Systems (Prefabricated Type)*, August 1989; Engineering Technical letter 88-6, *Heat Distribution Systems Outside of Buildings*; and Corps of Engineers Guide Specification (CEGS) 15709, *Heat Distribution Systems Outside of Buildings - Shallow Trench Systems.*

2 THE CLASS A CONDUIT SYSTEM

Overview

Before attempting a physical inspection of manholes, the inspector should be aware of the Class A conduit system design features. Although several manufacturers supplied these systems, the same general design was used. Conduit runs between manholes consist of heat-carrying pipes covered with insulation, encased in a coated steel or nonmetallic conduit casing, with an approximate 1-in. air space between the insulation and the inner surface of the casing. Heat-carrying pipes are usually in individual casings (Figure 1) but may be a dual-pipe casing design (Figure 2).

The conduit casing is terminated inside manholes and building entries with a steel endplate containing a drain plug and a vent pipe (Figure 3).

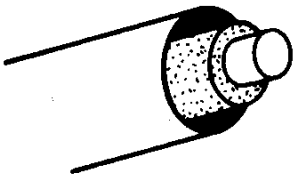

Figure 1. Single-pipe conduit.

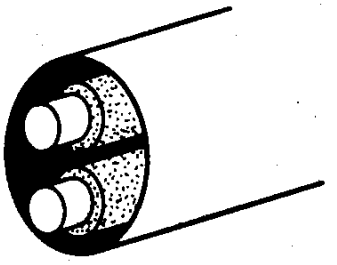

Figure 2. Dual-pipe conduit.

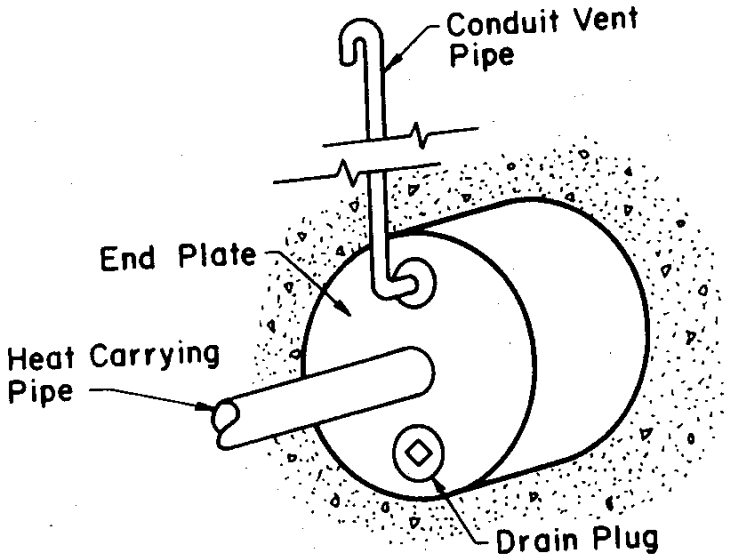

Figure 3. Conduit termination in manhole.

System Components

The Class A conduit system consists of several standard components. These components and their design features are described below. Step-by-step guidance for conducting an inspection is given in Chapter 3.

Piping

Steam and hot water piping is schedule 40, whereas condensate lines are schedule 80 to provide additional protection against internal corrosion. Recently installed systems may contain fiberglass reinforced plastic (FRP) condensate return lines.

Insulation

Insulation was, for many years, restricted to calcium silicate because of its ability to retain its physical structure and thermal conductivity after being boiled for a considerable period as would be the case if water entered the conduit system. Recently, other insulation materials have also been approved.

Conduit Pipe Supports

Supports are spaced at about 10-ft centers inside the casing and serve to center the piping and insulation within the conduit. Supports are designed to limit heat transfer from the inner pipe to the casing. They contain openings to permit drainage of water through the conduit to the conduit drain on the endplate in the manhole.

Air Space

The air space serves several functions:

1. In the event of an internal pipe leak or entry of groundwater into the casing, the air space permits free flow of steam generated to the vents in the manholes, thus preventing a major pressure buildup within the conduit.

2. Permits free drainage of water that may have accumulated inside the conduit casing.

3. Allows the conduit casing to be pressure-tested to ensure casing integrity during installation and later, when repairs are necessary.

4. Allows for even flow of air through the conduit when drying insulation which, for any reason, may have become wet.

Conduit Casing

The casing provides physical protection of heat-carrying pipes and insulation. Waterproof coating is provided on outer surface of steel casings to protect against corrosion. These systems may consist of steel or fiberglass casings.

Conduit Endplate

Endplates are welded onto conduits after entry into manholes and buildings. Endplates serve to:

1. Prevent backup of water from flooded manholes into the conduit.

2. Seal conduit runs to permit conduit pressure testing (15 psi to demonstrate conduit soundness).

Conduit Drains

This feature is used to drain water that may have entered conduit through a damaged casing or because of a leaking heat-carrying pipe. The opening should be plugged or capped during normal operation to prevent possible backup of water into the conduit from a flooded manhole. This opening can also be used as a compressor connection for pressure testing or drying insulation.

Conduit Vents

These vents serve to:

1. Alert maintenance personnel of problems in the conduit runs when steaming from the vents is observed.

2. Prevent excessive buildup of pressure in the conduit.

3. Provide a compressor connection for pressure testing or drying insulation.

Other Design Features

Generally, manholes include the following design features:

1. Spacing does not exceed 500 ft to minimize burial depth and simplify leak location.

2. Conduit is sloped a minimum of 1 in. per 40 ft to allow drainage of the casing and the heat-carrying pipe.

3. All contain a sump pump or gravity drain.

4. Larger manholes are fabricated from reinforced concrete whereas smaller ones may be constructed of prefabricated steel. Cathodic protection on interior and exterior surfaces of metallic manholes may be required.

5. Whenever possible, system expansion is accommodated through the use of expansion loops or bends in conduit runs rather than by expansion devices in manholes.

3 INSPECTIONS WHERE ASBESTOS MAY BE PRESENT

Installation Responsibility

Public recognition of the potential health hazards associated with exposure to asbestos fibers has resulted in numerous Federal, State, and local regulations regarding the safe handling of asbestos-containing materials. It is essential that the DEH determine to what extent these regulations apply for each specific project.

When inspecting manholes or doing remedial work, the probability of exposure to asbestos fibers is very high due to the types of pipe insulation used in the past. Prior to 1960, magnesium carbonate and mineral wool insulations were commonly used, both of which contain 15 percent and higher asbestos fibers. From 1960 to 1971, calcium silicate insulation was required exclusively for pipe insulation in manholes on Army installations. However, this material also contained some 6 to 15 percent asbestos fibers. It was not until after 1970 that manufacturers began providing calcium silicate insulation without asbestos. Other currently acceptable materials for pipe insulation are also free of asbestos. It may be fairly safe to assume, therefore, that systems installed after 1972 should be free of asbestos and that manhole inspection and maintenance can proceed at no risk to personnel from this material. However, insulation in all systems built prior to 1972 should be tested.

In most systems, standard requirements for installing insulation in manholes included providing a heavy waterproofing membrane over the exterior surface of the insulating material. This membrane was usually either asphalt or bitumen. In addition, the entire assembly was then covered with an aluminum sheet metal material. When this system is installed properly and is in good condition, the asbestos fibers are well contained and entry into the manhole is safe for both inspection and remedial work. Often, however, the coverings will be found to be damaged, usually due to boiling action of water in a flooded manhole, workers walking on the insulation, or failure to replace the insulation and coatings properly after doing repair work. In these cases, manholes containing asbestos-bearing insulation should not be entered until proper protective measures are taken.

Standards, rules, regulations, and procedures have been promulgated regarding asbestos by the Occupational Safety and Health Administration (OSHA), the U.S. Environmental Protection Agency (USEPA), the Department of Defense (DOD), and state, regional, and local entities. As more is learned about the effects of asbestos, these bodies are continuing to revise and refine their requirements. Since it is not reasonable to assume that the DEH could monitor and keep abreast of the latest regulations, installation commanders have been required to establish a Facility Asbestos Management Program headed by a team of managers knowledgeable in asbestos-related requirements. It is intended that this team consist of personnel from the following areas of responsibility: DEH, preventive maintenance, safety, environmental, judge's advocate, public affairs, civilian personnel, landfill operations, industrial operations, and union representation. Each of these team members should receive formal training in asbestos management and should be available for advice and information regarding any specific project at the facility. Where such a team has not yet been organized, the installation safety and environmental offices should be contacted when information is needed.

Inspection and Sampling Procedures

In developing the manhole maintenance project, the following procedures should be followed.

1. Determine the Date of Distribution System Installation

Manholes installed after 1972 can be assumed to be free of asbestos whereas those constructed prior to that date should be considered highly suspect. If a date cannot be established, or any question arises regarding the age of the pipe insulation, it should initially be assumed that the manhole contains asbestos.

2. Make a Cursory Inspection of Manholes if Asbestos Is Suspected

This step will involve making an observation of manhole internals from outside the manholes. Internals are easily observable in manholes topped with open grates, whereas closed manholes will require cover removal and the use of a strong-beamed flashlight. Notation should be made of manholes where damage to the insulation coatings and/or aluminum casings is found. This data will have a bearing on whether asbestos repair work is done in-house or by contract.

3. Take Insulation Samples

It is virtually impossible to positively identify asbestos material by field inspection alone. It will therefore be necessary to take samples for qualitative laboratory analysis. Usually, a few samples from any distribution system are adequate for verification of asbestos contamination. To reduce exposure to personnel, samples should be taken from manholes where the cursory inspection has shown only minimal damage.

Care should be taken to ensure that the person doing the sampling is fully apprised of all hazards, relevant symptoms, and proper conditions and precautions concerning the use of or exposure to asbestos. The extent of instruction necessary should be coordinated with the installation office responsible for personnel safety.

A sampling kit should be assembled consisting of the following:

- Plastic squeeze bottle containing water and a wetting agent. When empty, this bottle should be refilled with a 5 percent soap solution.
- Plastic containers with snap caps or any durable (unbreakable) container suitable for mailing with a secure top (such as a 35-mm film container).
- Tweezers and wooden sticks as aids for taking a sample if the container cannot be easily penetrated into the insulation.
- Container labels for identifying sampling location.
- Paper towels for wiping containers clean.
- Tape for sealing containers.
- Disposable plastic gloves for hand protection.

- Plastic bags for disposal of excess debris and used protective equipment.
- Protective eyewear.
- Disposable coveralls (sack suits, preferably).
- Disposable drop cloth.

Before entering the manhole, the sampler must don a properly fitted disposable or reusable respirator approved for protection against exposure to asbestos. Industrial hygiene personnel can recommend an approved respirator and it may be obtained from the local safety office. In addition, the sampler must wear disposable plastic gloves (impervious to asbestos), suitable protective eyewear, and disposable coveralls/headcover (sack suit). A disposable drop cloth should be used under the sampling area to prevent contamination of workspace from insulation material which might be loosened during sampling. The sampling procedure is outlined below.

Wetting. Spray the sampling area with liquid from the squeeze bottle. The immediate area (half-dollar size) should be thoroughly wet to reduce fiber release during sampling.

Penetration. Try to penetrate the insulation with a firm twisting motion of the container. If the container will not easily penetrate the insulation, obtain a sample by using the tweezers or wooden stick. Obtain a full core sample to the surface of the metal pipe. After filling the container, wipe it with a damp paper towel to remove material from the outside and to prevent possible contamination.

Prepare Envelope and Sample Container for Mailing. Write all appropriate information on the envelope and container as follows:

1. Sample identification number.
2. Manhole number.
3. Inspection date.
4. Name of person taking sample.

Seal the filled sample container around the cap with tape to ensure that contamination or loss of sample materials does not occur during mailing or handling.

Properly Dispose of Sampling Equipment. If tweezers are used, wipe with a damp paper towel. Tweezers must be thoroughly decontaminated to prevent cross-contamination of samples. If a wooden stick is used, discard it in the plastic bag provided in the kit. Disposable coveralls, single-use respirator, and plastic gloves should also be discarded in the plastic bag. If a cartridge-type respirator is used, it should be cleaned for reuse as prescribed by the local safety office. The disposable drop cloth should be misted with a solution of water plus a wetting agent, carefully folded onto itself, and disposed of with the other asbestos-contaminated items.

4. Have Samples Analyzed

The bulk samples obtained should be forwarded to a laboratory for qualitative evaluation to determine the presence, type, and amount of asbestos within a sample. The USEPA Regional Asbestos Coordinator has a current list of laboratories equipped to analyze bulk samples. The laboratory should be a participant in the National Institute for Occupational Safety and Health (NIOSH) Proficiency Analytical Testing Program for asbestos analysis and in the USEPA Bulk Sample Quality Assurance Program headquartered at Research Triangle Park, NC. Laboratory selection should be coordinated with the Asbestos Management Team at the facility.

If the bulk sample analysis indicates that no asbestos is present, the inspector can proceed to check the condition of manhole internals with no special asbestos-related precautions. However, if asbestos is found, it will be necessary to check each manhole in detail using techniques similar to those required for taking samples. If at all possible, the person checking for asbestos-related damage should also be capable of evaluating the other manhole internals, thus avoiding duplication of effort. Experience indicates that, in most manholes, the bitumastic or asphaltic coating and the aluminum casing will be in good condition so that the asbestos fibers are confined and present no problem. In other instances, where damage is found, it will usually be confined to small areas of 12 to 18 in. along the piping or at valves and fittings. Occasionally, however, manholes will be found where insulation deterioration is extensive, primarily due to long-term, continuous flooding.

Repair of Asbestos-Bearing Manholes

Essentially, three types of repair will be required for asbestos-bearing insulation in manholes:

1. Where damage is primarily limited to the aluminum covering and the coating material but the underlying insulation is still sound or only minimally eroded. This repair would consist of applying a heavy coating to match the existing one and installing a new aluminum casing.

2. Where damage has extended well into the insulation, or where parts of the insulation have fallen off, and where small sections of the piping are bare. This condition will require cutting portions of the insulation, reinsulating, coating, and covering to match the existing system.

3. Where large sections of the insulation are exposed and deteriorated due to protracted flooding within the manhole. This repair will require complete removal of the insulation and replacement with asbestos-free material.

The inspection report should specifically locate the problems in each manhole and designate the type of repair needed.

In most jurisdictions, the contractor or the DEH will be required to submit for approval to regulatory agencies a plan indicating in detail the steps to be taken in remedial asbestos-related work. The two methods of operation described below will generally be adequate for work in manholes.

Small Pipe Section Removal or Encapsulation (Localized Shroud Method)

This method should be used for small sections of insulation (up to 24 in. long) to ensure that gloves or special clothing are not required for the worker or to ensure that a high-efficiency particulate air (HEPA) vacuum is not required for cleanup.

1. Sealing or encapsulating insulation which is sound but where the covering and coating have been damaged, leaving the insulation exposed.

2. Removing damaged insulation and encapsulating exposed ends to permit easy replacement.

This process can be done by one fully trained and equipped employee.

The work consists of using a plastic sheet of at least 6 mil (0.006 in.) thickness to completely surround the pipe section. The ends and sides of the sheet are pulled together and sealed with double-sided tape. Two slits are made in the shroud just large enough to allow the worker to place his/her hands within the plastic. Commercially available shrouds of this type have armholes, an inside pouch for tools, and a side port to allow access for wetting the asbestos or evacuating the bag with a HEPA-filtered vacuum.

