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ZJG - SPECIFICATION FOR HEAT TRACING SYSTEMS

1.0 SCOPE

1.1 This document provides information on the various types of heat tracing available with guidelines on selection of most suitable method for heat tracing including detailed design and installation of Syltherm 800 Heat Tracing System (LT&C)

2.0 DEFINITIONS

2.1 LT&C: Liquid Traced and Covered
ST&C: Steam Traced and Covered
ET&C: Electrically Traced and Covered

3.0 REFERENCES

3.1 Adopted: 1 Jan 2006
3.2 Based on Barry site EMTN 15.073.009

4.0 DISCUSSION

4.1 Temperature Maintenance/Need for Tracing

Temperature maintenance for fluid systems may be necessary for one or more of the following reasons:-

* prevent freezing
* prevent condensation
* maintain viscosity
* prevent separation of components

Various means to achieve this are available, one of which is a tracing system. Initially therefore it must be determined that a tracing system is the best means. Some guidelines on this are given in the document 'Freeze Protection Guidelines' (EMTN No xx.xxx.xxx).

NOTE. Tracing in this specification is not designed to maintain the operating temperature of the process or service fluid.

4.2 Types of Tracing Systems

Once the need for tracing has been established, it is then necessary to decide which type of system to use.There are three types to be considered:

4.2.1 Syltherm 800 Tracing (LT&C)
4.2.2 Electric Tracing (ET&C)
4.2.3 Steam Tracing (ST&C)

4.2.1 Syltherm 800 Tracing (LT&C)

* Syltherm 800 is normally chosen in preference to other heat transfer fluid on environmental, technical and toxicity grounds. This document does not cover tracing systems using other types of heat transfer fluids such as Dowtherm or Santotherm.
* A separate recirculation loop generally operating at 70^{o}C is provided, tracers are not taken off the main Syltherm 800 headers from the boiler, and loop temperature control is precisely achieved by varying the inflow of hot liquid.

* Tracers will have temperature degradation along their length.The required tracer temperature within a loop system must be the same.
* Initial cost is higher than for steam, but, for a large system, is less than for T&C, as long as a source of Syltherm 800 is readily available. If this is not the case and lengthy pipelines have to be provided, then a re-evaluation of the economics accounting for these should be done.
* Additions to the system are inexpensive.
* System outage affects the whole system. Failure of an individual tracer only affects the process pipe serviced by the failed tracer.
* Safety hazards are personnel oriented through leaks and relate to burns.

4.2.2. **Electric Tracing (ET&C)**

* Self limited tracing is preferred for piping that is to be maintained at temperatures up to 110°C (the maximum exposure temperature for this tracing is 110°C continuous, and 185°C intermittent).
* Temperature control is achieved by the automatic reduction of thermal output from the tracing to the pipe as the pipe temperature increases. This tracing can be modified relatively easily to suit new/modified piping.
* Fixed resistance tracing is used when the temperature needs to be maintained above 110°C. This is used in series or parallel circuit arrangements. System design is usually made such that temperature control is via on/off power control. This tracing is not easily modified and if a fault occurs, generally all the tracer has to be replaced.
* Temperature is constant along the length of the traced line.
* Circuitry can be tailored to meet diverse needs of a process. Each circuit is protected by means of an earth leakage circuit breaker to minimise hazards from arcing or sparking should a fault occur.
* Initial cost is higher than steam tracing; may be higher or lower than Syltherm 800 Tracing, depending on the size of the system.

Design criteria for Electrical Trace Heating Installations are given in Dow Corning EMTN Document 16.856.000

4.2.2 **Steam Tracing (ST&C)**

Temperature control accomplished by varying steam supply pressure. Steam pressure up to 10 Barg (about 184°C) can be used. Some degree of control is possible by means of a regulator.

* Temperature maintained is less than source temperature and falls along the tracer length. Condensate return facilities should be provided for an extensive installation. For the limited use likely to be made of steam tracing, consideration could be given to the discharging condensate to grade.
* Barry Site systems have been prone to blocking/no flow and freezing. Ruptures of tracers can occur. ST&C is not favoured at the Barry Site.
* Assuming steam source is nearby, Engineering and initial costs of later additions are small.
* Failure of steam tracer/trap does not affect the whole system.
* Safety hazards are personnel oriented: burns or ice from leaks.

ST&C will generally **NOT** be used, except in special circumstances, for example: where only occasional tracing is required, such as on long pipelines where the contents may freeze.

