

DEP SPECIFICATION

HEAT TRANSFER FLUID SYSTEMS

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DESIGN AND ENGINEERING PRACTICE

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TABLE OF CONTENTS

1.	INTRODUCTION	4
1.1	SCOPE	4
1.2	DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS	4
1.3	DEFINITIONS	4
1.4	CROSS-REFERENCES	6
1.5	SUMMARY OF MAIN CHANGES.....	6
1.6	COMMENTS ON THIS DEP	7
1.7	DUAL UNITS.....	7
1.8	NON NORMATIVE TEXT (COMMENTARY).....	7
2.	GENERAL REQUIREMENTS FOR HEAT TRANSFER FLUID SYSTEMS	8
2.1	GENERAL	8
2.2	HEATER	9
2.3	EXPANSION VESSEL	9
2.4	STORAGE TANK.....	12
2.5	PIPING	13
2.6	HEAT EXCHANGERS (CONSUMERS)	14
2.7	PUMPS	14
2.8	INSTRUMENTATION AND CONTROL	15
2.9	MISCELLANEOUS	15
3.	GENERAL REQUIREMENTS FOR HOT WATER SYSTEMS	17
3.1	GENERAL	17
3.2	HEATER	17
3.3	EXPANSION VESSEL/STEAM DISENGAGEMENT DRUM	19
3.4	PIPING	21
3.5	HEAT EXCHANGERS (CONSUMERS)	22
3.6	PUMPS	22
3.7	INSTRUMENTATION AND CONTROL	23
3.8	MISCELLANEOUS	24
	REFERENCES	27

APPENDICES

APPENDIX A	TYPICAL LAYOUT OF AN HTF SYSTEM WITH A FURNACE.....	28
APPENDIX B	TYPICAL LAYOUT OF AN HTF SYSTEM WITH A WHRU	29
APPENDIX C	TYPICAL LAYOUT OF HOT WATER SYSTEM WITH A FURNACE	30
APPENDIX D	TYPICAL LAYOUT OF HOT WATER SYSTEM WITH A WHRU	31



1. INTRODUCTION

1.1 SCOPE

This DEP specifies requirements and gives recommendations for design of closed circuit heat transfer fluid (HTF) systems. It includes the application of organic (both mineral and synthetic), silicone-based HTFs operating in liquid phase and hot water but explicitly excludes water based tempered water systems and straight run refinery/process streams used as hot oils which are not commercially available as branded HTFs.

This DEP contains mandatory requirements to mitigate process safety risks in accordance with Design Engineering Manual (DEM) 1 – Application of Technical Standards.

This is a revision of the DEP of the same number dated February 2015; see (1.5) regarding the changes.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by Shell GSI, the distribution of this DEP is confined to Shell companies and, where necessary, to Contractors and Manufacturers/Suppliers nominated by them. Any authorized access to DEPs does not for that reason constitute an authorization to any documents, data or information to which the DEPs may refer.

This DEP is intended for use in facilities related to oil and gas production, gas handling, oil refining, chemical processing, gasification, distribution and supply/marketing. This DEP may also be applied in other similar facilities.

When DEPs are applied, a Management of Change (MOC) process shall be implemented; this is of particular importance when existing facilities are to be modified.

If national and/or local regulations exist in which some of the requirements could be more stringent than in this DEP, the Contractor shall determine by careful scrutiny which of the requirements are the more stringent and which combination of requirements will be acceptable with regards to the safety, environmental, economic and legal aspects. In all cases, the Contractor shall inform the Principal of any deviation from the requirements of this DEP which is considered to be necessary in order to comply with national and/or local regulations. The Principal may then negotiate with the Authorities concerned, the objective being to obtain agreement to follow this DEP as closely as possible.

1.3 DEFINITIONS

1.3.1 General definitions

The **Contractor** is the party that carries out all or part of the design, engineering, procurement, construction, commissioning or management of a project or operation of a facility. The Principal may undertake all or part of the duties of the Contractor.

The **Manufacturer/Supplier** is the party that manufactures or supplies equipment and services to perform the duties specified by the Contractor.

The **Principal** is the party that initiates the project and ultimately pays for it. The Principal may also include an agent or consultant authorised to act for, and on behalf of, the Principal.

The word **shall** indicates a requirement.

The capitalised term **SHALL [PS]** indicates a process safety requirement.

The word **should** indicates a recommendation.

The word **may** indicates a permitted option.