The employee must wear an approved respirator during all work as well as during personal and worksite decontamination procedures. This individual must reach inside the shroud through slits in the plastic to do the required work. Before and during asbestos removal, the employee should spray the insulation with a hand-held spray bottle containing water and an effective surfactant. The asbestos, once removed from the pipe, will remain in the shroud.

After the sealing or encapsulation of all exposed insulation, the employee will carefully withdraw his/her hands from the shroud and seal the openings with duct tape. The localized shroud will be removed carefully from the pipe and placed in the plastic bag for asbestos waste which, in turn, will be placed in an asbestos waste container.

The employee must first vacuum and then wet-wipe all exterior surfaces to decontaminate the area. At completion of the work, the employee must then vacuum and wet-wipe his/her hands and arms.

Complete Removal of Insulation (Wet Removal Method)

Workers must wear approved respirators, disposable head and shoe covers, coveralls (or a disposable sack suit), safety goggles, and protective gloves.

A containment structure (known as a shroud) must be made of framework supporting a layer of impermeable plastic (polyethylene sheeting). The frame should extend from the floor to the top of the manhole with the plastic on the inside of the frame. The plastic seams must be sealed with duct tape.

With the proper surfactant added to water in a pressurized container, using a misting or fogging nozzle, the worker must spray the asbestos-containing material before and continuously during the removal.

Upon removal of the asbestos material, it must be immediately placed in a plastic bag and sealed.

Proper cleanup is necessary after the asbestos removal operations. The employee must first use a special industrial-type vacuum cleaner equipped with high-efficiency particulate air filters to remove any remaining asbestos-containing material.

A minimum of two properly trained and equipped personnel must be present during this procedure. One employee will be responsible for applying a constant mist of water at the point of operation to contain loose asbestos fibers. Due to the possibility of a respirator failure, each employee in the shroud must carry an extra. The extra respirator can be worn around the neck under the head cover or kept in a sealed plastic bag inside the shroud.

Along with the above procedure, the contractor or DEH must furnish a statement to prove that:

1. Off-post disposal of asbestos materials is preferred and contracted with a permitted disposal firm meeting applicable Federal, State, and local regulations for the asbestos disposal or--

2. Asbestos materials will be disposed of at the installation in a permitted sanitary landfill designed, constructed, and operated under 40 CFR 241,[1] 40 CFR 257,[2] and applicable state and local regulations.

At some point, the DEH must determine if the asbestos-related work will be done in-house or by contractors. If it will be contracted, will it be by (1) a contractor who specializes in this type of work with a follow-on contract for the internals repair, or (2) a single contractor capable of doing both asbestos work and other required maintenance? Appendix A is a sample scope of work for preparing contracts. This sample should not be copied verbatim, but should be used as a general reference with regard to format and content. Often, changes will be required due to varying regional, state, and local regulations. Therefore, before attempting to develop a specific contract scope of work, the current safety, coordination, training, recordkeeping, and technical requirements of all involved agencies must be determined. Assistance in obtaining this information is available from the facility asbestos management team.

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[1]40 CFR 241, *Guidelines for the Land Disposal of Solid Wastes* (14 August 1974).
[2]40 CFR 257, *Criteria for Classification of Solid Waste Disposal Facilities and Practices* (13 September 1979).

4 INSPECTION OF MANHOLE INTERNALS

At many facilities, maintenance of manholes and their internals is performed only after obvious failure has occurred, and the repairs are completed at the point of failure in individual manholes rather than on a system-wide basis. It is characteristic of these systems that a minor, easily corrected deficiency in a manhole can cause major damage and loss of efficiency in the conduit runs for which replacement, in contrast, can be extremely expensive. Therefore, a manhole-by-manhole inspection should be performed for systems that have been operating for at least 5 years. The results of this relatively inexpensive survey and subsequent corrective action can produce major savings by maintaining system efficiency and extending service life. Based on this inspection, the DEH can determine what work should be done and if it should be contracted or performed by in-house personnel. If the decision is made to proceed by contract, the contract documents can be prepared by a private architect-engineer firm, the local USACE District design office, or the DEH staff. Appendix B contains a sample scope of work for preparing repair contracts.

Guidance in this chapter focuses on identification and correction of deficiencies in manhole equipment such as piping, valves, fittings, insulation, conduits, and sump pumps. Inspection of these items may be complicated by the presence of asbestos (see Chapter 3). In such cases, every effort should be made to combine the asbestos-related inspection with the internal equipment survey by using personnel knowledgeable in both fields. Chapter 3 provided guidance for inspecting asbestos-containing manholes.

Preliminary Steps

Before proceeding with the detailed inspection of manhole internals, the following general data should be obtained for inclusion in the inspection report:

1. A general thermal distribution map showing:
   - Manhole location and identification.
   - Boiler plant locations.
   - Distribution line sizes.
   - General indication of types of facilities being served such as barracks complexes, medical facilities, etc.
2. Boiler plant data:
   - Capacity of each plant.
   - Heating medium and operating temperatures and pressures.
   - Type of fuel.
   - Type, size, and capacity of individual boilers.

3. Age of the specific segments comprising the distribution system.

4. Any available data on soil characteristics, corrosivity, and water table elevations. U.S. Geological Survey (USGS) records will usually be helpful.

5. Maintenance history with particular emphasis on major or recurring problems.

6. Names of conduit manufacturers.

The inspection should be conducted manhole-by-manhole. The inspection team should consist of a minimum of two persons and, for safety, one person should remain outside the manhole at all times during the inspection. The following items have been found to be necessary or helpful during the inspection:

1. Manhole cover removal tool.
2. Heavy work gloves.
3. Flashlight.
4. Rust solvent.
5. Heavy wrench with pipe extension.
6. Knife with 4-in. blade.
7. Scraping tool and file.
8. Tape measure.
9. Voltmeter.
10. Portable sump pump.
11. Wire cutter.
12. Insertion and surface-type thermometers.

Figure 4 is a "Manhole Inspection Checklist" to be used as a guide to the inspection procedure and for noting specific repairs required. The next section, **Inspection Procedure**, briefly explains each checklist item. The checklist in Figure 4 should be reproduced and completed for each manhole inspected.

Inspection Procedure

The descriptions below pertain to numbered items in the Manhole Inspection Checklist (Figure 4). Sample notations are provided for some items to show how inspectors might complete the form.

Item 1: Manhole Number

Indicate the manhole identification number or other designation. Make sure your identification matches that on the heat distribution system drawings.

Item 2: Manhole Size

Indicate the internal dimensions and depth for concrete manholes. For cylindrical prefabricated steel manholes, indicate the internal diameter and depth. These dimensions are useful to the contractor in determining space available for accomplishing the necessary work.

MANHOLE INSPECTION CHECKLIST

1. Manhole no. _____
2. Manhole size (internal dimensions) ___' x ___' x ___' deep.
3. Manhole access -
4. Soil type and water table -
5. Manhole location -
6. Evidence of conduit failure between manholes -
7. Manhole type - _____
   If concrete, indicate wall thickness - _____ inches.
8. Condition of manhole construction -
9. Manhole ventilation -
10. Manhole drainage -
11. Evidence of flooding -
12. Debris in manhole -
13. Wall penetrations -

Figure 4. Manhole inspection checklist.

MANHOLE INSPECTION CHECKLIST (CONT'D)

14. Manhole ladder -

15. System piping in manholes -

16. Thermal insulation and covering -

17. Pipe supports -

18. Conduit endplates -

19. Conduit vents and drains -

20. Valves, traps, expansion joints and other auxiliaries -

21. Sump pumps -

22. Type of cathodic protection system

    - sacrificial

    - electrical isolation flanges/gaskets

Figure 4. (Cont'd).

Item 3: Manhole Access

Indicate whether the manhole has removable open grates, a solid steel plate, or a manhole cover. Figure 5 shows typical open-grate manholes. If it has a manhole cover, indicate the diameter. If the manhole is prefabricated steel with a completely removable top, state whether a lifting device is required. If a concrete tube extends from the grade to a completely buried manhole, indicate its diameter and length.

Item 4: Soil Type and Water Table

Note the soil type (i.e., sand, clay, or loam) and its percolation characteristics. Also note the height of the water table, if possible. This information is not necessary for preparing contract documents but can help in determining if some repair work should be done. For example, cracks in manhole walls would not be considered a serious deficiency in areas with a low water table and sandy soil.

Item 5: Manhole Location

The manhole location is established during the initial design phase and relocation after construction is almost never cost-effective. However, there are some cases of improper design for which corrective action may be justified.

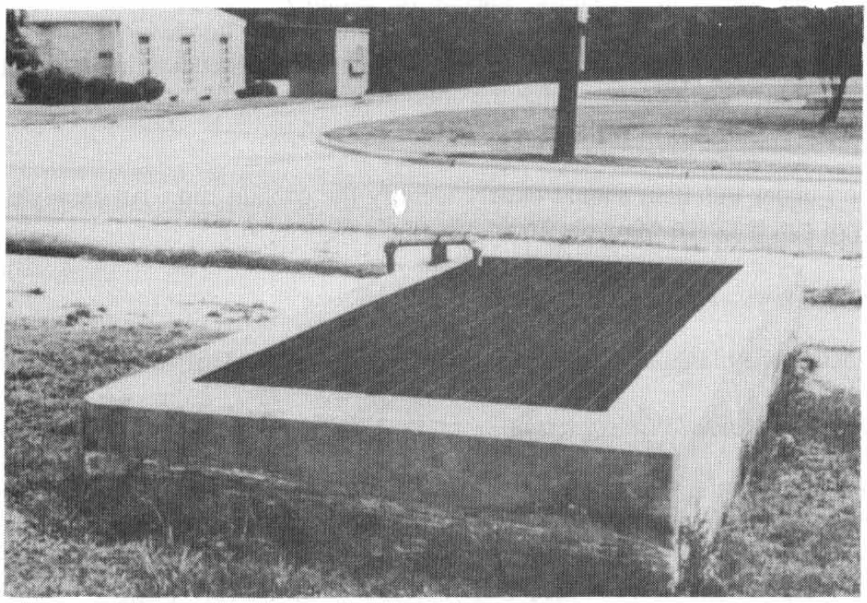
Manhole spacing: design criteria, for years, have required that spacing of manholes not exceed 500 ft in order to limit burial depth and simplify location of conduit casing or internal pipe leaks. At times, however, systems have included conduit runs between manholes of up to several thousand feet. Where it is obvious from ground contours along the system and manhole entries that conduit low points exist between manholes, these low points should be located and a determination made as to whether new manholes should be installed. New manholes would provide a means for draining and drying the system before extensive damage occurs to the insulation in the event water enters the cavity between the internal pipe and the conduit casing.

Offset manholes: in some older systems, many manholes were not installed directly over the distribution mains, but were positioned near the lines with "tees" extending from the mains to the manhole. These tees are usually located at low points in the line and are commonly called "drain pits" or "valve pits." Although useful for draining the system, the fact that they do not isolate the specific sections of the mains makes leak detection and conduit pressure testing difficult. Corrective action is seldom, if ever, economically warranted. However, in cases for which conduits must be replaced, you should consider routing the new conduit so that it enters directly into the manhole.

This item will normally be rated "Satisfactory" because it is not intended that new manholes or rerouting be done as part of the maintenance contract. When such work is considered critical, proper details should be shown on the drawings and the latest new construction guide documents integrated into the contract specification.

Item 6: Evidence of Conduit Failure Between Manholes

Indication of problems in conduits between manholes should alert the inspectors to closely observe the conduit and piping extending into the manhole. High heat loss from conduit runs is often indicated by burnt grass directly over the route of the line, or in winter by rapid snow melting over the route. When



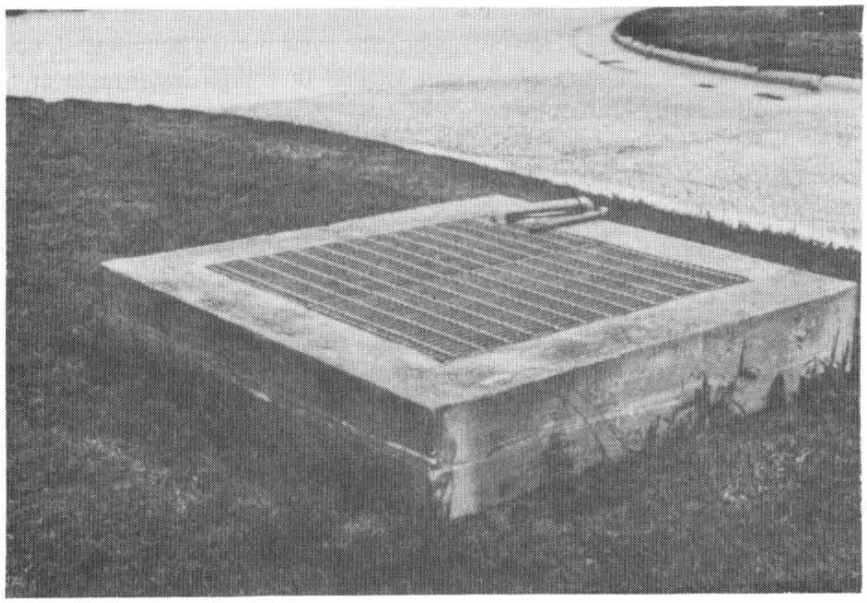


Figure 5. Typical open-grate manholes.

these conditions are observed, the associated conduit vent should be checked for steaming or vapor. If the vent is steaming and the manhole is dry, it can be assumed that the steaming vent is caused by water entering the conduit casing through a break or that one of the heat-carrying pipes is leaking. If the conduit vent is not steaming, it can be presumed that the insulation in the conduit may have been seriously damaged at some time, very possibly due to backup of water from a flooded manhole. Inspectors should note carefully the condition of the endplate and the conduit casing extending into the manhole, check the welds at the conduit termination, ensure that the drain plug and conduit vent piping are installed properly and tightly, and make sure gland seals are tight.

The notation under this item should clearly identify the conduit run. An example is: "Dead grass along the conduit run between Manhole 26 and Manhole 30."

Item 7: Manhole Type

Indicate whether the manhole is concrete or prefabricated steel. If concrete, state the wall thickness.

Item 8: Condition of Manhole Construction

Concrete manholes will rarely require maintenance and will usually last far beyond the anticipated life of the conduit portion of the system. After many years, some spalling of interior walls may occur, but this condition appears to have little impact on the walls' strength or water-repellent capability. Steel grate covers for manholes should be examined and replaced if excessively pitted, corroded, or otherwise damaged.

Occasionally, serious problems can develop in manhole construction mainly due to improper construction or design as shown in Figure 6. In this case, expansion devices have been installed in the manhole, but the distribution piping has been anchored at the manhole wall. As the system piping expanded, tremendous pressures built up with resultant buckling and severe cracking of the manhole walls. It was fortunate that the manholes in this system were located in sandy soil with a low water table so that no major water infiltration was evident. However, when the system must be replaced, new manholes will have to be constructed. If the manholes had been located in a high-water-table area, some type of patching or sealing would have been required.

In some older systems, a very poor manhole design was used. This design consists of a buried concrete box with access through a vertical concrete tube (usually 3 to 7 ft deep) extending into the top of the manhole (Figures 7 and 8). The manholes are very small and crowded with a vertical height of 4 to 5 ft, requiring personnel to remain in a crouched position during inspection or maintenance. These manholes provide poor visibility, high temperatures, poor ventilation, difficult accessibility and, in fact, constitute a hazardous work area. As a minimum, the top should be removed from the buried manhole and the walls extended to 6 in. above grade, and an open-grate top provided (Figure 9).

