PERMA-PIPE, Inc.

Conduit / Containment Drying Installation Manual Supplement

GENERAL

Conduit and containment piping systems are designed to provide a long service life when properly installed, operated and maintained. These systems must be installed and operated with the annular space between the service pipe and conduit / containment pipe in a dry condition. These systems are designed to be drainable, dryable and testable (DDT) so that in the event the annular space does become wet it can be drained, dried and tested, thereby restoring it to a dry condition.

The annular space of a conduit / containment system can become wet during installation or during operation for a variety of reasons. If the annular space becomes wet, it is critical it be immediately dried to prevent reduced service life or severe damage to the conduit / containment system.

A conduit / containment system with a wet annular space can result in corrosion to the service pipe, corrosion to the conduit / containment pipe and degradation to the insulation system. Operation of a conduit / containment system with a wet annular space can cause damage to the insulation system and the conduit / containment coating. This damage can result in costly repairs and in severe cases result in irreparable damage.

NOTICE: Damage to a conduit / containment system due to a wet annular space is not covered by PERMA-PIPE'S warranty. It is the installer's and owner / operator's responsibility to keep the conduit / containment system annular space dry.

The reason a conduit / containment system annular space became wet should be investigated and the cause determined so repairs, if necessary, can be made or precautions taken to avoid reoccurrence.

Refer to the appropriate PERMA-PIPE product Installation Manual for complete installation recommendations. This Installation Manual Supplement only addresses the drying of a wet conduit / containment annular space.

DRYING METHOD(S)

There are a number of methods available for drying piping systems. PERMA-PIPE recommends the dry gas purge method. This method uses a dry gas purge through the conduit / containment annular space to absorb and carry out moisture reducing the moisture in the annular space until an acceptable level is achieved.

Compressed air or nitrogen gas can be used as the dry gas. Compressed air is generally more economical than nitrogen gas due to the quantity of gas required and the associated cost and the hazards associated with nitrogen gas (asphyxiation, high-pressure gas).

An alternative method is vacuum drying. This can be an effective method, although, it is generally more expensive and difficult than the dry gas purge method. This method requires all standing water be removed or that water can be frozen when a vacuum is applied to the annular space exists. The frozen water will remain and will return to liquid water when the vacuum is removed.

CAUTION: If vacuum drying is used the ability of the conduit / containment pipe to withstand vacuum and not buckle must be verified. Contact PERMA-PIPE for assistance if needed.

SAFETY PRECAUTIONS

During all phases of drying exercise the proper precautions and follow applicable safety regulations. There are numerous safety considerations, including but not limited to the following;

- Entering and working in confined spaces (manholes, basements, crawl spaces, etc.)
- Asphyxiation (if nitrogen gas is used)
- Electrical and mechanical equipment (air compressor, heaters)
- Hazards associated with pressurized gasses
- High temperature fluids
- High temperature piping

DRYING EQUIPMENT

The equipment listed below will be needed for conduit / containment drying using the dry gas purge method. Where the equipment is optional it is noted as such. A schematic of the drying equipment showing recommended components and their locations and connections to the conduit / containment system is included at the end of this Installation Manual Supplement.

- Dry gas supply
- Pressure regulator
- Pressure relief valve
- Gas flow gauge (SCFM)
- Dew point meter
- Pressure gauges
- Temperature gauges
- Isolation valves
- Interconnecting piping
- Inlet and exhaust taps for dew point meter
- Dry gas supply heater (optional)
- Service pipe heat source (optional)
- Temperature gauges (required if heating used)

DRY GAS SUPPLY

The most common source of dry gas is compressed air. Compressed air must be oil free and have a dew point temperature of $-20^{O}F$ or lower. Air compressors with membrane or desiccant dryers are readily available and can easily achieve a $-20^{O}F$ dew point temperature. Refrigerant dryers typically cannot provide a low enough dew point temperature and therefore should be avoided or not used for final drying. The lower the air supply dew point temperature the less moisture in it and the more moisture it can absorb resulting in less time to dry out the system. See **Water Removal Rate** below for additional information.