1.3.2 Specific definitions

Term	Definition
Expansion vessel	Vessel that accommodates expanded volume and surge of the HTF, and allows for venting of low boiling point components from the system.
Fire point	Lowest temperature beyond the flash point, at which the specimen sustains combustion, for a minimum of five seconds.
Flash point	The lowest temperature corrected to a barometric pressure of 101.3 kPa (760 mmHg), at which application of an ignition source causes the vapour of a specimen of the sample to ignite under specified conditions of test.
HTF system	Heaters, piping, pumps, vessels, heat exchangers and auxiliaries that constitute a closed circuit containing the HTF.
Heat transfer fluid (HTF)	Fluid capable of transporting heat energy within a specified temperature range. Specific hydrocarbon-based fluids are available on the open market for use in heat transfer applications. Generally, this includes synthetic aromatic, silicone-based and a limited selection of specific HTF designated mineral oils and water of controlled quality
Heater	Heat energy producer in the system, either a heat exchanger, a furnace or a waste heat recovery unit (WHRU).
High boilers	Components of high molecular weight and higher boiling point than the original fluid, formed when the heat transfer fluid breaks down on exposure to a high temperature.
Low boilers	Components of low molecular weight and lower boiling point than the original fluid, formed when the heat transfer fluid breaks down on exposure to a high temperature.
Maximum allowable bulk temperature (MABT)	Maximum bulk temperature of the HTF allowed anywhere in the circuit, as specified by the Manufacturer of the HTF.
Maximum allowable film temperature (MAFT)	Maximum temperature to which the HTF may be subjected in the heater. This highest temperature is on the tube inner wall of the heater and is determined by the heat flux and heat transfer coefficient. The Manufacturer of the HTF recommends the MAFT.
Maximum operating temperature (MOT)	Maximum HTF bulk temperature at which the system is designed to operate, as measured at the outlet of the heat source.
Minimum operating temperature	Lowest HTF bulk temperature at which the system is designed to operate under all conditions including start-up and shutdown. It shall always be higher than the pumpability limit.

Term	Definition
Pump-out cooler	Cooler in the run-down line to the storage tank to cool down hot HTF in case of evacuation of the system.
Spill-over bypass	Bypass line parallel to consumers, which controls the flow and pressure in the HTF supply header, in case of consumer trip or demand change.
Storage tank	Tank for storage of HTF.
Trim cooler	Cooler in the heating circuit used to adjust the temperature of the HTF

1.3.3 Abbreviations

Term	Definition
FAC	Flow Accelerated Corrosion
HP	high pressure
HSSE	Health, Safety, Security and Environment
HTF	Heat Transfer Fluid
MABT	maximum allowable bulk temperature
MAFT	maximum allowable film temperature
MOT	Maximum Operating Temperature
NPSH	Net Positive Suction Head
NRV	Non Return Valve
ROV	Remote Operated Valve
TEG	turbine exhaust gas
WHRU	waste heat recovery unit

1.4 CROSS-REFERENCES

Where cross-references to other parts of this DEP are made, the referenced section or clause number is shown in brackets (). Other documents referenced by this DEP are listed in (4).

1.5 SUMMARY OF MAIN CHANGES

This DEP is a full revision of the DEP of the same number dated February 2015. The changes followed a requirements quality review and were not a full technical update. The following are the main, non-editorial changes.

Section/Clause	Change
All	Restructured and clarified requirements, enforced use of shall / should / may for normative statements.

1.6 COMMENTS ON THIS DEP

Comments on this DEP may be submitted to the Administrator using one of the following options:

Shell DEPs Online (Users with access to Shell DEPs Online)	Enter the Shell DEPs Online system at https://www.shelldeps.com Select a DEP and then go to the details screen for that DEP. Click on the "Give feedback" link, fill in the online form and submit.
DEP Feedback System (Users with access to Shell Wide Web)	Enter comments directly in the DEP Feedback System which is accessible from the Technical Standards Portal http://swwww.shell.com/standards . Select "Submit DEP Feedback", fill in the online form and submit.
DEP Standard Form (other users)	Use DEP Standard Form 00.00.05.80-Gen. to record feedback and email the form to the Administrator at standards@shell.com .

Feedback that has been registered in the DEP Feedback System by using one of the above options will be reviewed by the DEP Custodian for potential improvements to the DEP.

1.7 DUAL UNITS

This DEP contains both the International System (SI) units, as well as the corresponding US Customary (USC) units, which are given following the SI units in brackets. When agreed by the Principal, the indicated USC values/units may be used.

1.8 NON NORMATIVE TEXT (COMMENTARY)

Text shown in italic style in this DEP indicates text that is non-normative and is provided as explanation or background information only.

Non-normative text is normally indented slightly to the right of the relevant DEP clause.

2. GENERAL REQUIREMENTS FOR HEAT TRANSFER FLUID SYSTEMS

2.1 GENERAL

1. The HTF system should be designed for automated control from start-up to minimum stable operating duty and to design duty with minimum fuel consumption in all operating cases.
 - a. Liquid burners may require local start up.
2. The area classification for high temperature HTF systems SHALL [PS] be based on a closed-cup flash point in the ranges of class IIIA (NFPA: 60 °C (140 °F) <FP < 93 °C (200 °F)) or class III (IP15: 55 °C (130 °F) < FP < 100 °C (212 °F)), except for flash point fluids lower than above.
3. Welded connections shall be applied to HTF systems unless a flanged connection is required for maintainability requirements.
4. Installation of HTF systems on floating facilities shall take the effect of vessel motion ('sloshing') on the equipment, into account.

This is especially relevant to large vessels and tanks.
5. Refer to Section 5.2 of DEP 31.22.05.12-Gen. for guidance on sloshing considerations for floating facilities.
6. Contractor shall design and engineer an HTF system with associated equipment and develop the specifications and drawings.