For prefabricated manholes, inspection should ensure that the inner coating remains bonded to metal and that no corrosion is evident. Any problem areas should be repaired and associated cathodic protection systems checked for proper operation.

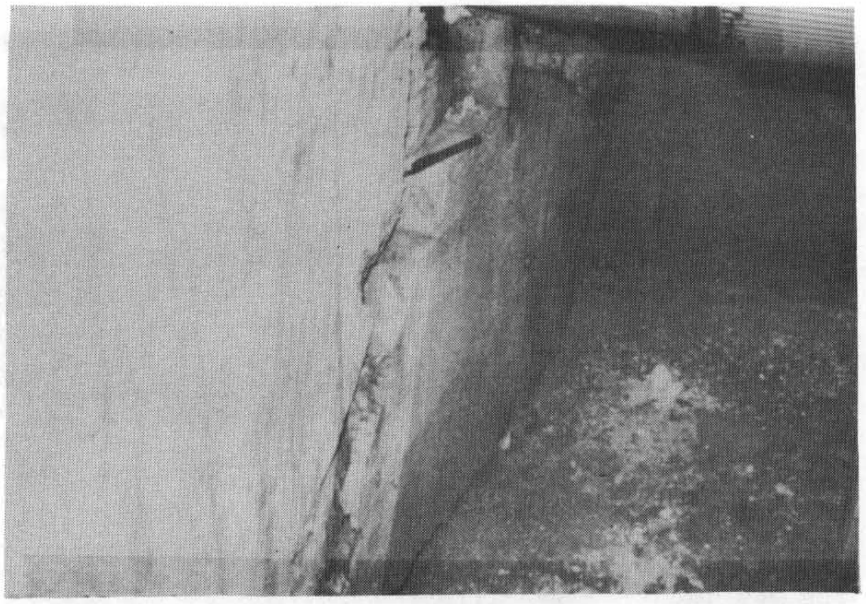


Figure 6. Manhole wall failures.

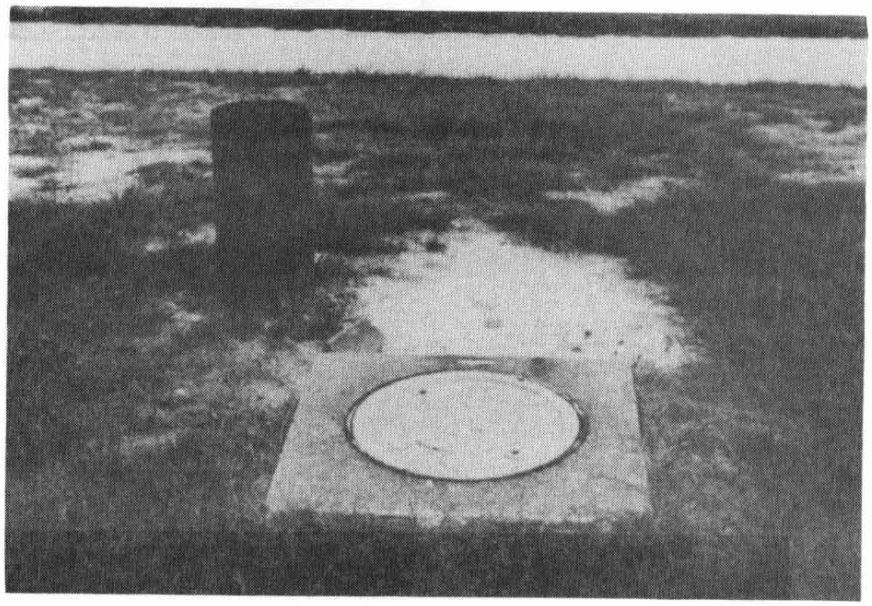


Figure 7. Buried manhole.

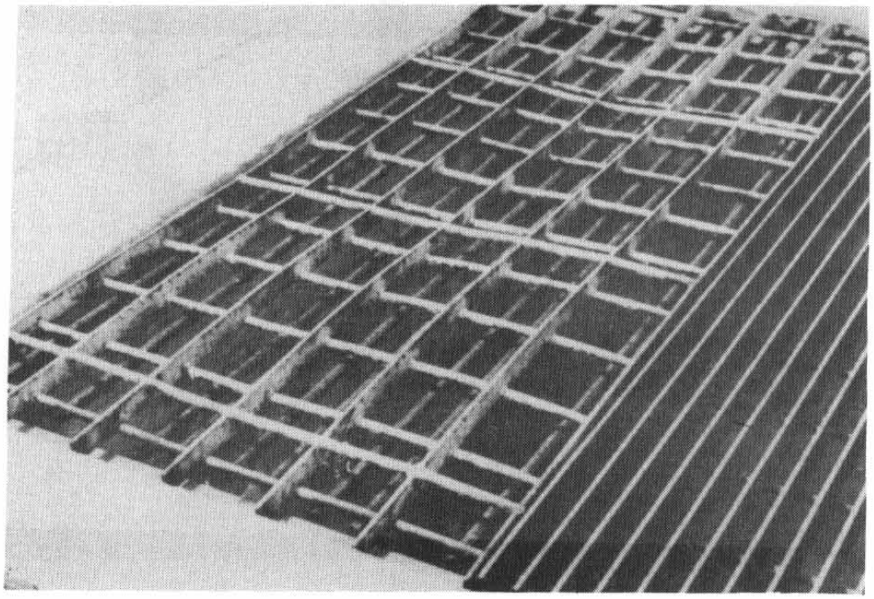


Figure 8. Makeshift manhole grate.

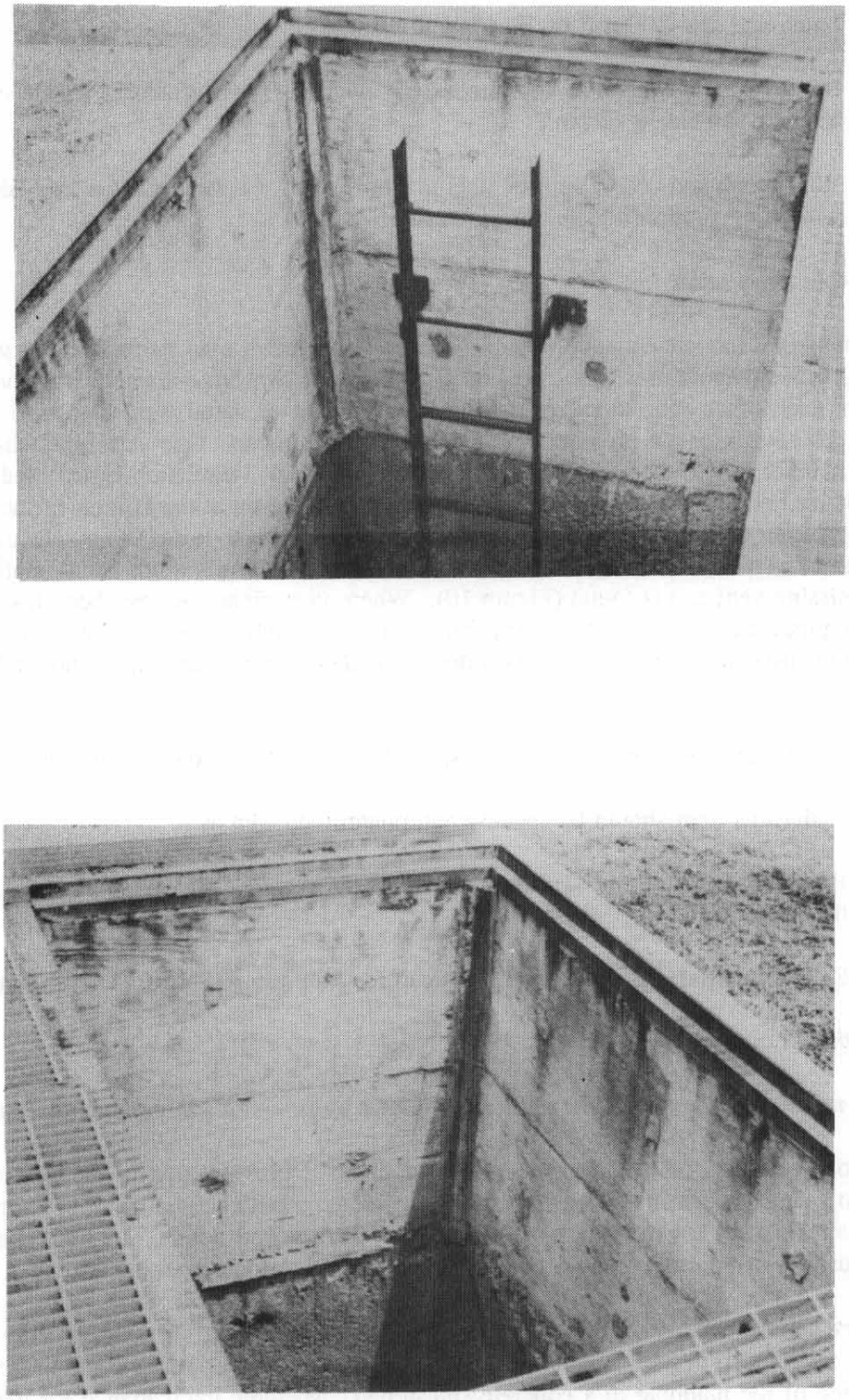


Figure 9. Extension of buried manhole walls to grade.

Notations under this item should be specific and quantified, such as:

- Replace 4 by 8 ft section of damaged grating to match existing. [Describe.]
- Patch and seal 20 lin ft of 1/4-in. wall cracks.
- Remove buried manhole top and extend walls to above grade. Provide open grates for access. [Include a sketch.]
- Wire brush and coat 6 sq ft of steel manhole wall. Coating is to be applied in accordance with manufacturer's recommendations.

Item 9: Manhole Ventilation

Covered manholes (concrete manholes with slab cover or prefabricated steel manholes with steel cover plate): this type of manhole must be ventilated by the use of two large-diameter steel vent pipes well separated from each other and extending through the concrete or metal top. The tops of these pipes terminate in a gooseneck or are provided with some type of rain cap. One vent pipe will extend to the bottom of the manhole while the other will terminate near the top. Ventilation is provided by colder and heavier outside air entering the longer vent pipe and being dispersed at the bottom of the manhole, and the warmer, lighter air being expelled through the short vent pipe at the top of the manhole. Maintenance for these vents or vents blocked by debris is not usually required, although occasionally a damaged, corroded, or missing vent cap is found (Figure 10). Where vent pipes have not been installed or where only one vent pipe has been provided, temperatures in the manhole can become very high, making maintenance and inspection difficult and hazardous. In these cases, vent pipes should be installed as indicated above.

- Open manholes (grate cover): no special ventilation is required for these manholes.

Notations under this item should be specific and quantified, such as:

- Provide 6-in. vent pipe with gooseneck. Pipe to extend to within 18 in. of the bottom of the manhole.
- Replace corroded and damaged vent cap for 5-in. pipe. [Show details to match existing.]

Item 10: Manhole Drainage

Manholes are drained by two basic methods: (1) gravity flow and (2) pumped discharge.

Gravity flow: consists of installing a drain in a pit or depressed area in the manhole floor and connecting it to an adjacent storm sewer, french drain, or other gravity system. This system requires little or no maintenance except for manholes subjected to mud, dirt, and debris. In such cases, an annual cleanup and flushing of the drain should be adequate to provide proper operation.

Pumped discharge: consists of an electric-motor-driven sump pump or steam ejector mounted in a sump pit 12 to 18 in. deep in the manhole floor with the discharge line passing through the manhole top and over the side of the manhole to a concrete splash pad. Manhole maintenance for these systems is delete

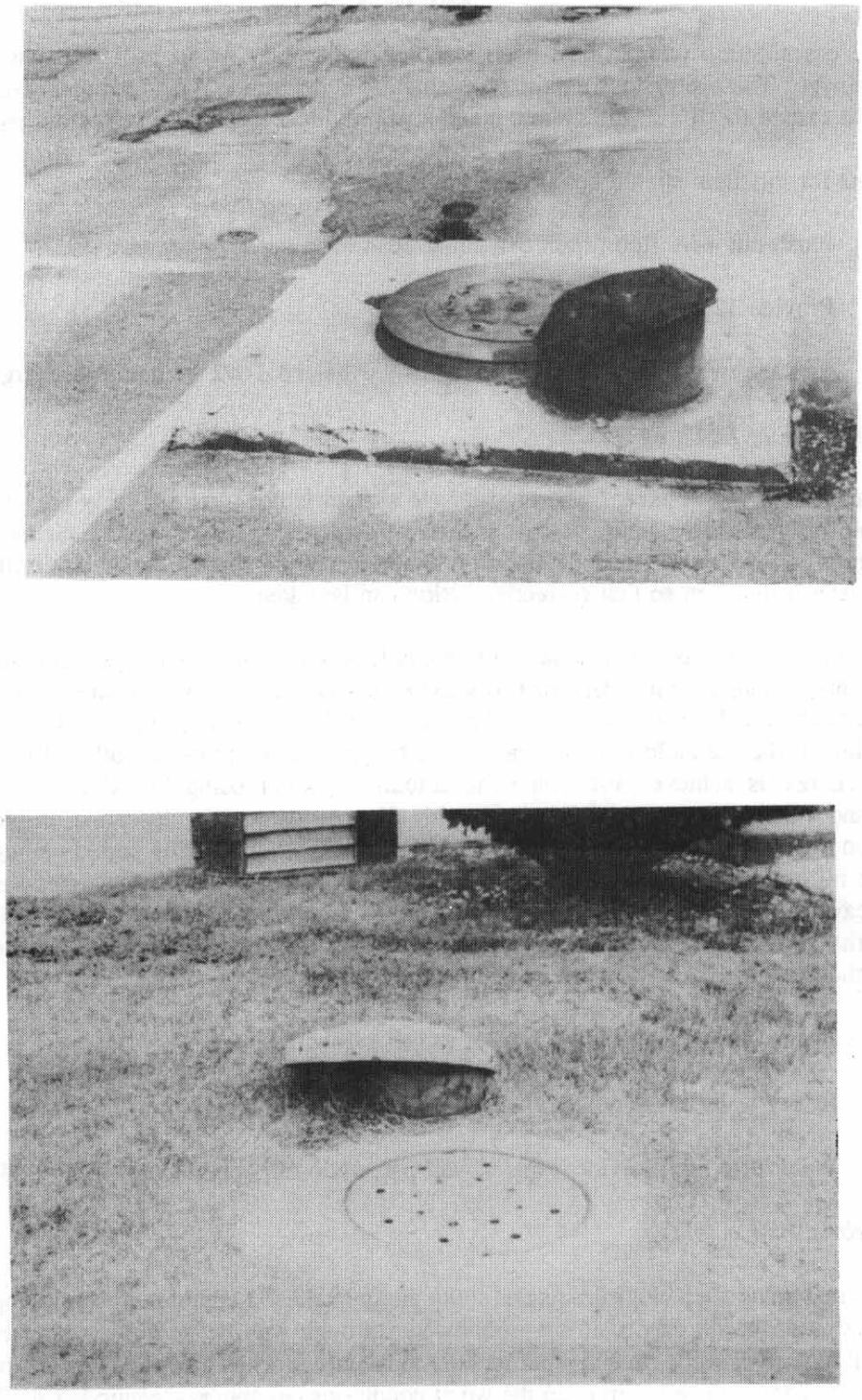


Figure 10. Damaged manhole vent caps.

minimal and primarily involves periodic cleaning of debris from sump pits and ensuring proper placement of concrete splash pads. For manholes with open-grate tops, annual or biannual cleaning is usually adequate whereas for closed-top manholes, even longer periods may be allowed. Manholes should be cleaned in conjunction with an inspection of sump pump or steam ejector operation.