4.3 **Selection of Type of Tracing System**

A thorough understanding of the process, equipment and piping system is essential. This is also required to establish in fact that a tracing system is needed for temperature maintenance, in preference to other methods.
The choice between ET&C and LT&C is aided by the following table:

ITEM	LT&C	ET&C
Reliability	Very good	Good
Troubleshooting	By production personnel	Usually need Electrician
Ease of maintenance or modification	Reasonable	Self-limiting: easy fixed resistance: hard
Temperature control	Good	Very Good
Maintenance Temperature limit	50°C to 90°C	up to 300°C (though is expensive at high temperatures)
Power increase capability if needed (special)	Good	Poor
Max tracer length	30-60M	105-130M (depends on pipe size)
Initial cost	Higher if smaller system (<15 tracers)	Higher if larger system (>15 tracers)
Safety Hazards	Burns Flammability Spills Auto-ignition above 90°C	Arcing Shocks (Risk is low if earth leakage circuit breakers are installed)

Generally, it is recommended that LT&C be used for those areas/processes where the need for tracing is substantial and Syltherm 800 is readily available, such that it becomes cost-effective.
The Methyl Chloride, Hydrolysis and Splitter processes are prime candidates for LT&C.

It is the preferred method over ET&C for other processes too provided the tracing needs are large enough and Syltherm 800 is available to make it economically justifiable.
The limitations of LT&C systems are as follows:

* Do not use on pipework beyond the physical limits of the system.
* Within the process, any isolated spots which are remote from other parts of the system but which may be near to ET&C already installed, for example, on a piperack close by.
* Instrument impulse lines may be traced with an LT&C system but a judgement needs to be made as to whether it is preferable to ET&C. For example, if the line that contains the instrument is LT&C, then the instrumentation is probably best served also by LT&C.

Purpose-made insulated impulse line systems with LT&C are available, comprising a tracer that runs closely alongside the impulse line(s), all insulated together. This decision should be made in consultation with the Instrument Engineer.

4.4 Design Points for LT&C Systems

4.4.1 Flow scheme, (for circulation loop).

Recommended system flow scheme is per P&ID No BDC 00040362.
Note that an expansion tank is not required, since the loop runs full and essentially 'floating' on the main headers from the Syltherm 800 Boiler.
The loop piping should be run with:

* As few high points as possible. At these points a vent is required and this should be designed to be easily accessible and to allow safe venting of vapours with minimum risk of contact with hot vapour or liquid.
* Drains at all low points (to allow draining if required, especially for commissioning and initial system cleanout).

It is recommended that the final routing of the loop be left till late in the design stage so that the most efficient piping layout can be used to minimise pockets and cover all the areas of the process. This recommendation is based on NAMEX experience, where there was much field rework of the loop and subheaders. Indeed, there may even be a case for field running some of the loop and any subheaders (25 mm or 40 mm supply lines over to clusters of tracers that start some distance away from the loop). This will need to be decided once the layout and schedule of lines to be traced is known.
An in-line static mixer should be provided to mix the incoming hot Syltherm 800 with the contents of the loop. Temperature control is achieved by bleeding in 'fresh' hot Syltherm 800 to the loop upstream of the mixer to maintain a constant loop temperature, measured at the outlet of the mixer. An equivalent volume of cold Syltherm 800 is displaced from the loop upstream of where the fresh Syltherm 800 is bled in.

4.4.2 Safety Protection (Trip system)

A DCS-based trip system (operational interlock) is to be provided to guard against over temperature of the loop and the consequence of rupture of a tracer or of the loop piping. (Maximum possible temperature of about 380°C exceeds most process pipe specification temperature limits.
Note especially the need to set the temperature trip appropriately for line pipe systems so that they are protected).

Previous HAZOPS have resulted in two separate high temperature switches, (TSH's Maximum temperature trip setting will be 90 ^{o} C), local to the loop supply and return take-off points to the Syltherm 800 mains; a (reverse flow) DP trip with the DP measured across an automatic valve on the Syltherm 800 return line from the loop to the main headers and a mechanical non-return valve as a further level of protection.

The TSH's trip closed automatic valves on the supply/return lines from the main headers into the loop, whilst the return valve is tripped closed when the DP shows flow **from** the headers **into** the loop. Note that this DP loop cannot operate measuring the DP in the opposite direction, since once it trips - so the loop then cools and contracts - it will no longer run full and will never again satisfy the DP.

This low DP trip should also be 'auto-reset' since in practice it tends to operate regularly as a consequence of the temperature control and dynamics of the loop and so the auto-reset minimises the need for operator intervention.

4.4.3 Tracer operation monitoring

Temperature elements (TE's) installed where the tracers return to the loop are an excellent aid to monitoring system integrity and to troubleshooting, indicating that flow is normal (low readings show that tracer is blocked). A separate TE is required for each tracer. The installation of TE's is strongly recommended.

4.4.4 Sizing/Number of Tracers

As a general rule for horizontal product and service pipelines, a single tracer is to be installed for pipe sizes up to and including 150 mm NB. For all line sizes greater than 200 mm NB two tracers should be used. On vertical pipelines the pitch of the spiral rap may be adjusted to increase the effect on the larger lines.