The dry gas supply must be capable of delivering the required flow rate on a continuous basis. If an air compressor is used, check to verify it can deliver the required flow rate on a continuous basis.

PRESSURE CONTROL AND VENTING

The pressure rating of steel conduit / containment pipe is 15 psig and of FRP, polyethylene, polypropylene and PVDF containment pipes 10 psig. This is due to the mitered construction of the conduit / containment fittings.

A pressure regulator and pressure relief valve on the dry gas supply are required to ensure the conduit / containment pipe cannot be over pressurized by the dry gas supply pressure. The internal construction (supports, anchors, etc.) of a conduit / containment system will cause backpressure to develop. This backpressure will increase as the dry gas flow rate through the annular space is increased.

CAUTION: Do not exceed the pressure rating of the conduit or containment pipe or a hazardous condition may occur possibly resulting in personnel injury and / or property or equipment damage.

All piping and relief valve vents should be routed to a safe location to prevent any hazard to personnel, property or equipment.

FLOW RATE

A flow gauge is required to measure the dry gas flow rate so it can be adjusted to a safe level and so the performance (water removal rate) of the drying process can be monitored. The flow gauge should provide a measurement in standard cubic feet per minute (SCFM).

CAUTION: Too high a gas flow rate can over pressurize the conduit / containment due the back pressure developed by the conduit / containment annular space restrictions. Too high a gas flow rate can also damage service pipe insulation due to high forces generated by high velocity gas through the annular space.

The gas flow rate should be high enough so the gas velocity through the conduit / containment annular space is between 10 and 20 ft./sec. The SCFM required for this will depend on the size of the conduit / containment annular space and can be calculated by;

SCFM = annular space cross sectional area ($ft.^2$)
x air velocity (ft. / sec.) x 60 (sec./ min.)

Where the annular space cross sectional area is that of the conduit / containment ID minus the service pipe OD or service pipe insulation OD if insulated. Contact PERMA-PIPE for assistance if needed.

During drying the airflow may be increased or decreased to optimize the performance (water removal rate) of the drying process. See **Water Removal Rate** below for additional information.

DEW POINT METER

Electronic dew point meters are readily available and inexpensive. A dew point meter is needed to measure dew point temperatures during the drying process and for dryness final verification. Contact PERMA-PIPE for assistance if needed.

OPTIONAL HEATING

Applying heat to the service pipe or dry air purge can speed up the drying process by warming the moisture in the annular space, increasing its vapor pressure and thereby increasing the amount of moisture absorbed and removed by the dry gas purge.

CAUTION: If the service pipe or dry gas purge is heated it must be done in a controlled manner to avoid overheating of the conduit / containment system materials. Damage to the conduit / containment system caused by overheating is not covered by PERMA-PIPE's warranty.

The following precautions should be observed when applying heat during the drying process;

- The design temperature of the piping system must never be exceeded. Exceeding the design temperature can damage the conduit / containment system materials, can cause mechanical damage due to thermal expansion movements greater than the conduit / containment system is designed for, and can result in a hazardous condition.
- Violent or prolonged boiling of water in the conduit / containment annular space can severely damage the service pipe insulation and can overheat and severely damage the conduit / containment coating or insulation.
- Insulation that is wet is much less effective an insulator. Therefore the service pipe is not as well insulated from the conduit / containment pipe and a high temperature service pipe can cause the conduit / containment pipe temperature to be much higher than under normal operating conditions. This can cause mechanical damage to the conduit / containment pipe due to thermal stresses and severe damage to the conduit / containment coating or insulation.

If heat is being applied to the service pipe or dry gas purge, temperature gauges should be used to monitor the temperature of dry gas purge, service pipe and conduit / containment pipe near the dry gas Inlet end as shown on the drying equipment schematic included at the end of this Installation Manual Supplement.