In some cases, sump pumps have been installed improperly or no provision has been made for manhole drainage. These situations require an evaluation to determine if the installation of drains or sump pumps would extend the life of the system enough to provide a reasonable economic payback.

Notations for this item should be specific, such as:

- Flush out 4-in. floor drain extending 30 ft to sewer.
- Provide 12 by 24 in. concrete splash pad.
- Replace two 90-degree Els and 2 ft of galvanized 1-1/2 in. pump discharge line.

Item 11: Evidence of Flooding

Manholes seldom flood except when a drainage system is not provided or is not functional (e.g., a clogged drain or inoperative sump pump) since the drainage capacity normally far exceeds the water infiltration rate. However, to preclude flooding, maintenance personnel should determine the probable sources of water infiltration so that corrective action can be taken.

Aside from obvious leaks, water marks on manhole walls often indicate problem areas (Figure 11). These water marks range from a dark rust to a light gray in color. Most common is a ring around the interior wall of the manhole at a level near the bottom of the heat-carrying pipe. This condition is due to water rising in the manhole until it touches the hot pipe and begins to boil and evaporate rapidly. Usually, a balance is achieved for which the amount of water being boiled off equals the amount infiltrating and a constant level is maintained, with a heavy water stain deposited on the walls. Water stains are also often found at wall penetrations and wall cracks where, during periods of high water tables, considerable infiltration will occur. Other evidence of flooding includes deteriorated insulation and its covering; heavy pitting and corrosion of metallic pipe supports; corroded bottom sections of conduits, valves, and fittings; and encrusted auxiliary piping. Any of these conditions should alert inspectors to the need for further detailed inspection and corrective action.

Notations under this item should be similar to the following:

- Heavy water mark noted 14 in. above manhole floor.
- Water drip marks evident under wall penetration in conduit run from building no. 143.

Item 12: Debris in Manholes

Debris in manholes often clogs drains and sump pump intakes. Manholes with solid tops seldom have this problem except for silt carried in by groundwater through wall penetrations. Manholes with open-grate tops will require periodic cleaning, particularly in heavily forested areas and where wind-carried sand and soil are prevalent. However, in even the worst conditions, an annual cleanup is usually adequate for proper system functioning.

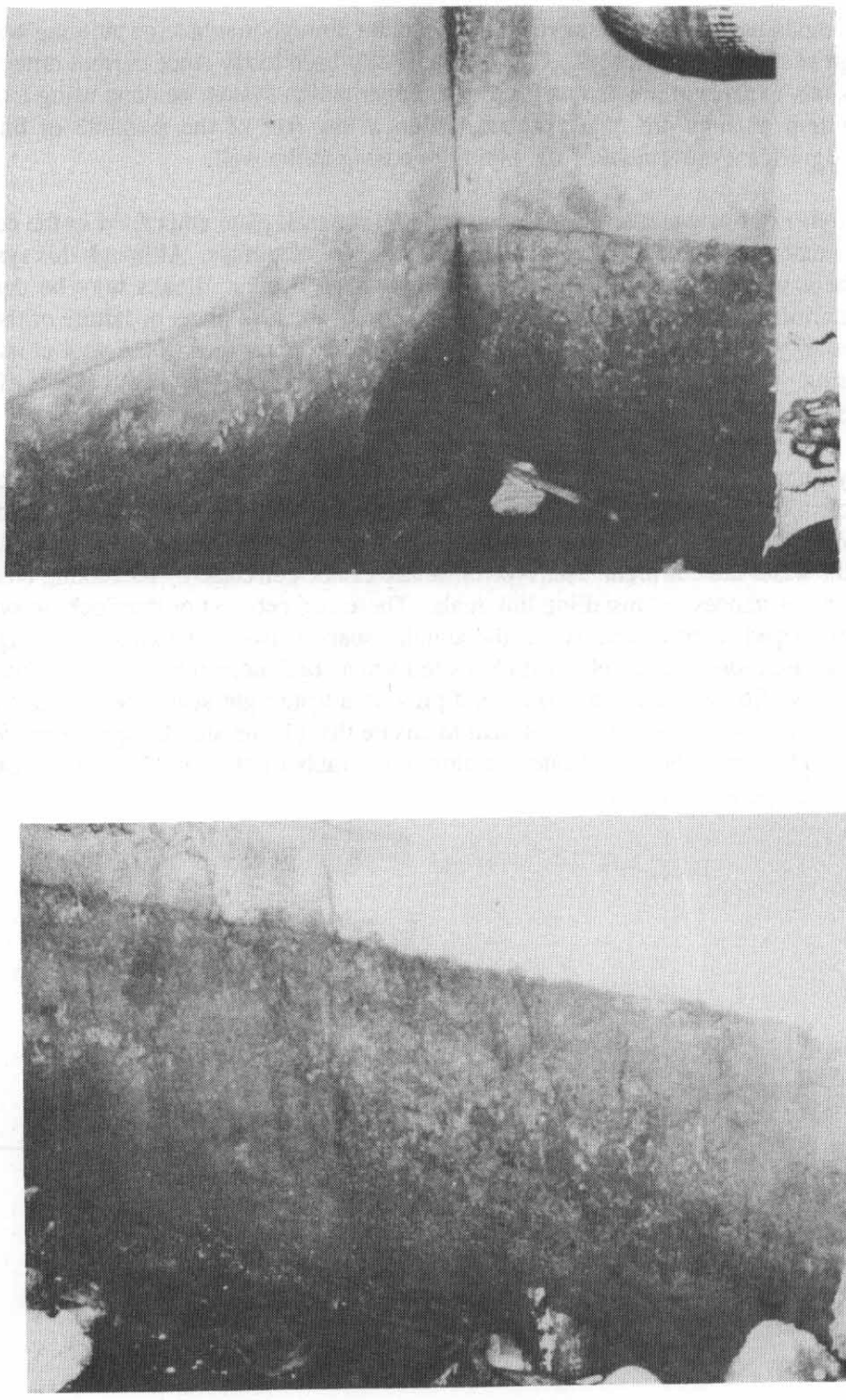


Figure 11. Water marks on manhole walls.

The notation for this item should simply indicate whether cleanup is or is not required.

Item 13: Wall Penetrations

Several methods have been used to construct conduits through manhole or building walls. The most common design is shown in Figure 12. This design is still used today since current criteria require that, whenever possible, expansion provisions for the heat distribution system be done using loops outside the manholes. System anchors are then installed within a few feet of the manhole or building wall to eliminate any significant movement of the piping or casing at the wall.

Leakage from exterior water sources is contained by the leak plate embedded in the concrete and by a sealant on the exterior face of the wall extending to the conduit surface. Although this system is usually satisfactory, there will be cases where considerable leakage occurs. Leaks may be due to improper installation, deterioration of the exterior sealant, corrosion of the leak plate, or failure of the anchor. The problem can usually be corrected by applying a sealant on the inner face of the wall at its junction with the conduit casing. Often attempts are made to correct leakage by applying heavy layers of cement at the juncture of the conduit and wall, but this practice has not been found satisfactory.

In older systems, wall penetration was done using a metal sleeve through which the conduit passed into the manhole. The space between the casing and the sleeve was then caulked with standard caulking material. However, this material tends to deteriorate with age and can become a source of leakage during periods when the water table is high. This type of failure can be corrected by recaulking on an as-required basis and, in some instances, by installing link seals. These seals consist of interlocking synthetic rubber links which are shaped to continuously fill the annular space between the conduit casing and the wall sleeve. The links are loosely assembled with bolts to form a continuous rubber belt. Tightening the bolts causes the rubber sealing elements to expand and provide a watertight seal between the conduit and the sleeve. Care must be taken in using the link seal to ensure that (1) the annular space between the conduit and the sleeve is adequate to accommodate insertion of the rubber links and (2) the link seal composition is proper for the temperature involved.

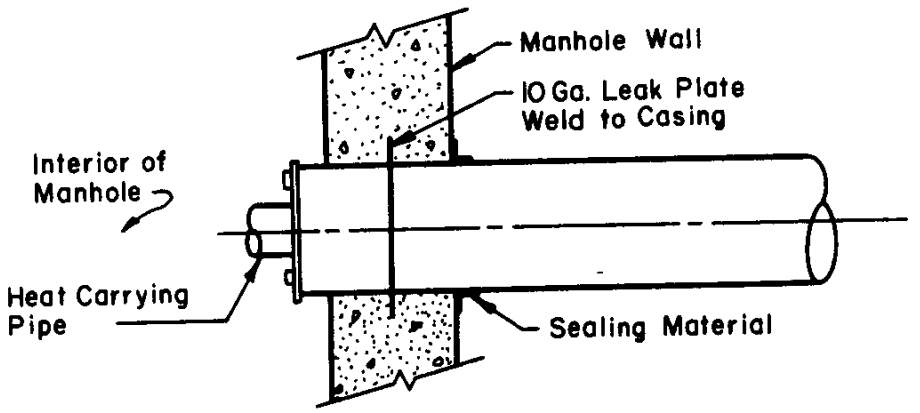


Figure 12. Typical conduit wall penetration detail.

Prefabricated steel manholes are specially designed and constructed at the factory to match installation requirements. These manholes include conduit stubs to permit welded connection to system conduit casings and the entire manhole is required to be pressure-tested. This procedure ensures watertightness, so that water infiltration from outside the manhole is seldom a problem unless physical damage has occurred.

Electrical isolation of the heat distribution system conduits can be a major concern because they are in metallic contact with the carrier pipes at conduit terminations (Figure 12).[3] Further, supports for the carrier pipes typically make electrical contact with the conduits. This creates the need to electrically isolate the carrier pipes (e.g., by placing an isolating flange in each line) immediately after they enter the buildings and before they can contact any other metallic structure within the buildings. Examination of Figure 12 also suggests that the steel leak plates that are electrically continuous with the conduits could very well contact steel reinforcements in concrete foundations/walls, creating a short that could be of monumental magnitude. Although it is theoretically possible to avoid shorts between the conduits and the steel reinforcements in the concrete by placing insulation between the steel wall sleeves and the conduits (Figure 13),[4] attempts to achieve electrical isolation by this method are not always successful (e.g., when the insulation is not properly installed or when the conduit is "cocked" in the steel wall sleeve). Rigid, nonmetallic sleeves and flexible, nonmetallic (e.g., neoprene) seals should be used where pipes penetrate concrete walls and foundation.[5]

Notations for this item should be specific, such as:

- Remove old caulking material and recaulk two 18-in. conduit casings.
- Apply sealant at interior wall penetration for 24-in. casing.
- Install link seals at three 14-in. casings.

Item 14: Manhole Internal Ladders

Internal manhole ladders are generally of two types: (1) individual rungs embedded in the concrete wall or welded to the prefabricated steel manhole wall and (2) a prefabricated ladder fastened to the manhole wall. Damage to ladders is primarily due to corrosion. Special care should be taken to ensure soundness, as failed ladders can be hazardous to maintenance personnel. In many instances, the lower rungs or sections of the ladder will have been exposed to flooding for long periods of time and are severely corroded and weakened whereas the upper portions are in excellent condition. In this situation, corrective action should be taken as soon as practical and, meanwhile, some type of warning posted to alert personnel entering the manhole. Damaged individual rungs embedded in or welded to manhole walls or parts of prefabricated ladders should be replaced with materials of identical size, shape, and spacing as the existing. Most maintenance personnel seem to prefer prefabricated ladders rather than individual ladder rungs. Therefore, when complete replacement is required, this option should be seriously considered.

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[3]*Perma-Pipe Underground Conduit System for U.S. Military Construction* (Midwesco Enterprises, Inc., september 15, 1964) p 19.

[4]*Submittal Brochure for Tri-Service Specifications: Class A Underground Heat distribution Systems* (Durant Insulated Pipe Company, May 29, 1967), p 25.

[5]J.H. Fitzgerald, "Corrosion Control for Buried Piping," *Heating/Piping/Air Conditioning*, Vol 46, No. 3 (March 1974).

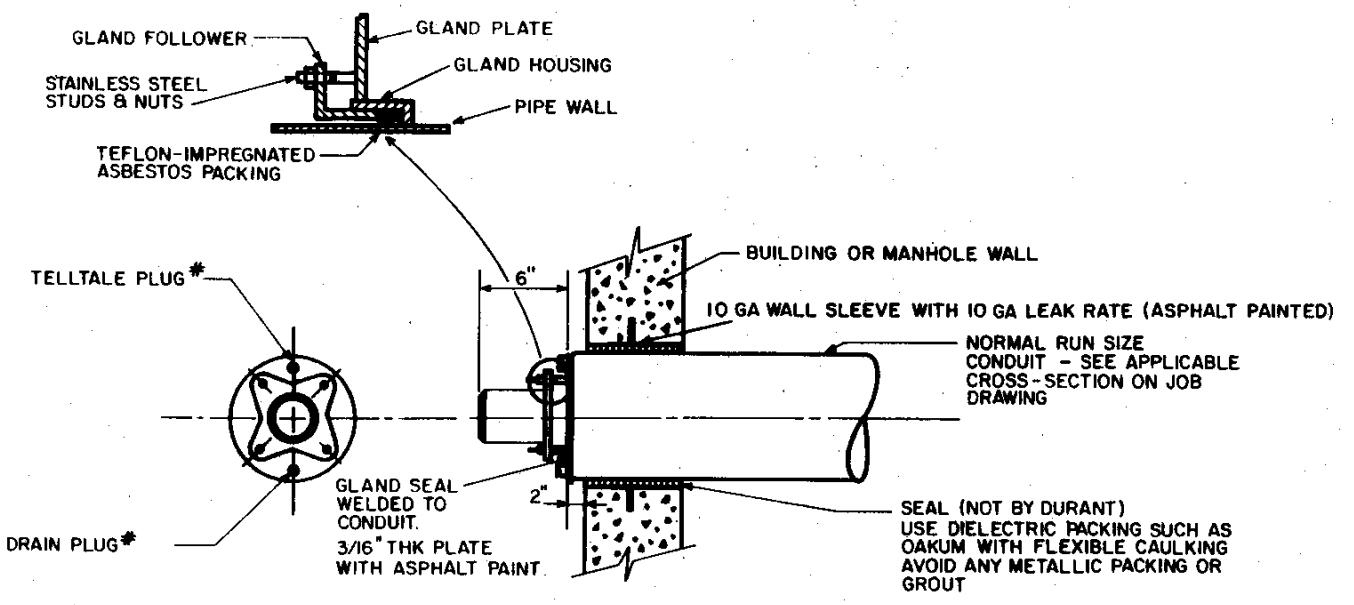

Figure 13. Insulation between wall sleeves and conduit.

Sample notations are:

- Replace three bottom ladder rungs to match existing.
- Remove all embedded ladder rungs and install a 10-ft prefabricated ladder.
- Remove bottom rung of prefabricated ladder and install a new rung to match the existing.