4.4.5 Tracing Tubing and in-line Valves.

The specification for tracer tubing will be as follows:

* Refer to EMTN Doc 13.417.005 Barry - Specification for Instrument Tubing
* Stainless steel to ASTM A269 Gr. TP316L Max hardness RB80 - typically 10 mm O.D., 1 mm wall thickness with the tracer length chosen to give the desired flow.
* Fittings will be of Swagelok manufacture - 316 stainless steel.
* The actual diameter will depend on available DP and flow required for a certain process line length: typically a standard diameter, such as 10 mm is selected and a limit set on tracer length.
* In-line valves will be Whitey Type SS-83.

4.4.6 Design/Installation

* Is it recommended that a manual regulating valve be used in the loop to generate the DP in the loop between the tracer supplies and returns. This DP is critical since it sets the tracer flows/heat input, and it is difficult to successfully size an orifice in this case, especially where setting the DP in the field, and verifying from the tracer temperature indicators that it is correct is such a good, easy alternative.

* The number of fittings should be minimised but attention is required to removable items such as flanges and flanged valves to enable tracers to be disconnected at these points and therefore reduce the amount of damage to insulation and cladding. Tracers should be installed at pumps and other items of equipment so that they can be easily sprung apart (if possible) for equipment removal. If this is not possible and the tracers will need to be broken apart, then consideration should be given to installing a low point tracer drain and in-line isolation valves so that the tracing around the equipment can be safely prepared prior to removal.
* Tracer tubing should be attached to horizontal process pipework along the underside using a strapping system with 12 mm wide steel band at a spacing of approximately 450 mm centres. On vertical lines the tracer may be spirally wound round the pipework.

4.4.7 Insulation

Note that the system operating temperature will normally negate the need for foam glass insulation as long as over temperature protection as described above is in place.
Mineral wool insulation shall be used for pipework, the next available size upwards of the pipe size will generally accommodate the tracer. Calcium silicate insulation must not be used due to the risk of chemical degradation and failure of the stainless steel.

4.4.8 System Contamination

It is recommended that the system be thoroughly blown out to remove all loose debris, completely dried and Nitrogen inerted prior to introducing Syltherm 800. A pump suction strainer (80 mesh basket) is also recommended (a single strainer is sufficient if the loop can be shut down for as long as is needed to service it).
Chemical cleaning is NOT considered necessary.

4.4.9 Pumps

Canned or Magdrive pumps are used on Syltherm duty (all are horizontal mounted).
Pump must have DCS status and current indication with a low current trip. **Canned** Pumps also to have a low level trip and over temperature trip. These are **Mandatory** requirements for Canned Motor type of pump.

4.4.10 Supplier of Static Mixers

CHEMINEER Limited

4.5 DESIGN POINTS FOR ST&C SYSTEMS

4.5.1 Sizing/Number of Tracers

* Steam tracing will be connected to a dedicated reduced pressure steam header operating at 1.7 BarG (25PSIG). The header will be furnished with 1/2" NPT tracer connections along its top surface. To these will be fitted 1/2" NPT/12 mm male stud couplings for the tracers.

* The sizing of tracer is more of an art than a science. For this standard, a tracer O.D. of 12 mm has been chosen and the selection of the length left with the designer. On line size up to 2" use 3/8" copper tubing tracer. For 3" to 6" use single 1/2" carbon steel tracer and for lines 8" dia and above use two 1/2" carbon steel tracers. It should be remembered that on exposed site such as Barry, wind chill can effectively lower a temperature of 0°C to -16°C and allowances must be made for this.

4.5.2 Tracer Tubing and Fitting Schedule

Tubing and fittings for steam tracers will be as follows:

a) 15 mm: carbon steel pipe in accordance with Spec S150SW, EMTN Document No 15073002.
b) Copper tube to ASTM B86 No 122 soft annealed. Fittings to be of Wade manufacture.

The following is a list of preferred steam handling equipment (Spiral Sarco manufacture):
Steam separator
Steam pressure reducing valve, Fig DP 17, fitted yellow spring (0.2 - 3 Barg)
Steam trap, Fig TD 42

4.5.3 Installation

For trouble free operation of ST&C systems it is vital that good steam practices are followed. The headers must be thoroughly flushed out prior to adding the tracer fittings.
A pipeline strainer and steam separator will be installed between the steam isolation valve and the pressure reducing valve. This separator will be fitted with a steam trap and will remove most of the condensate droplets before the steam reaches the actual tracers. The header will be furnished with a pressure gauge and syphon trap to indicate the reduced steam pressure. A typical range for the gauge will be 0 - 4 Barg and operating pressure of the header 2 Barg, but adjustments to this may be made during commissioning.
The 90 degree male stud couplings should be installed to face downstream. Using 'Ells' at these points will allow the tracer to be wrapped around the process line to its under surface along which it will be clipped. Using ells also facilitates insulating.
The tracer shall be installed so that at no point will it rise. Provision must be made for its expansion - this will typically be in the form of a horizontal loop. Where the tracer is set around, for example, a pair of flanges, again the loop must be horizontal. At the end of the tracer run the tubing will leave the process pipework and run to a steam trap which will be serviceable from grade. Insulation for personnel protection shall be continuous throughout.
It is essential that the system is documented and any post commissioning modifications are included.