The temperature of the service pipe should never exceed its design temperature. The temperature of the conduit / containment coating should not exceed 160^{O}F. The temperature of an insulated conduit / containment pipe should not exceed 200^{O}F.

CONDUIT / CONTAINMENT DRYING

PRELIMINARY STEPS

Prior to beginning the drying of a conduit / containment system conduct the following preliminary steps as needed;

- If mud, dirt, sand, sediment or any other solid or granular material has accumulated in the conduit / containment it will need to be flushed out. Flush the annular space with fresh water. Continue flushing until all debris is removed and the discharge water is clean.

  CAUTION: If the service pipe or conduit / containment pipe is stainless steel the fluid and any solids in the annular space will need to be checked for chloride content. If a stainless steel service pipe or conduit / containment pipe has been contaminated with chlorides additional cleaning may be required to remove the chloride contamination. Chlorides may be present in ground water.

  CAUTION: Chloride contamination of stainless steel can cause stress corrosion cracking resulting in reduced service life and mechanical failure of the contaminated material.
- The service pipe should be pressure tested and the conduit / containment should be air tested to verify they are leak tight. See PERMA-PIPE"S Installation Instructions for additional information on service pipe and conduit / containment pressure testing. Any leaks must be located and properly repaired. These leaks can be a source of moisture in the annular space and must be repaired before proceeding. See PERMA-PIPE"S Installation Instructions for additional information on repairs.
- Drain all water from the conduit / containment system low points. Access all low point areas such as end seals, inspection ports, leak detection pull ports to remove as much free standing water

PRELIMINARY STEPS *(continued)*

as possible. Use any effective means to remove free standing water – gravity draining, pumping out, vacuuming out, blowing dry gas over local areas, dry rags, etc.

Free standing water left in the conduit / containment system will increase the time required to dry the system.

- A properly installed conduit / containment system is sloped so that free standing water will flow to accessible low point areas (end seals, inspection ports, etc.). If there are inaccessible low points in the conduit / containment system adjust the elevations and sloping as conditions permit.

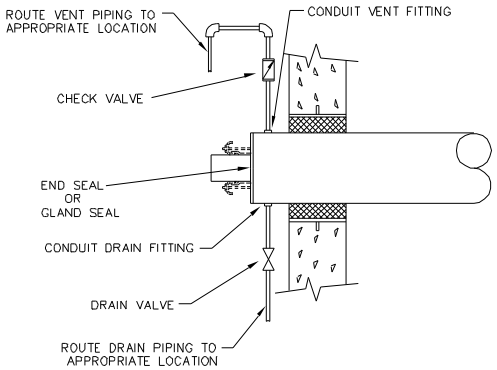
EQUIPMENT SET-UP

The drying equipment described above should be assembled as shown in the Conduit / Containment System Drying Equipment Schematic at the end of this Installation Manual Supplement.

If there are tees or branches within the run of conduit / containment piping being dried each end seal should be equipped with the vent piping shown on the Conduit / Containment System Drying Equipment Schematic so the entire conduit / containment system will be dried.

Use both the vent and drain fittings on the conduit / containment end seals for the dry gas inlet and outlet connections. The dry gas supply should be connected at the high point of the conduit / containment system and the vents at the low point(s).

After drying is complete, install the conduit / containment end seal vent and drain piping in accordance with PERMA-PIPE'S recommendations. See PERMA-PIPE"S Installation Instructions for additional information.



DRYING PROCESS

Once the drying equipment is assembled and connected to the conduit / containment system the drying process can begin.

While drying, record the dry gas flow rate, dry gas inlet pressure, dry gas inlet dew point temperature and dry gas outlet dew point temperature on a regular basis. If heat is being applied also record the dry gas inlet, dry gas outlet and conduit / containment pipe temperatures. This monitoring is needed to verify the drying process is not overheating or over pressurizing the conduit / containment system. This data can be used to calculate the water removal rate, see **Water Removal Rate** below, and provide an indication of when the drying process may be complete, see **Final Dryness Verification** below.