Item 15: System Piping in Manholes

Damage to pipe, valves, traps, fittings, and other auxiliaries in manholes is primarily due to corrosion caused by flooding or the high temperature and humidity. Damage most often appears at condensate lines and fittings, traps, system drains, and other low-temperature auxiliaries, and at threaded rather than welded connections (Figure 14). Condensate lines are particularly likely to fail because they are subject to internal corrosion due to improper water treatment as well as external corrosion. The extent of damage due to corrosion is difficult to ascertain, but metal with heavy scaling or with deep pitting should be replaced. In general, a thin, even film over metal surfaces does not indicate a serious problem. When replacement is necessary, it is advisable to replace a complete assembly rather than individual fittings or piping sections. Replacement parts must extend back to sound, uncorroded metal.

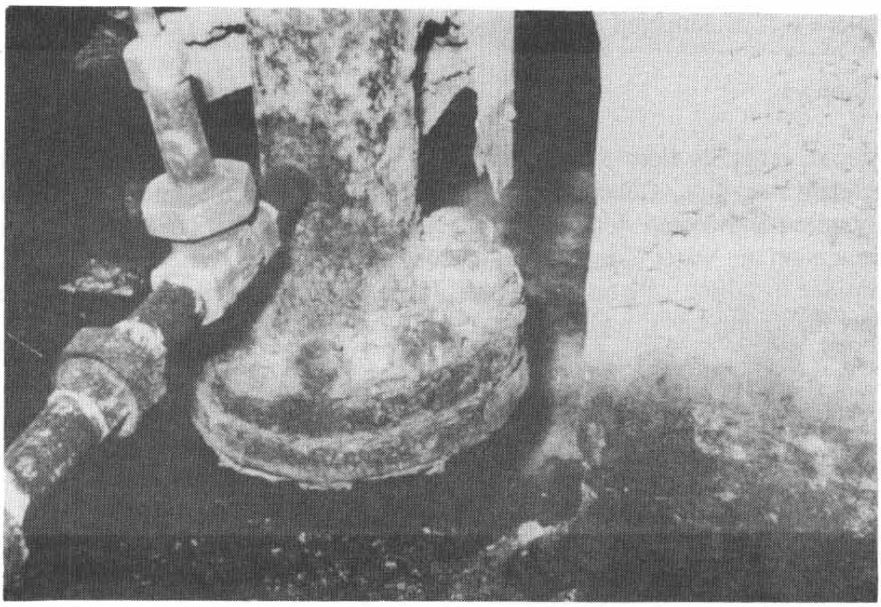

Figure 14. Severely corroded blind flange.

Sample notations are:

- Replace 6 ft of 8-in. steam piping with two 8-in. welded 90-degree elbows.
- Replace 12 ft of condensate return piping, two 90-degree elbows, four unions, four nipples, and two plugs (all threaded and 2-in. diameter).
- Replace trap [state type and capacity], 3 ft of adjoining threaded 1-1/2 in. condensate piping with two unions, and 10-in.-long drip pipe, 1 in. diameter, with cap.

Item 16: Thermal Insulation and Covering

Insulation in manholes is usually calcium silicate which was required because of its compressive strength and ability to retain its thermal efficiency and physical characteristics after being wet and boiled for a protracted period. Problems are usually due to: failure to replace insulation after maintenance, damage by workmen during inspection and repair procedures, and water damage resulting from repeated manhole flooding. Insulation is normally covered with waterproofing and with a lightweight aluminum sheet attached with wires or bands.

Notations under this item should be specific, such as:

- Provide 2-in.-thick calcium silicate insulation on 12 ft of 4-in. steam pipe. Also provide waterproofing and aluminum cover.

- Provide 2-in.-thick preformed insulation with waterproofing and aluminum cover for two 4-in. HTW valves.

- Replace 6 ft of damaged aluminum cover on insulated 6-in. line.

Item 17: Pipe Supports

Pipe supports are generally floor-mounted and made of either concrete (Figure 15), fabricated steel, or sections of standard steel pipe. Concrete supports seldom present a problem. Steel supports, however--even though galvanized and coated--tend to corrode and weaken rapidly since bottom portions are often subjected to immersion in water standing on the manhole floor. When metallic supports require replacement, consider installing concrete supports. In all replacement procedures, take care to provide temporary support for piping being replaced.

Sample notations are:

- Replace 2-in. galvanized steel pipe support, 2 ft long, with 6-in. square base plate, 1/4 in. thick.

- Remove 3-ft-long, 4-in.-diameter steel pipe support and install concrete support. [Design should be shown on a drawing.]

- Wire-brush and coat 4-ft-long, 4-in.-diameter I-beam support with 10-in.-square base plate, 1/4 in. thick.

Figure 15. Concrete pipe support.

Item 18: Conduit End Closures

At penetrations through manhole walls, conduits are usually sealed with a 10-gauge steel plate. This endplate is coated with the same material used for the exterior of the buried conduit runs. The plate is welded to the conduit casing and also to the heat-carrying pipe. Problems with endplates often result from coating failure at high-temperature areas and, in particular, where the plate is welded to the heat-carrying pipe. This condition exposes bare metal to the atmosphere and accelerated corrosion can occur. When endplates have corroded through or have been severely damaged, a new endplate should be installed. If reasonable additional life can be expected, the plate should be sandblasted or wire-brushed, and an appropriate coating applied. Coating specifications and surface preparation are contained in Appendix B, Section II.

A less often seen conduit design at wall penetrations is the use of a gland seal at the juncture of the heat-carrying pipe and the conduit endplate. This design is necessary when pipe movement is expected as when expansion devices are located in the manhole. The seal consists of a packed stuffing box and gland follower mounted on the steel plate which is welded to the conduit. This configuration permits movement of the heat-carrying pipe while still providing a seal at that point in the system. Replacement is seldom necessary, although tightening of the seal is recommended on an annual or biannual basis.

In both of the above closures, corrosion of the endplate may be present on the portion of the conduit that extends into the manhole (usually 2 to 8 in.). In that event, the casing should also be wire-brushed or sandblasted and coated.

Sample notations are:

- Wire-brush or sandblast and coat the following: 12-in. diameter endplate; 16-in.-diameter casing extending 4 in. into the manhole; and the 16-in.-diameter endplate.

- Replace and coat 18-in.-diameter endplate containing 8-in. steam pipe.

- Tighten gland seals on four conduits.

Item 19: Conduit Vents and Drains

Conduit vents are provided at the tops of endplates as an aid to inspectors in locating problems in the conduit runs between manholes. The vent pipes are 1-in.-diameter and terminate in a gooseneck to prevent blockage from airborne dirt, sand, and other particles. In manhole solid covers, vent pipes should extend through the manhole top so that inspection will not require manhole entry. For manholes with open-grate tops, termination of vents beneath the grates is usual. Most deficiencies found in vents involve failure to install the gooseneck and/or the vent piping in its entirety. Often the vent piping is removed and the vent opening plugged at the endplate (Figure 16). This situation is hazardous because pressure within the conduit can build up to system pressure, thus exposing both the system and personnel to potential explosive forces and high temperatures.

Conduit drain plugs in many systems are made of steel and due to corrosion are effectively frozen to the endplate and virtually impossible to open. All steel drain plugs should be removed and replaced with a brass or bronze plug installed with slightly more than hand-tightened pressure to permit easy removal when required. Another common problem is failure to replace the drain plug after inspection, which exposes the conduit run to water infiltration when the manhole becomes flooded. In many instances,

access to the drain plug is blocked by the butting of pipe insulation against the endplate, requiring removal of the insulation and covering or damaging the insulation system to remove the drain plug. This condition should be corrected by installing a right-angle extension from the drain opening which will terminate beyond the insulation surface; a brass or bronze plug or cap also should be installed at that point.

Sample notations are:

- Install 1-in. vent piping, 6 ft long, with gooseneck.
- Remove four 1-in. drain plugs and replace with brass or bronze plugs.
- Extend drain from endplate about 8 in. to clear pipe insulation. Use 1-in. pipe and fittings and install brass or bronze caps or plugs. Three drains involved.

Item 20: Valves, Traps, Expansion Joints, and Other Auxiliaries

As for system piping, all of these components should be examined carefully for excessive scaling or deep pitting. Such items should be replaced, including all connective piping and fittings in poor condition, back to clean, noncorroded metal. Several of these items, such as valves and slip-type expansion joints, contain packing where leakage may occur. Packing should be tightened, if possible or, if necessary, replaced. Another source of leakage is the gasketing at flanged connections, but these of gaskets must be replaced during system shutdown. Special attention should be given to the steam traps' operation to determine if they are clogged, leaking, or functioning properly. This inspection can be done with reasonable accuracy by noting supply and discharge temperatures at the traps.

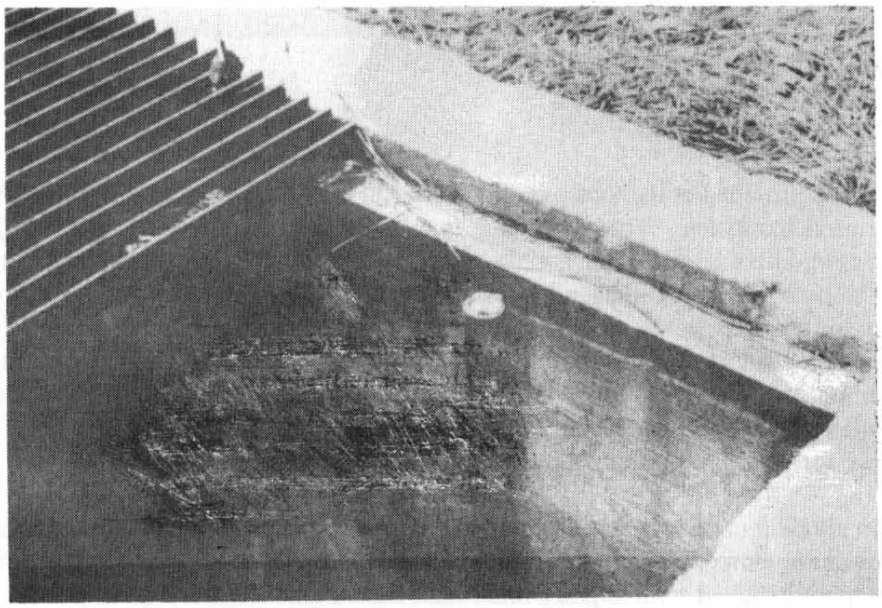

Figure 16. Clogged conduit vent pipe.

Sample notations are:

- Replace three traps [give type and capacity].
- Tighten packing on two 6-in. expansion joints.
- Replace two 3-in. HTW valves with 6 ft of adjoining piping. Six 3-in. pipe welds will be required.

Item 21: Sump Pumps

One of the most important items in system preventive maintenance is sump pump condition. Proper operation will eliminate damage to insulation and insulation coverings, minimize corrosion due to flooding, reduce the probability of water backing up into conduit runs, and increase system efficiency and longevity. Common failures in sump pumps are due to: loss of electrical power; clogging of pump intake; disconnected, corroded, or clogged discharge line; damaged float mechanism; burned-out motor; or damaged impeller. In most cases, corrective action is simple and immediate, such as: resetting circuit breakers or replacing fuses; clearing float mechanisms; closing switches; removing debris; or tightening discharge line connections. For manholes where flooding occurs, a periodic (preferably annual) operational check is strongly recommended.

Sample notations are:

- Replace sump pump. [Give capacity and electrical characteristics.]
- Replace 25 ft of electrical wiring and conduit from switch on pole to existing receptacle in manhole. Fifteen feet of run is buried.
- Replace damaged ball on float mechanism.

Maintenance Decision Factors

Factors influencing repair/replace decisions are: age of the system; history of maintenance; type of soil and height of water table; potential for and consequences of interrupted service; and life-cycle cost analysis. These factors should be kept in mind for each specific work item being evaluated.

For example, in areas where groundwater percolates readily through the soil and the water table is well below the bottom of the manhole, resealing of the conduit penetrations through manhole walls would not be justified. Another example is a system with a recent history of excessive repairs to the condensate lines indicating that major deterioration has occurred and that complete replacement will soon be necessary. Under these conditions, recoating the endplates in manholes for the condensate conduits would be economically imprudent.

All elements that present a safety hazard to personnel should be repaired or replaced, regardless of other factors. These conditions include exposed asbestos-containing insulation; damaged or weakened grates, ladders, supports; and high-pressure piping and equipment. The special handling requirements for asbestos-containing materials were described in Chapter 3.

If manhole repair will be done in-house, the following drawings should be made available:

1. Provide a site layout showing location of manholes and distribution piping to scale. Label or number manholes and show distribution pipe sizes. Indicate whether piping is in individual conduits or contained in a single conduit. Indicate any obstructing structures or utilities which may impact the worker's ability to do the necessary work.

2. Provide drawings showing details of concrete work, such as new manholes, extensions to or modifications of existing manholes, and new concrete pipe supports.

5 CONCLUSION

This report has provided guidance for installation DEHs to inspect underground heat distribution system manholes, determining repair requirements, dealing with manholes that contain asbestos insulation, and contracting work. This guidance was prepared for Class A conduit systems but also applies to other classes of manholes because of the similarity in manhole designs.

Before a full-scale inspection proceeds, the DEH must determine if the manhole may contain asbestos materials. In general, manholes installed after 1972 can be considered asbestos-free. However, those constructed prior to 1972 should first be inspected from the outside to identify any covering damage or exposure of insulation. If damage is noted, the insulation must be sampled according to OSHA requirements. Guidance was provided for the inspector. If possible, the same qualified individual should be retained to inspect all manholes since this arrangement is the most cost-effective. Instructions also were given for repairing damage in asbestos-contaminated areas. Appendix B is a sample scope of work for preparing asbestos encapsulation contracts.

Manholes should be inspected thoroughly once per year. An inspection checklist was provided for a step-by-step survey of internal components. Inspectors should complete a checklist for each manhole surveyed. Information required on the checklist was outlined, with sample entries provided to show how inspectors might record their findings.

Guidance also was provided to help DEHs determine what type of repair work should be performed or if complete replacement would be more prudent. Appendices A and B are sample scopes of work for preparing contract documents.

All installations that currently do not have a regular program of manhole inspection and maintenance should consider establishing one that follows the guidance in this report. The relatively low cost for the survey and remedial action are quickly regained through cost avoidance should a major conduit failure occur. Proper manhole condition is essential to efficient, economic, reliable operation of the underground heat distribution system. Poorly maintained manholes eventually result in a shortened service life for the system.

METRIC CONVERSION TABLE

1 psi	=	6890 N/m^3
°F	=	(°C + 17.78) x 1.8
ft	=	0.305 m
in.	=	25.4 mm

APPENDIX A:

SAMPLE SCOPE OF WORK FOR CONTRACTING ENCAPSULATION AND/OR REMOVAL OF ASBESTOS MATERIALS IN MANHOLES

SECTION I - GENERAL

1.1 APPLICABLE PUBLICATIONS: The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

1.1.1 Code of Federal Regulations (CFR) Publications:

29 CFR 1910.1001	Asbestos
29 CFR 1910.134	Respiratory Protection
29 CFR 1910.145	Specifications for Accident Prevention Signs and Tags
40 CFR 61, Subpart A	General Provisions
40 CFR 61, Subpart B	National Emission Standard for Asbestos
AAR 200-1 (draft)	Asbestos Control
TM 5-612	Asbestos Control

1.1.2 American National Standard Institute (ANSI) Publications:

Z9.279	Fundamentals Governing the Design and Operation of Local Exhaust Systems
Z88.280	Practices for Respiratory Protection

1.1.3 American Society for Testing and Materials (ASTM) Standard:

ASTM Standard will be issued in the near future.