Refer to (Appendices A and B) for simplified typical schemes of HTF systems with furnace and with WHRU. For design guidance, refer to the Standard Drawing S.01.005.

The Principal might specify a maximum operating temperature for the HTF that is lower than the MABT for a specific application.
7. Minimum Operating Temperature for HTF shall be selected so that the:
 - a. HTF viscosity is lower than the pumpability limit (HTF viscosity 150 mm²/s - 300 mm²/s, depending on pump size);
 - b. MAFT is not exceeded in the heater during start-up.

2.2 HEATER

1. An HTF heater shall be designed to ensure that the HTF is not subjected to temperatures above the maximum allowable film and bulk temperatures.
This will minimize risk of overheating and coking that can lead to failure of tubes.
2. Refer to DEP 31.24.00.30-Gen. for the requirements pertaining to the design of Fired Heaters.
3. Heater duty and allowance for heat losses shall be based on the Project design class chosen.
WHRUs might contain additional heating coils such as those required for regeneration gas heating.
4. The location and orientation of regeneration gas heating coils in a WHRU shall be based on the coking tendency of the regeneration gas, gas composition, temperature and turbine exhaust gas conditions for all operating cases.
5. Doubling the normal design pressure should be considered for the heating coils in WHRUs
This solves issues with respect to manifold design, crossover design, hydrostatic test pressure and future tube rejection criteria.
6. The next higher schedule for heating coils should be applied rather than the minimum required schedule per the design code.
7. Irrespective of a ferritic or an austenitic steel material, schedule 40 wall thickness shall be selected as minimum for the coils.
8. The applicable tolerances to be taken into account during coil wall thickness selection which shall be subject to approval of the Principal.

2.3 EXPANSION VESSEL

2.3.1 Capacity and purpose

1. For determining the volume of an expansion vessel, the following aspects shall be taken into account:
 - a. accommodate for the thermal expansion of the HTF heated from minimum ambient to maximum operating temperature (MOT);
 - b. maintain the required net positive suction head (NPSH) for the HTF circulation pumps under all operational scenarios;
 - c. reduce the risk of HTF losses into the flare system.
In the event of a tube rupture inside heat transfer equipment operating at process pressures above that of the HTF circuit, sudden displacement of fluid from the system into the vessel can result in HTF loss into the flare system;
 - d. venting of low boilers and possible residual water present in the circuit during start-up for synthetic or mineral HTFs;
 - e. to allow filling of equipment and re-commissioning after shut down.
The largest volume of the individual equipment that can be maintained while the HTF system remains in operation determines this inventory.

2.3.2 Location and configuration

1. The expansion vessel should be elevated so that the normal operating level of the HTF in the vessel is higher than the highest possible HTF level in the system.
2. A lower elevation of the expansion vessel may be provided if additional design measures are included to:
 - a. evacuate vapours locked in the higher parts of the circuit;
 - b. cater for HTF draining into the expansion vessel during a shutdown to avoid HTF overflow into the flare system;
 - c. ensure that the HTF system pressure remains positive enough at the highest point to avoid boiling.
3. The expansion vessel shall be connected to the system return line on the pump suction side.

It is acceptable to allow the operator to initiate HTF make-up and draw-off manually.
4. The vessel and the piping around it shall be designed for the full flow of the HTF through the vessel.
5. Where separation of low boiler components is not required to be done in the expansion vessel, a "single-leg" design may be applied ("cold fluid" expansion vessel) subject to the Principal's approval.
6. Low boiling degradation products shall be vented on pressure control and routed to the flare.
 - a. If regular venting of vapours is unavoidable and/or the collection of HTF in the flare knockout drum undesirable, e.g., for operational or HSSE reasons, the vent line should be routed via a condenser to a collecting drum prior to venting the non-condensable components to flare.
 - b. The liquid HTF shall be collected for safe disposal off-site.
 - c. Collected liquids may also be routed via the on-line purification unit (if fitted) for recovering part of the HTF (2.9.5).
7. The expansion vessel shall be equipped with a safety relief valve arrangement capable of protecting the system against over-pressure caused by events such as fluid degradation, contamination, mal-operation, blanket gas control failure, blocked outlet, overheating, fire or tube failure in the system:
 - a. Refer to DEP 80.45.10.11-Gen. for requirements pertaining to Design of Safety valves.
8. The safety relief valve outlet line shall be routed to the flare.
9. Potential for choked two phase flow from the condensation of HTF in relief valve discharge line shall be evaluated.
 - a. Mitigation steps shall be taken e.g., Provision of knock-out drum, continuous sloped piping from flare header down to relief valve to avoid pockets, or heat traced lines to prevent adverse impact on the flare header system.
10. Nitrogen lines and valves, vent back pressure lines and valves and safety relief valves and lines shall be heat traced in order to prevent plugging due to:
 - a. fall in the ambient temperature below the freezing point of the fluid or its degradation products;
 - b. accumulation of high boiling point components in the line.