During drying the dry gas flow rate can be increased or decreased to improve the water removal rate of the drying process. See **Water Removal Rate** below for additional information. Be careful not to over pressurize the conduit / containment annular space or have too high a dry gas velocity within the annular space. See **Flow Rate** above for additional information and precautions

Heating of the dry gas purge or service pipe can speed the drying process. The heat will warm the moisture in the annular space, increase its vapor pressure and increase the amount of moisture absorbed and removed by the dry gas purge.

CAUTION: If the service pipe or dry gas purge is heated it must be done in a controlled manner to avoid overheating of the conduit / containment system materials. Damage to the conduit / containment system caused by overheating is not covered by PERMA-PIPE'S warranty. Refer to **Optional Heating** above for additional information and precautions.

The temperature of the service pipe should never exceed its design temperature. The temperature of the conduit / containment coating should not exceed 160^{O}F. The temperature of an insulated conduit / containment pipe should not exceed 200^{O}F.

Continue the drying process until the dew point temperature of the conduit / containment annular space is 20^{O}F or lower. When it is believed this point is reached the drying process can be stopped and the dryness verified. See **Dryness Final Verification** below.

DRYING PROCESS *(continued)*

The time required to dry a wet conduit / containment system depends on many factors and cannot be accurately predicted. These factors include;

- Size (diameter and length) of the conduit / containment system
- The amount of water in the conduit / containment annular space
- If there is insulation in the annular space (insulation will absorb water)
- The type of insulation in the annular space (different insulations absorb water differently).
- The thickness of the insulation in the annular space
- The inlet dew point temperature of the dry gas used for drying
- The flow rate of the dry gas during drying
- Whether heat is being used to speed the drying process

Although the time required to dry a wet conduit / containment system cannot be accurately predicted, it can be expected to take several or more days depending on the factors above.

DEW POINT TEMPERATURE, WATER CONTENT, WATER REMOVAL RATE

The dew point temperature is the temperature at which water vapor begins to condense out of a gas at atmospheric pressure. At any given dew point temperature there is a corresponding moisture content. The table below shows water content per 100,000 standard cubic feet (SCF) of air for dew point temperatures from 100^{O}F to –40^{O}F.

Dew Point Temperature	Gallons Water per 100,000 SCF air
100 ^{O}F	36.7
90 ^{O}F	27
80 ^{O}F	19.5
70 ^{O}F	14
60 ^{O}F	10
50 ^{O}F	7.1
40 ^{O}F	5.4
30 ^{O}F	3.2
20 ^{O}F	2.2
10 ^{O}F	1.3
0 ^{O}F	0.80
-10 ^{O}F	0.41
-20 ^{O}F	0.26
-30 ^{O}F	0.15
-40 ^{O}F	0.08

The amount of water being removed from the system at any point in time can be calculated by measuring the inlet and outlet dew point temperatures and the dry gas purge flow rate and using the chart above.

For example;