1.1.4 National Institute for Occupational Safety and Health (NIOSH) Publications:

77-173 NIOSH Occupational Exposure Sampling Strategy Manual.

1.2 ENCAPSULATION AND/OR REMOVAL AND DISPOSAL:

1.2.1 Description of Work:

The work covered by this section includes the encapsulation, removal, and disposal of friable materials containing asbestos and procedures and equipment required to protect workers in the manholes from contact with airborne asbestos fibers. The asbestos work involves cutting and removal of damaged pipe

insulation, encapsulation of exposed friable material, and in some instances, complete removal of pipe insulation in individual manholes. Descriptions of work to be accomplished in each manhole are contained on attached sheets.

1.2.2 Definitions:

1.2.2.1 Encapsulant: The term "encapsulant" is used synonymously with "sealant" or "coating." Encapsulants are of two kinds: those that penetrate the sprayed material and those that cover or bridge the material with a protective coating.

1.2.2.2 Asbestos: The term "asbestos" includes chrysolite, amosite, crocidolite, tremolite, anthophylite, and actinolite.

1.2.2.3 Asbestos Control Area: An area where asbestos operations are performed which is isolated by physical boundaries to prevent the spread of asbestos dust, fibers, or debris.

1.2.2.4 Asbestos Fibers: This expression refers to asbestos fibers having an aspect ratio of 3:1 and longer than 5 micrometers.

1.2.2.5 Ceiling Concentration: A concentration of airborne asbestos fibers at any time in excess of 10 fibers, longer than 5 μm, per cubic centimeter of air.

1.2.2.6 Area Monitoring: Sampling of asbestos fiber concentrations within the asbestos control area and outside the asbestos control area which is representative of the airborne concentrations of asbestos fibers that may reach the breathing zone. Sampling is to be conducted under NIOSH procedures and guidelines.

1.2.2.7 Friable Asbestos Material: Material that contains more than 1 percent asbestos by weight and that can be crumbled, pulverized, or reduced to powder by hand pressure when dry.

1.2.2.8 HEPA Filtered Equipment: High-efficiency particulate air (HEPA)-filtered equipment with a filter system capable of collecting and retaining asbestos fibers. Filters shall be at least 99.97 percent efficient for retaining fibers of 0.3 μ or larger.

1.2.2.9 Personal Monitoring: Sampling of asbestos fiber concentrations within the breathing zone of an employee. Sampling performed to NIOSH Standards.

1.2.2.10 Time Weighted Average (TWA): A minimum of three samples are required to establish the 8-hr time weighted average. The TWA is an 8-hr time weighted average airborne concentration of fibers, longer than 5 μm, per cubic centimeter of air.

1.2.3 Title to Materials: All materials resulting from encapsulation and removal work, except as specified otherwise, shall become the property of the Contractor and shall be disposed of as specified herein.

1.2.4 Protection of Existing Work to Remain: Perform removal and encapsulation without damage or contamination of adjacent work. Where such work is damaged or contaminated, it shall be restored to its original condition.

1.2.5 Medical Requirements: 29 CFR 1910.1001.

1.2.5.1 Medical Examinations: Before exposure to airborne asbestos fibers, provide workers with a comprehensive medical examination as required by 29 CFR 1910.1001. This examination is not required if adequate records show the employee has been examined as required by 29 CFR 1910.1001 requirements within the last year. The same medical examination shall be given on an annual basis to employees engaged in an occupation involving asbestos fibers and within 30 calendar days before or after the termination of employment in such occupation. Specifically identify x-ray films of asbestos workers to the consulting radiologist and mark the medical record jackets with the word "ASBESTOS."

1.2.5.2 Medical Records: Maintain a complete and accurate record of employees' medical examinations for a period of [40] [20] [ ] years after termination of employment and make records of the required medical examinations available for inspection and copying to: the Assistant Secretary of Labor for Occupational Safety and Health, the Director of the National Institute for Occupational Safety and Health (NIOSH), authorized representatives of either of them, and an employee's physician upon the request of the employee or former employee.

1.2.6 Training: Within 3 months prior to assignment to asbestos work, instruct each employee with regard to the hazards of asbestos, safety and health precautions, and the use and requirements of protective clothing and equipment including respirators. Fully explain and demonstrate engineering and work practice techniques and procedures.

1.2.7 Permits and Notifications: Secure necessary permits in conjunction with the asbestos removal, encapsulation, hauling, and disposition, and provide timely notification of such actions as may be required by Federal, State, regional, and local authorities. Notify the Regional Office of the United States Environmental Protection Agency (USEPA) in accordance with 40 CFR 61.22 [d][1] and provide copies of the notification to the Contracting Officer and the State Environmental Regulatory Agency 20 days prior to commencement of the work.

1.2.8 Safety Compliance: In addition to detailed requirements of this specification, comply with laws, ordinances, rules, and regulations of Federal, State, regional, and local authorities regarding handling, storing, transporting, and disposing of asbestos waste materials. Comply with the applicable requirements of the current issue of 29 CFR 1910.1001 and 40 CFR 61, Subparts A and B. Submit matters of interpretation of standards to the appropriate administrative agency for resolution before starting the work. Where the requirements of this specification and referenced documents vary, the most stringent requirement shall apply.

1.2.9 Respirator Program: Establish a respirator program as required by ANSI Z88.2 and 29 CFR 1910.134.

1.2.10 Industrial Hygienist: Conduct air monitoring and training by or under the direction of an industrial hygienist certified by the American Board of Industrial Hygiene in the Comprehensive Practice of Industrial Hygiene.

1.3 SUBMITTALS: The following items shall be submitted to and approved by the Contracting Officer prior to commencing encapsulation or removal of asbestos-bearing materials.

1.3.1 Encapsulant: Submit 3 qt of encapsulating material in manufacturer's unopened containers with certificate of compliance with ASTM P 189. Encapsulant shall be water-based.

1.3.2 Certificates of Compliance: Submit manufacturers' certification that vacuums, ventilation equipment, and other equipment required to contain airborne asbestos fibers conform to ANSI Z9.2.

1.3.3 Asbestos Plan: Submit a detailed plan of the work procedures to be used in the encapsulation and removal of materials containing asbestos. Such plan shall include the location of asbestos control areas, change rooms, layout of change rooms, interface of trades involved, sequencing of asbestos-related work, disposal plan, asbestos encapsulant to be used, air monitoring procedures, and a detailed description of the method to be employed to control pollution. This plan must be approved prior to the start of any asbestos work.

1.3.4 Testing Laboratory: Submit the name, address, and telephone number of the testing laboratory selected for the monitoring of airborne concentrations of asbestos fibers along with certification that persons counting the samples have been judged proficient by successful participation in the National Institute for Occupational Safety and Health (NIOSH) Proficiency Analytical Testing (PAT) Program.

1.3.5 Industrial Hygienist: Submit the name, address, and telephone number of the industrial hygienist selected to direct monitoring and training, and certification of the industrial hygienist by the American Board of Industrial Hygiene.

1.3.6 Monitoring Results: Fiber counting shall be completed and the results reviewed by the industrial hygienist within 16 hours. The industrial hygienist shall notify the Contractor and the Contracting Officer immediately of any exposures to asbestos fibers in excess of the acceptable limits. Submit all monitoring results to the Contracting Officer within 3 working days.

1.3.7 Notification: Notify the Contracting Officer 3 working days prior to the start of asbestos work.

1.3.8 Landfill: Submit written evidence that the landfill for disposal is approved for asbestos disposal by the USEPA and state or local regulatory agencies.

1.3.9 Training: Submit certificates signed by each employee that the employee has received training in the proper handling of materials that contain asbestos; understands the health implications and risks involved, including the illnesses possible from exposure to airborne asbestos fibers; understands the use and limits of the respiratory equipment to be used and understands the results of monitoring airborne quantities of asbestos as related to health and respiratory equipment.

1.4 MATERIAL: Shall conform to ASTM P 189. The encapsulant may be of the bridging, penetrating, or a combination of bridging and penetrating type.

1.5 EQUIPMENT: At all times, make available to the Contracting Officer for personal use <u>two</u> complete sets of protective equipment as required herein for entry to the asbestos control areas for inspection of these areas.

1.5.1 Respirators: Select respirators from those certified by the Mine Safety and Health Administration (MSHA), Department of Labor, or the National Institute for Occupational Safety and Health (NIOSH), Department of Health and Human Services.

1.5.1.1 Respirators for Handling Asbestos: Provide personnel engaged in the application of encapsulants on, or the removal of, asbestos materials with Type C supplied-air respirators, continuous flow or pressure-demand class.

1.5.1.2 Optional Respirators for Encapsulant Applications: Use type C continuous flow or pressure-demand, supplied-air respirators until the Contractor establishes that the average airborne concentrations of asbestos the employees will confront will not exceed 100 times the permissible exposure limits; i.e., 8-hr TWA and ceiling limit. When the exposure limits are established, the respirators presented in 29 CFR 1910.1001 that afford adequate protection at such upper concentrations of airborne asbestos may be used. If the contractor decides to provide respirators other than a Type C continuous flow or pressure-demand, supplied-air respirator, the Contractor shall determine the exposure of each employee to airborne asbestos during each type of encapsulation operation. Determine both the ceiling limit and the 8-hr TWA concentration of asbestos to which each of the employees is exposed during each type of encapsulant operation.

1.5.2 Special Clothing:

1.5.2.1 Protective Clothing: Provide personnel exposed to airborne concentrations of asbestos fibers with fire retardant disposable protective whole body clothing and headcoverings, gloves, and foot coverings. Provide disposable plastic or rubber gloves to protect hands. Cloth gloves may be worn inside the plastic or rubber gloves for comfort, but shall not be used alone. Make sleeves secure at wrists and make foot coverings secure at the ankle by the use of tape.

1.5.2.2 Work Clothing: Provide cloth work clothes for wear under the disposable protective coveralls and foot coverings.

1.5.3 Change and Decontamination Rooms: Provide a temporary unit with a separate decontamination locker room and a clean locker room for personnel required to wear whole body protective clothing. Provide two separate lockers for each asbestos worker, one in each locker room. Workers will keep street clothing and street shoes in the clean locker. They must vacuum and remove asbestos-contaminated disposable protective clothing while still wearing respirators at the boundary of the asbestos work area and seal in impermeable bags or containers for disposal. Workers shall not remove disposable protective clothing in the decontamination locker room. Cloth work clothing will be removed in the decontamination room. Cloth work clothes shall be tagged and bagged for laundering and work shoes kept in the decontamination locker. Do not allow workers to wear work clothing between home and work. Locate showers between the decontamination locker room and the clean locker room and require that all employees shower before changing into street clothes. Clean asbestos-contaminated work clothing in accordance with 29 CFR 1910.1001.

1.5.4 Eye Protection: Provide goggles to personnel engaged in asbestos operations when the use of a full face respirator is not required.

1.5.5 Caution Signs and Labels: Provide caution signs at all approaches to asbestos control areas containing a concentration of airborne asbestos fibers. Locate signs at such a distance that personnel may read them and take the necessary protective steps before entering the area. Provide labels and affix to all asbestos materials, scrap, waste, debris, and other products contaminated with asbestos.

1.5.5.1 Caution Sign: Vertical format conforming to 29 CFR 1910.145 [d][4], minimum 20 by 14 in.

1.5.6 Local Exhaust System: Provide a local exhaust system in the asbestos control area. The local exhaust system shall be in accordance with ANSI Z9.2. Equip exhaust with absolute HEPA filters. Local exhaust equipment must be sufficient to maintain a minimum pressure differential of minus 0.02 in. of

water column relative to adjacent unsealed areas. Provide continuous 24-hr/day monitoring of the pressure differential with an automatic recording instrument.

1.6 WORK PROCEDURE: Perform asbestos-related work in accordance with 29 CFR 1910.1001 and as specified herein. Personnel shall wear and utilize protective clothing and equipment as specified herein. Eating, smoking, and drinking shall not be permitted in the asbestos control area. Personnel of other trades not engaged in the encapsulation or removal of asbestos shall not be exposed at any time to airborne concentrations of asbestos unless all the personnel protection provisions of this specification are complied with by the trade personnel.

1.6.1 Masking and Sealing: Seal openings in manholes where the release of airborne asbestos fibers is expected. Control area development shall include protective covering of walls and top of manhole with a continuous membrane of one layer of minimum 4-mil (0.004-in.) plastic sheet sealed with tape to prevent water or other damage. Provide two layers of 6-mil (0.006-in.) plastic sheet over floors and extend a minimum of 12 in. up walls. Seal all joints with tape. Provide a local exhaust system in the asbestos control area. Openings will be allowed in enclosures of asbestos control areas for the supply and exhaust of air for the local exhaust system. Replace filters as required to maintain the efficiency of the system.

1.6.2 General Procedures: Encapsulation of exposed areas of insulation and insulation removal shall be accomplished in strict accordance with the approved plan provided by the Contractor.

1.6.3 Application of Encapsulant: Apply the encapsulant in accordance with the manufacturer's recommended application instructions. In the presence of the Contracting Officer, determine if the encapsulation material and application technique are acceptable in accordance with ASTM P 189.

1.6.4 Monitoring: Monitoring of airborne concentrations of asbestos fibers shall be in accordance with 29 CFR 1910.1001 and as specified herein.

1.6.4.1 Monitoring Prior to Asbestos Work: Provide area monitoring and establish the reference TWA 1 day prior to the masking and scaling operations for manholes requiring enclosure.

1.6.4.2 Monitoring During Asbestos Work: Provide personal and area monitoring and establish the TWA during the first exposure to airborne concentrations of asbestos. Thereafter, provide area monitoring once every 4 hr during the work shift inside the asbestos control area, outside the entrance to the asbestos control area, and at the exhaust opening of the local exhaust system. If monitoring outside the asbestos control area shows airborne concentrations have reached the specified TWA, stop all work, correct the condition(s) causing the increase, and notify the Contracting Officer immediately.

1.6.4.3 Monitoring After Final Cleanup. Provide area monitoring of asbestos fibers and establish the TWA of less than 0.5 fibers/cm^3 after final cleanup but before removal of the enclosure for the asbestos control area. Provide area monitoring and establish the TWA 5 days and 15 days after the enclosure of the asbestos control area is removed. The fiber counts from these samples shall be less than the reference TWA, or not greater than 0.5 fibers/cubic centimeter, whichever is less. Should any of the final samplings indicate a higher value, the Contractor shall take appropriate actions to reclean the area and shall repeat the monitoring.

1.6.5 Government Inspection: While performing asbestos encapsulation or asbestos removal work, the Contractor shall be subject to onsite inspection by the Contracting Officer who may be assisted by safety

or health personnel. If the work is found to be in violation of this specification, the Contracting Officer will issue a stop work order to be in effect immediately and until the violation is resolved. Standby time required to resolve the violation shall be at the Contractor's expense.

1.7 CLEANUP AND DISPOSAL:

1.7.1 Housekeeping: Housekeeping and cleanup procedures are essential parts of asbestos dust control. Maintain surfaces of the asbestos control area free of accumulations of asbestos fibers. Give meticulous attention to restricting the spread of dust and debris; keep waste from being distributed over the general area. Do not blow down the space with compressed air. When asbestos encapsulation or removal is complete, all asbestos debris is removed from the worksite, and final cleanup is completed, certify the area as safe before the signs are removed. After final cleanup, remove all filters used in exhaust systems and dispose of them as asbestos-contaminated materials. The Contracting Officer will visually inspect for accumulated dust and the Contractor shall reclean all areas showing dust. If recleaning is required, monitor the asbestos airborne concentration after recleaning. Notify the Contracting Officer before unrestricted entry into manholes is permitted. The Government shall have the option to perform monitoring to certify the areas are safe before entry is permitted.

1.7.2. Disposal of Asbestos:

1.7.2.1 Procedure for Disposal: Collect asbestos waste, masking debris, and asbestos-contaminated clothing which may produce airborne asbestos fibers and place in sealed impermeable bags. Affix a caution label to each bag. Dispose of waste asbestos material by burial under a cover of at least 6 in. of daily compacted nonasbestos materials and by final cover of at least 2 ft of compacted earth at an Environmental Protection Agency (EPA) or state-approved sanitary landfill off Government property. For temporary storage, store sealed impermeable bags in asbestos waste drums or skips. An area for interim storage of asbestos waste-containing drums or skips will be assigned by the Contracting Officer or his authorized representative. Procedure for hauling and disposal shall comply with 40 CFR 61 (Subpart B), state, regional, and local standards. Sealed plastic bags may be dumped from drums into the burial site unless the bags have been broken or damaged. Damaged bags shall remain in the drum and the entire contaminated drum shall be buried. Uncontaminated drums may be recycled. Workers unloading the sealed drums shall wear appropriate respirators and personal protective equipment when handling asbestos materials at the disposal site.

APPENDIX B:

SAMPLE SCOPE OF WORK--REPAIR OF UNDERGROUND HEAT DISTRIBUTION SYSTEM

INTRODUCTION

The work primarily involves corrective measures for deteriorating conduits, piping, valves, and other accessories contained in and extending from manholes and building equipment room pits for high temperature water and steam distribution systems. The Attachment is an integral part of this specification and details the specific work to be accomplished.

In general, the work will consist of, but is not limited to, the following and shall be accomplished as hereinafter specified:

[a. Manhole floors, building pits, and sumps shall be cleaned of debris and other foreign matter.

b. Where specified, new sump pumps with electrical connections to existing buildings or adjacent poles shall be installed. In some cases, electrical supply to the manholes is in place.

c. Corroded metalwork shall be sandblasted or wire-brushed and coated. Contractor shall note carefully when sandblasting is required or is optional, and shall provide the particular coating specified.

d. Existing piping, valves, fittings, endplates, and other accessories shall be replaced.

e. Insulation and aluminum covering shall be installed.

f. Floor mounted pipe supports shall be replaced.

g. Manhole and pit wall penetrations shall be caulked.

h. Manhole wall sleeves shall be sealed.

i. Conduit drains shall be extended and brass caps installed.

j. Conduit vents shall be installed.

k. Cathodic Protection Components

l. Other miscellaneous work shall be performed as contained in the Attachment.]

- NOTE -

The above listing in brackets is shown as a typical sample and is intended to give interested contractors a general idea as to the type of work involved. The list should be modified to accurately reflect the specific project involved. Item "k" above shall be included in all listings.

[Manholes No. 42 and 43 will require dewatering after system shut-off by the Contractor in the presence of a representative of the Contracting Officer.

Contractor shall then prepare a proposal and cost estimate for work at these two manholes. The Contracting Officer retains the option of accepting the proposal or accomplishing the work with his own personnel.]

Since much of the work is in confined spaces, the Contractor shall take all necessary precautions to ensure the safety of his personnel. When it is necessary to valve-off or shut down portions of the system to accomplish the required work, such actions shall be coordinated with and approved in advance by the Contracting Officer.

- NOTE -

The top paragraph in brackets is shown as an example of what may be required where manhole entry during the inspection phase was not possible due to excessive steaming. This will permit system shut-off, inspection, and repair at the convenience of the Contracting Officer.

SECTION I - GENERAL

1.1 APPLICABILITY: This section applies to all sections of this project except as specified otherwise in each individual section.

1.2 REFERENCES: The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

1.2.1 Federal Specifications (Fed. Spec.):

HH-I-551E	Insulation Block and Board, Thermal (Cellular Glass)
HH-I-523c	Insulation Block and Pipe Covering Thermal (Calcium Silicate - for Temperatures up to 1200 °F)
WW-N-351C	Nipples, Pipe, Threaded
WW-P-521G	Pipe Fittings, Flange Fittings and Flanges: Steel and Malleable Iron (Threaded and Butt-Welding) Class 150
WW-U-531E	Unions, Pipe, Steel or Malleable Iron; Threaded Connection, 150 lb and 250 lb
TT-S-00227E	Sealing Compound; Elastomeric Type, Multi-Component (for Caulking, Sealing, and Glazing in Buildings and Other Structures)
W-C-375B/GEN	Circuit Breakers, Molded Case; Branch Circuit and Service
L-C-530B & Am-1 & Int. Am-2	Coating, Pipe, Thermoplastic Resin or Thermosetting Epoxy

1.2.2 Military Specifications:

MIL-P-21214B	Pump Unit, Centrifugal, Vertical Sump, Electric Motor Driven, Automatic, Wet Pit Type
MIL-V-18434B(YD)	Valves: Gate, Globe, and Angle; Steel
MIL-T-27730A (ASG)	Tape, Antiseize, Polytetrafluoro-ethylene, With Dispenser
MIL-G- 21032B & Am-3	Gaskets, Metallic-Asbestos, Spiral Wound (for ASA Commercial Flanged Joints in Piping Systems)

1.2.3 American Society for Testing and Materials (ASTM) Standards:

A 53-81a	Pipe, Steel, Black and Hot Dipped, Zinc-Coated Welded and Seamless
A 106-80	Seamless Carbon Steel Pipe for High-Temperature Service
A 234-81a	Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
A 120-72	Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Ordinary Uses

1.2.4 American National Standards Institute (ANSI) Standards:

B16 9-1978 & Am-3	Factory-Made Wrought Steel Buttwelding Fittings
B16.11-1980	Forged Steel Fittings, Socket-Welding and Threaded
B31.1-1980	Power Piping

1.2.5 Federal Standards (Fed. Std.):

H28 & Suppl. 1	Screw Thread Standards for Federal Services

1.3 SUBMITTALS: Submit shop drawings, manufacturer's data and certificates for equipment, materials and finish, and pertinent details for each system where specified in each individual section, and have them approved before procurement, fabrication, or delivery of the items to the jobsite. Partial submittals will not be acceptable and will be returned without review. Submittals shall include the manufacturer's name, trade name, catalog model or number, nameplate data, size, layout dimensions' capacity, project specification and paragraph reference, applicable Federal, military, industry, and technical society publication references, and other information necessary to establish contract compliance of each item the Contractor proposes to furnish. In addition, the following items shall be included under submittal requirements:

a. Steel Pipe and Fittings

b. Valves

c. Zinc-Rich and Mastic Coatings

d. Sump Pumps

e. Caulking Material

1.3.1 Shop Drawings: Drawings shall be a minimum of 8.5 inches by 11 inches in size, except as specified otherwise. Drawings shall include floor plans, sectional views, wiring diagrams, and installation

details of equipment; and equipment spaces identifying and indicating proposed location, layout and arrangement of items of equipment, control panels, accessories, piping, ductwork, and other items that must be shown to assure a coordinated installation. Wiring diagrams shall identify circuit terminals, and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Drawings shall indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices. If equipment is disapproved, drawings shall be revised to show acceptable equipment and be resubmitted.

1.3.2 Manufacturer's Data: Submittals for each manufactured item shall be manufacturer's descriptive literature of cataloged products, equipment drawings, diagrams, performance and characteristic curves, and catalog cuts.

1.3.3 Standards Compliance: When materials or equipment must conform to the standards of organizations such as the American National Standards Institute (ANSI), American Society for Testing and Materials (ASTM), National Electrical Manufacturers Association (NEMA), and Underwriters Laboratories (UL), proof of such conformance shall be submitted to the Contracting Officer for approval. If an organization uses a label or listing to indicate compliance with particular standards, the label or listing will be acceptable evidence, unless otherwise specified in the individual sections. In lieu of the label or listing, the Contractor shall submit a certificate from an independent testing organization, which is competent to perform an acceptable test and is approved by the Contracting Officer. The certificate shall state that the item has been tested in accordance with the specified organization's test methods and that the item conforms to the specified organization's standard. For materials and equipment whose compliance with an organization's standards or specifications is not regulated by an organization using its own listing or label as proof of compliance, a certificate of compliance from the manufacturer shall be submitted for approval. The certificate shall identify the manufacturer, the product, and the referenced standard and shall simply state that the manufacturer certifies that the product conforms to all requirements of the project specification and of the referenced standards listed.

1.3.4 Certified Test Reports: Before delivery of materials and equipment, certified copies of all test reports specified in the individual sections shall be submitted for approval.

1.3.5 Certificates of Conformance or Compliance: Submit certification from the manufacturer attesting that materials and equipment to be furnished for this project comply with the requirements of this specification and of the reference publications. Pre-printed certifications will not be acceptable; certifications shall be original. The certification shall not contain statements that could be interpreted to imply that the product does not meet all requirements specified, such as "as good as"; "achieves the same end use and results as materials formulated in accordance with the referenced publications"; and "equals or exceeds the service and performance of the specified material." The certification shall simply state that the product conforms to the requirements specified.

1.3.6 Welders' Performance Qualification Records and Welding Procedures: Submit welders' performance records and welding procedure specification.

1.4 DELIVERY AND STORAGE: Equipment and materials shall be carefully handled, properly stored, and adequately protected to prevent damage before and during installation, in accordance with the manufacturer's recommendations and as approved by the Contracting Officer. Items that are damaged or defective in the opinion of the Contracting Officer shall be replaced.

1.5 CATALOGED PRODUCTS: Materials and equipment shall be catalogued products of manufacturers that are regularly engaged in the production of such materials or equipment and shall be the manufacturer's latest design that complies with the specification requirements. Materials and equipment shall duplicate items that have been in satisfactory commercial or industrial use at least 2 years prior to bid opening. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the components of the items need not be the products of the same manufacturer. Each item of equipment shall have the manufacturer's name, address, model number, and serial number on the name plate securely affixed in a conspicuous place; the name plate of the distributing agent will not be acceptable.

1.6 SAFETY REQUIREMENTS: Belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts located so that any person can come in close proximity thereto shall be fully enclosed or properly guarded. High-temperature equipment and piping so located as to endanger personnel or create a fire hazard shall be properly guarded or covered with insulation of a type as specified herein. Items such as catwalks, ladders, and guardrails shall be provided where required for safe operation and maintenance of equipment.

1.7. MANUFACTURER'S RECOMMENDATIONS: Where installation procedures or any part thereof are required to be in accordance with the recommendations of the manufacturer of the material being installed, printed copies of these recommendations shall be furnished to the Contracting Officer prior to installation. Installation of the item will not be allowed to proceed until the recommendations are received. Failure to furnish these recommendations can be cause for rejection of the material.

1.8 ELECTRICAL REQUIREMENTS: Electrical components of mechanical equipment and systems such as motors, starters, and controls shall be provided under this specification and shall be as specified herein and as necessary for complete and operable systems. Extended voltage range motors will not be permitted. Interconnecting wiring for components of packaged equipment shall be provided as an integral part of the equipment.

1.9 VERIFICATION OF DIMENSIONS: The Contractor shall become familiar with all details of the work, verify all dimensions in the field and shall advise the Contracting Officer of any discrepancy before performing the work.

1.10 WELDING: Piping shall be welded in accordance with qualified procedures using performance-qualified welders and welding operators. Procedures and welders shall be qualified in accordance with Section IX, American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ANSI B 31.1. The Contracting Officer shall be notified 24 hours in advance of tests and the tests shall be performed at the work site if practical. The Contracting Officer shall be furnished with a copy of qualified procedures and a list of the names and identification symbols of qualified welders and welding operators.

SECTION II - MATERIALS

2.1 GENERAL: All replacement parts, materials, items, and accessories shall be of the same class, type, grade, and size as those being replaced. Where specific characteristics cannot be identified, the following shall be provided.

2.1.1 Pipe: Steam and high temperature water lines shall be black steel, plain end beveled. Those 14 inches and smaller shall be Schedule 40; 16 inches and larger shall have 0.500-inch wall thickness. Condensate return lines, drip lines, and gauge connections shall be black steel or wrought iron, plain end beveled, and shall be Schedule 80. Steel pipe 2 in. in diameter and larger shall be seamless or electric-resistance welded conforming to ASTM A 53, Grade B, type E or S; or to ASTM A 106, Grade B. Steel pipe 1-1/2 in. in diameter and smaller shall be seamless conforming to ASTM A 106, Grade B. Nonpressure pipe shall conform to ASTM A 120, Schedule 40, or ASTM A 53.

2.1.2 Fittings:

2.1.2.1 Steel welding fittings shall conform to ASTM A 234. Butt welding fittings shall conform to ANSI B16.9. Socket welded fittings shall conform to ANSI B16.11. Flanges shall be serrated or raised-face type.

2.1.2.2 Malleable-iron pipe fittings shall conform to Fed. Spec. WW-P-521, Type I or II, as required to match adjoining piping.

2.1.2.3 Nipples shall conform to Fed. Spec. WW-N-351, standard weight or extra strong weight, as required to match adjoining piping.

2.1.2.4 Unions shall conform to Fed. Spec. WW-U-531, type as required to match adjacent piping.

2.1.3 Pipe Threads: Pipe threads shall conform to Fed. Std. H28, as applicable.

2.1.4 Gaskets: Asbestos gaskets shall conform to ANSI B16.21. Metallic asbestos gaskets shall conform to MIL-G-21032, Type II.

2.1.4.1 Isolating flanges requiring isolating gaskets and washers and sleeves for the bolts.

2.1.5 Strainers: The strainer-body connections shall be the same size as the pipelines in which the connections are installed. The strainer bodies for steam systems shall be heavy and durable, of cast steel or gray cast iron, with bottoms drilled and plugged. The bodies shall have arrows clearly cast on the sides to indicate the direction of flow. Each strainer shall be equipped with an easily removable cover and sediment basket. The body or bottom opening shall be equipped with nipple and gate valve for blowdown. The basket for steam systems shall not be less than 0.025 inch thick stainless steel, Monel, or sheet brass, with small perforations of sufficient number to provide a net free area through the basket of at least 2.5 times that of the entering pipe. The flow shall be into the basket and out through the perforations. For high-temperature water systems, only cast steel bodies and stainless or Monel baskets shall be used.

2.1.6 Steam Valves:

2.1.6.1 Gate Valves: Sizes of 1-1/2 inch or less shall conform to Fed. Spec. WW-V-54, Type I or II, Class A; 2-in. size shall conform to Fed. Spec. WW-V-58, Class I, Design NRS, flanged end; greater than 2-inch size shall conform to Fed. Spec. WW-V-58, Design 0SY, flanged ends.

2.1.6.2 Globe Valves: Shall conform to Fed. Spec. WW-V-51, Type I, Class A.

2.1.6.3 Check Valves: Shall conform to Fed. Spec. WW-V-51, Type III or IV, Class A.

2.1.6.4 Angle Valves: Shall conform to Fed. Spec. WW-V-51, Type II, Class A.

2.1.7 High-Temperature Water Valves: Shall be cast or forged steel conforming to MIL-V-18434 and shall be of the type and class suitable for the operating temperature and pressure, and in no case less than 300-pound class.