Inlet dew point temperature = -20^{O}F
0.26 gallons of water / 100,000 SCF air

Outlet dew point temperature = 40^{O}F
5.40 gallons of water / 100,000 SCF air

Flow rate = 20 SCFM

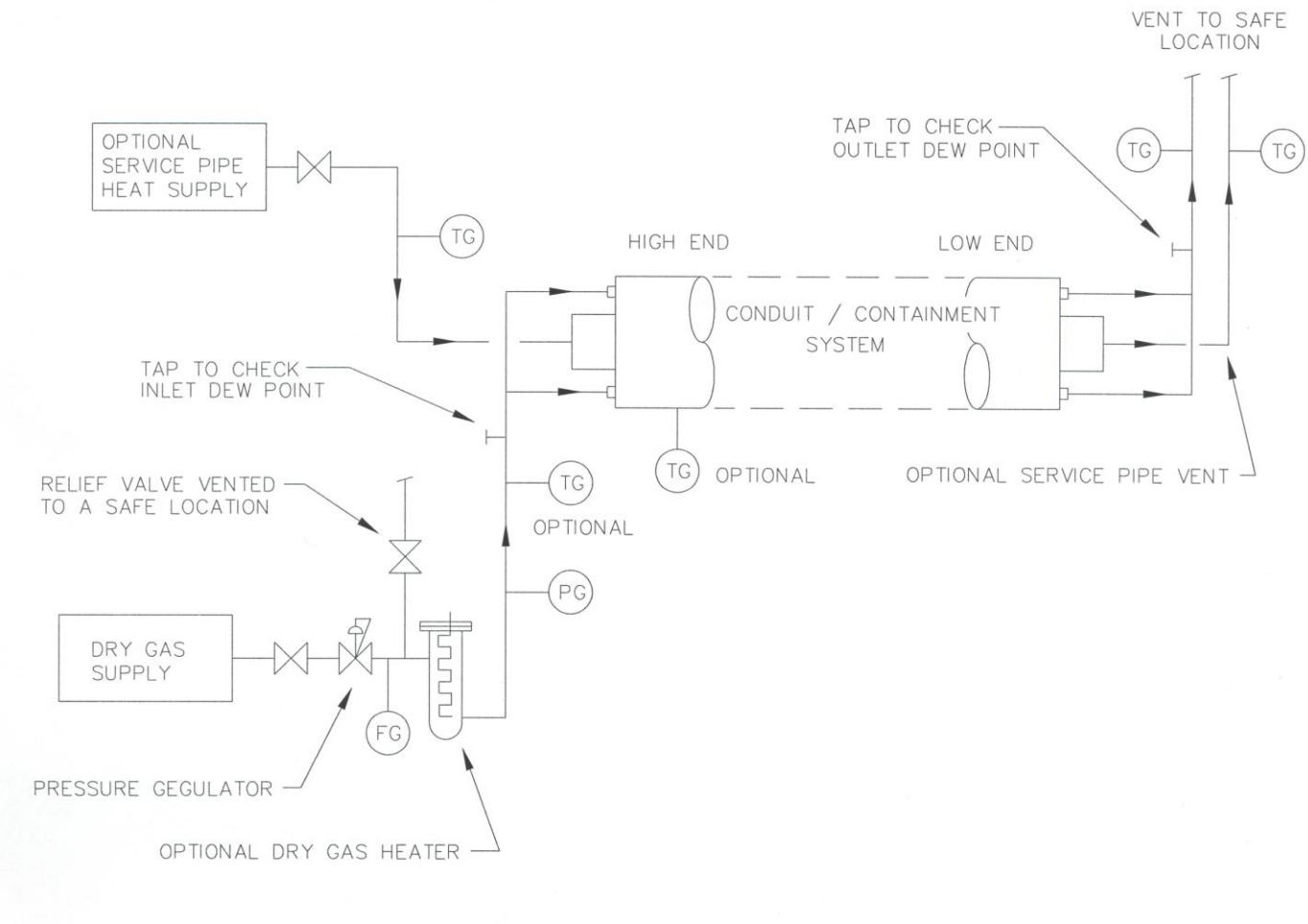
Water removal rate

$$= \frac{(5.40 - 0.26) \text{ gal. water}}{100{,}000 \text{ SCF air}} \times 20 \text{ SCFM} \times 1440 \frac{\text{min.}}{\text{day}}$$

= 1.5 gallons / day

DRYNESS FINAL VERIFICATION

A final dew point temperature check of the conduit / containment annular space should be made no sooner than four (4) hours after the drying process has been stopped to allow the conduit / containment annular space to reach equilibrium. At this time a final check of the annular space dew point temperature at all accessible points should be made to verify the conduit / containment system has been properly dried. The conduit / containment annular space dew point should be 20^{O}F or less. If the conduit / containment annular space dew point exceeds 20^{O}F continue drying.



CONDUIT / CONTAINMENT SYSTEM
DRYING EQUIPMENT SCHEMATIC

Symbol Key
FG = Flow Gauge
TG = Temperature Gauge
PG = Pressure Gauge