2.1.8 Steam Traps: Bucket traps shall be an inverted-bucket type or a vertical-bucket type with automatic air discharge. The traps shall be designed for a working pressure of 150 psig. Thermostatic, thermodynamic, and/or impulse traps designed for a steam working pressure suitable for the application may be furnished in lieu of the bucket traps. The thermostatic impulse traps shall be equipped with valves and seats of stainless steel, Monel metal, or approved corrosion resisting metal.

2.1.9 Insulation: Insulation for steam and high-temperature water systems shall be molded calcium silicate conforming to Fed. Spec. HH-I-523, Type II, class A.

2.1.10 Caulking Material: Shall be polysulfide Base Synthetic Rubber Sealant conforming to Fed. Spec. TT-S-00227 E, Type II, Non-sag, and to ANSI A116.1.

2.1.11 Zinc-Rich Metal Coating Material: Single-package, self-curing, inorganic zinc-filled coating, providing a basic zinc silicate complex. Zinc content in dry film shall be not less than 80 percent (as conforming to MIL-P-38336). Coating shall be resistant to continuous operating temperature of 400 °F.

2.1.12 Mastic Metal Coating: Two-part, high-build, modified epoxy mastic. Solids content of mixed material shall be not less than 88 percent by volume.

2.1.13 Oil-Based Metal Coating Material: As furnished by the Contracting Officer.

2.1.14 Sump Pumps: Shall conform to applicable requirements of MIL-P-21214 B.

2.1.15 Cathodic protection components.

SECTION III - DESCRIPTION OF WORK

3.1 PIPING, VALVES, AND ACCESSORIES:

3.1.1 General: All pipe shall be accurately cut to measurements established at the construction site and shall be worked into place without springing or forcing, properly clearing all openings and equipment. Excessive cutting or other weakening of structural members to facilitate piping installation shall not be permitted. Changes in direction may be made by bending of pipe provided that a hydraulic pipe bender is used. Bent pipe showing kinks, wrinkles, or malformations will not be acceptable. Open ends of pipe lines and equipment shall be properly capped or plugged during installation to keep dirt and other foreign matter out of the system.

3.1.2 Piping and Pipe Accessories: Shall conform to the requirements of ANSI B31.1, and shall be of the proper type for the pressure and temperature of the heating medium. Joints for ferrous piping in manholes shall be welded, flanged, or threaded as determined by the connections being replaced.

3.1.3 Flanged Joints: Shall be faced true, provided with proper gaskets, and made perfectly square and tight. Full faced gaskets shall be used with cast iron flanges, and all gaskets shall be as thin as the finish of the flange face permits.

3.1.4 Valves: Shall be installed with stems horizontal or above and as the valves which they are replacing were installed.

3.1.5 Miscellaneous and Nonpressure Pipe and Fittings: Conduit vent and drain piping shall be 1-inch, standard weight, black steel conforming to ASTM A 120 or ASTM A 53. Threaded fittings shall conform to ANSI B16.3, Class 150. The conduit vent piping shall terminate in a gooseneck which may be fabricated with 90-degree Els and nipples or by bending with a hydraulic pipe bender. Bent steel pipe shall conform to ASTM A 53. Bent pipe showing kinks, wrinkles, or malformations shall not be acceptable. The terminal end of the gooseneck shall be threaded to accept either a cap or plug in the event the casing is to be pressure tested. For conduit drain openings, brass plugs or caps shall be installed to replace existing steel caps of plugs and where it is noted that caps or plugs are missing. Where it is indicated that the conduit drain shall be extended to facilitate access, the extension shall be made with threaded steel pipe and fittings. The terminal end of the extension shall be closed with a brass cap or plug. Care shall be taken to ensure that the caps and plugs are easily accessible for removal and inspection without damage to adjacent insulation. Miscellaneous piping and metalwork to be replaced shall be of the same type, size, and class as that being replaced. Threaded joints shall be made tight with polytetrafluoroethylene tape applied to the male threads.

3.2 INSULATION:

3.2.1 General: The insulation shall be installed in such a manner that it will not be damaged by pipe expansion or contraction. Insulation shall be held in place with stainless steel straps 1/2 inch wide and 32 gauge in thickness and installed on not more than 18-inch centers. All flanges, unions, valves, and fittings shall be insulated with premolded, prefabricated or field-fabricated segments of insulation of the same material and thickness as the adjoining pipe insulation.

3.2.2 Insulation Selection: Where minor patching or short sections of insulation are required, the Contractor shall provide insulation of the same type and thickness as the adjoining to ensure a neat finished appearance. For more extensive repairs, insulation shall be molded calcium silicate conforming

to Fed. Spec. HH-I-523, Type II, Class A. Laminated construction shall not be used. Insulation thickness shall be as follows:

Pipe Size (in.)	Insulation Thickness (in.)
1/2 through 2	1.5
2 1/2 through 5	2.0
6 through 10	2.5
12 and over	3.0

3.2.4 Insulation Covering: Insulation for the heat distribution systems shall be provided with a protective covering of one layer of impregnated roof felt and an aluminum jacket. The roof felt shall be applied with longitudinal and circumferential seams lapped not less than 4 inches, and secured with stainless steel wire loops (not less than 0.054 inch nominal diameter), or with stainless steel staples. Wire loops shall be individually fastened and spaced not more than 6 inches apart. Staples shall be spaced not more than 4 inches apart on both longitudinal and circumferential seams. Aluminum jackets shall not be less than 0.016 inch thick and shall be secured with aluminum bands not less than 3/8 inch wide and not more than 8 inches apart. Jacket sections shall have a 1-inch hem turned along one longitudinal edge and shall be applied with the hemmed edge over the unhemmed edge. The longitudinal and circumferential seams shall be lapped not less than 2 inches. Jackets on horizontal lines shall be so installed that the longitudinal seams are on the bottom side of the pipe with the seam of each jacket slightly offset from the seam of the adjacent jackets. The seams of the jackets on vertical lines shall be placed on the off-weather side of the pipe and shall be slightly offset as on horizontal lines. The jackets on vertical lines and lines pitched from the horizontal shall be installed from low point to high point so that the lower circumferential edge of each jacket overlaps the jacket below it. Jackets for fittings, valves, and flanges shall also be properly overlapped.

3.3 SUMP PUMPS: New and replacement pumps shall be of the submersible type and shall conform to applicable portions of MIL-P-21214 and the following additional requirements. Sump pumps shall have permanently lubricated bearings and shall be of the type capable of operating while completely submersed. The pump and motor shall have the capability of continuously pumping liquids at a temperature of 120 °F. The pump shaft shall be stainless steel with bronze or cast iron impeller and screened inlet, and with a housing of close-grained cast iron or of bronze. The unit shall be capable of passing a 3/8-inch solid (sphere). The motor shall be 1/2 Hp and shall be furnished complete with overload protection in a separate underground conductor. The pump shall be automatically controlled by a submersible switch assembly. Wiring from switch to pump shall be waterproof-type cord suitable for continuous submersion in 120 °F water. Motor shall be 120-v, 60-hz, single phase. Sump pump manufacturer shall verify and provide written certification of all special requirements noted herein. In the event that two pumps are specified, the pumps will be staggered to allow one pump to function normally and the other pump to function as an emergency backup. The water level should never reach the piping system and operating water levels shall be as follows:

	1st Pump (Normal)	2nd Pump (Emergency)
Turn-on Water Level: (Above Sump Floor)	9-1/2 in.	15 in.
Turn-off Water Level: (Above Sump Floor)	3-1/2 in.	3-1/2 in.

3.4 REPLACEMENT OF PIPE SUPPORTS: Pipe supports to be replaced are indicated in the Attachment. New supports shall be standard weight, black steel pipe conforming to ASTM A 120 or ASTM A 53. While this work is being accomplished, temporary support shall be provided to the manhole internals by the use of a hydraulic jack or other means approved by the Contracting Officer. The existing support shall be carefully marked and cut at sound metal well above the corroded bottom section of the support. The new base plate shall be not less than 1/4-inch steel plate and shall be of the same dimensions as the base plate being removed. Dimension tolerances for the new section of the support shall be such that a firm, solid weld can be made for pipe-type supports. To assure proper alignment and complete weld penetration, split welding rings shall be used on supports over 2 inches in diameter. Welding sockets may be used for supports 2 inches and smaller in diameter. Upon completion of the installation, the entire support shall be coated with a mastic-type coating as hereinafter specified.

3.5 CAULKING OF MANHOLE WALL PENETRATIONS: The caulking material shall be a two-part, non-sag, polysulfide base, synthetic rubber sealant conforming to Fed. Spec. TT-S-00227, Type II, Non-sag. The primer shall be as specifically required by the sealant manufacturer. The caulking system shall be approved by the Contracting Officer. Extreme care shall be taken to ensure that surface preparation requirements for the concrete and metal are met. This, in most cases, will require sandblasting, wire brushing, or hand chipping to meet joint design dimension and cleanliness standards of the manufacturer. The Contractor shall take all necessary precautions in the handling of solvents, activators, and other materials which may be toxic or irritating and shall carefully meet manufacturer's recommended application procedures.

3.6 COATING OF RUSTED SURFACES:

3.6.1 Sandblasting: Metal surfaces specified to be sandblasted shall be cleaned of all oil, grease, and extraneous material with clean rags soaked in an approved commercial solvent. The surface shall be dry abrasive blasted to a Commercial Grade Finish in accordance with SSPC - SP6 - 63 to a degree of cleanliness in accordance with NACE #3 to obtain a 1 to 3 mil (0.001 to 0.003 inch) blast profile. Where the steel to be sandblasted is in contact with concrete (such as manhole wall penetrations), the concrete surface shall also be sandblasted for a minimum distance of 1 inch from the metal surface to remove loose cement and provide a proper bonding surface.

3.6.2 Wire Brushing: Metal surfaces specified to be wire brushed shall be cleaned of all oil, grease, and extraneous material with clean rags soaked in an approved solvent. Whenever possible, wire brushing shall be done with a rotary power tool. Areas not accessible with the power tool may be brushed by hand. Where the steel to be wire brushed is in contact with concrete (such as manhole wall penetrations), the concrete surface shall also be wire brushed for a minimum distance of 1 inch from the metal surface to remove loose cement and provide a proper bonding surface.

3.6.3 Zinc-Rich Coating: Where specified in the contract documents, and after surface preparation as designated under "Sandblasting:" above, a spray coat 3.5 ± .5 mils in thickness shall be applied to the metal surfaces. The coating shall be a single-package, self-curing, inorganic zinc-filled coating providing a basic zinc silicate complex and shall contain a minimum percentage of zinc in the dry film of 80 weight percent as conforming to MIL-P-38336.. The coating material shall be approved by the Contracting Officer and shall be applied in strict accordance with the manufacturer's recommendations.

3.6.4 Mastic Coating: Where specified in the contract documents, and after surface preparation as designated under "Sandblasting:" or "Wire Brushing:" above, two coats, each not less than 5 mils in thickness, shall be applied to the metal surfaces. The coating shall be a high-solids, aluminum-pigmented,

epoxy mastic specifically formulated to encapsulate rust and shall be approved by the Contracting Officer. The coatings shall be applied in strict accordance with the manufacturer's recommendations.

3.6.5 Scheduling for Coating: Where it is necessary to shut off portions of the system for short periods to accomplish the coating of high-temperature components, the Contractor shall coordinate with, and receive approval of, the Contracting Officer for such shutdowns.

3.6.6 Safety Precautions: The Contractor shall take all necessary safety precautions in accomplishing the above work, taking into consideration the proximity of high temperature piping, limited space in manholes, ventilation requirements, and possible toxicity of materials. Where highly combustible materials are involved, workmen shall use nonferrous tools and shall wear conductive and nonsparking shoes.

3.7 ELECTRICAL WORK:

3.7.1 General: Electrical work shall consist of installation of materials and equipment to supply 120-v, single-phase, 60-hz service from circuits in existing buildings or lighting circuits on adjacent poles to new sump pumps, as indicated in contract documents. All electrical work shall be in strict accordance with the requirements of the National Electrical Code (NEC).

3.7.2 Installation Requirements: Circuit breakers, if required, shall be single pole, 15 amp conforming to Fed. Spec. W-C-375 B/GEN. Two #12 conductors and one #12 ground shall be run in 3/4-inch rigid steel conduit conforming to Fed. Spec. WW-C-581. Cable shall be THWN or THHN copper. Conduit installed in the ground shall have a factory applied coating system of plastic resin (Fed. Spec. L-C-530, Type 1); epoxy (Fed. Spec. L-C-530, Type II); or coal tar (primer and enamel conforming to MIL-P-15147). The thickness of the dry coal tar coating shall not be less than 1/16 inch at any point. Building interior conduit shall extend through the building wall to a weatherproof junction box and shall drop to grade along the exterior wall surface. Conduit shall be securely and rigidly fastened to the wall. Conduit on poles shall be securely and rigidly fastened to the pole and a 30-amp, 2-pole, 240-v weatherproof switch shall be installed 6 ft above grade. Conduit shall be run underground from the building wall or base of the pole to the manhole, and shall be buried a minimum of 24 inches below grade and extend through the manhole wall to a weatherproof junction box. Trenches shall be back-filled and compacted to their original grade. Where streets or sidewalks must be crossed, damage to the conduit coating shall be prevented by suitable predrilling. A 30-amp, 2-pole, 240-v weatherproof switch shall be securely mounted on the interior manhole wall at the same elevation as the junction box and connections made to the sump pump power cable. Conduit penetrations through the building and manhole walls shall be thoroughly caulked with an approved sealing compound. The Contractor shall demonstrate the proper system operation by running water at a continuous rate into the sump pit and allowing the sump pump to operate a minimum of four on-off cycles.

3.8 MISCELLANEOUS METALWORK: Miscellaneous items such as hasps, ladder rungs, prefabricated ladders, grate sections, drain caps, air bottles, endplates, etc., shall essentially match items being replaced or that are in the existing system. Proposed items, together with the method of installation, shall be approved by the Contracting Officer before the items are installed.

3.9 MANHOLE CLEANUP: Upon completion of all work on the interior of each manhole or building pit, the Contractor shall:

a. Remove all construction materials, trash, leaves, dirt, and any other extraneous material from the floor of the manhole or pit.

b. The manhole or pit floor shall be manually swept to remove finer materials.

c. The manhole or pit floor shall then be hosed down with water drained to the sump pit. Hose connections can be made at nearby buildings.

d. Water in the sump pit shall be removed with a portable sump pump and the pit shall be thoroughly cleaned. If the manhole sump pump is freestanding, it shall be removed from the pit during cleaning operations.

e. Upon completion of cleaning of the sump pit, the pump shall be reset and water shall be run into the pit at a continuous rate. To demonstrate proper operation, the sump pump shall operate for a minimum of four on-off cycles and until the discharge from the sump pump is running free and clear and devoid of observable suspended solids.

3.10 OPERATIONAL TEST: Upon completion of all work, the contractor shall refill all sections of the lines which may have been drained, properly position all valves, and place the system in full and complete operating condition. The system shall then be operated for a period of not less than 6 hr and shall demonstrate satisfactory function and effectiveness. The Contracting Officer shall be informed of the operating test at least 24 hours in advance.

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