

DEP SPECIFICATION

CHILLING SYSTEMS

DEP 31.21.01.38-Gen.

February 2017

ECCN EAR99

DESIGN AND ENGINEERING PRACTICE

DEM1



© 2017 Shell Group of companies

All rights reserved. No part of this document may be reproduced, stored in a retrieval system, published or transmitted, in any form or by any means, without the prior written permission of the copyright owner or Shell Global Solutions International BV.

This document contains information that is classified as EAR99 and, as a consequence, can neither be exported nor re-exported to any country which is under an embargo of the U.S. government pursuant to Part 746 of the Export Administration Regulations (15 C.F.R. Part 746) nor can be made available to any national of such country. In addition, the information in this document cannot be exported nor re-exported to an end-user or for an end-use that is prohibited by Part 744 of the Export Administration Regulations (15 C.F.R. Part 744).

This document has been supplied under license by Shell to:
UOP Honeywell ted.fuger@honeywell.com 19/01/2018 06:45:22

PREFACE

DEP (Design and Engineering Practice) publications reflect the views, at the time of publication, of Shell Global Solutions International B.V. (Shell GSI) and, in some cases, of other Shell Companies.

These views are based on the experience acquired during involvement with the design, construction, operation and maintenance of processing units and facilities. Where deemed appropriate DEPs are based on, or reference international, regional, national and industry standards.

The objective is to set the standard for good design and engineering practice to be applied by Shell companies in oil and gas production, oil refining, gas handling, gasification, chemical processing, or any other such facility, and thereby to help achieve maximum technical and economic benefit from standardization.

The information set forth in these publications is provided to Shell companies for their consideration and decision to implement. This is of particular importance where DEPs may not cover every requirement or diversity of condition at each locality. The system of DEPs is expected to be sufficiently flexible to allow individual Operating Units to adapt the information set forth in DEPs to their own environment and requirements.

When Contractors or Manufacturers/Suppliers use DEPs, they shall be solely responsible for such use, including the quality of their work and the attainment of the required design and engineering standards. In particular, for those requirements not specifically covered, the Principal will typically expect them to follow those design and engineering practices that will achieve at least the same level of integrity as reflected in the DEPs. If in doubt, the Contractor or Manufacturer/Supplier shall, without detracting from his own responsibility, consult the Principal.

The right to obtain and to use DEPs is restricted, and is typically granted by Shell GSI (and in some cases by other Shell Companies) under a Service Agreement or a License Agreement. This right is granted primarily to Shell companies and other companies receiving technical advice and services from Shell GSI or another Shell Company. Consequently, three categories of users of DEPs can be distinguished:

- 1) Operating Units having a Service Agreement with Shell GSI or another Shell Company. The use of DEPs by these Operating Units is subject in all respects to the terms and conditions of the relevant Service Agreement.
- 2) Other parties who are authorised to use DEPs subject to appropriate contractual arrangements (whether as part of a Service Agreement or otherwise).
- 3) Contractors/subcontractors and Manufacturers/Suppliers under a contract with users referred to under 1) or 2) which requires that tenders for projects, materials supplied or - generally - work performed on behalf of the said users comply with the relevant standards.

Subject to any particular terms and conditions as may be set forth in specific agreements with users, Shell GSI disclaims any liability of whatsoever nature for any damage (including injury or death) suffered by any company or person whomsoever as a result of or in connection with the use, application or implementation of any DEP, combination of DEPs or any part thereof, even if it is wholly or partly caused by negligence on the part of Shell GSI or other Shell Company. The benefit of this disclaimer shall inure in all respects to Shell GSI and/or any Shell Company, or companies affiliated to these companies, that may issue DEPs or advise or require the use of DEPs.

Without prejudice to any specific terms in respect of confidentiality under relevant contractual arrangements, DEPs shall not, without the prior written consent of Shell GSI, be disclosed by users to any company or person whomsoever and the DEPs shall be used exclusively for the purpose for which they have been provided to the user. They shall be returned after use, including any copies which shall only be made by users with the express prior written consent of Shell GSI. The copyright of DEPs vests in Shell Group of companies. Users shall arrange for DEPs to be held in safe custody and Shell GSI may at any time require information satisfactory to them in order to ascertain how users implement this requirement.

All administrative queries should be directed to the DEP Administrator in Shell GSI.

TABLE OF CONTENTS

1.	INTRODUCTION	4
1.1	SCOPE	4
1.2	DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS	4
1.3	DEFINITIONS	5
1.4	CROSS-REFERENCES	7
1.5	SUMMARY OF MAIN CHANGES.....	7
1.6	COMMENTS ON THIS DEP	8
1.7	DUAL UNITS.....	8
1.8	NON NORMATIVE TEXT (COMMENTARY).....	8
2.	DESIGN AND ENGINEERING	9
2.1	GENERAL	9
2.2	TECHNOLOGY SELECTION CONSIDERATIONS.....	10
2.3	VAPOUR ABSORPTION CHILLERS	10
2.4	VAPOUR COMPRESSION CHILLERS	18
2.5	INSTALLATION	25
2.6	MATERIALS, FABRICATION AND STRUCTURES.....	25
2.7	PRESERVATION AND INITIAL PREPARATION.....	26
2.8	NOISE LIMITATIONS	26
3.	INSTRUMENTATION	27
4.	CONTROLS.....	28
4.1	GENERAL	28
4.2	VAPOUR ABSORPTION CHILLERS	29
4.3	VAPOUR COMPRESSION CHILLERS	29
5.	SAFEGUARDING.....	30
5.1	VAPOUR ABSORPTION CHILLERS	30
5.2	VAPOUR COMPRESSIVE CHILLERS	31
6.	QUALITY ASSURANCE AND INSPECTION	31
6.1	QUALITY ASSURANCE	31
6.2	INSPECTION AND TESTING.....	31
7.	ERECTION, CLEANING, START-UP AND PERFORMANCE TESTING	33
7.1	MECHANICAL ERECTION/CLEANING	33
7.2	START-UP	33
7.3	PERFORMANCE/ACCEPTANCE TESTS.....	33
8.	DOCUMENTATION	34
8.1	GENERAL	34
8.2	DATA/REQUISITION SHEETS AND DOCUMENTATION REQUIRED AT THE TENDERING STAGE.....	34
8.3	DOCUMENTATION AND INFORMATION REQUIRED AFTER CONTRACT AWARD.....	38
9.	REFERENCES	40

APPENDICES

APPENDIX 1	TERMINAL POINTS	44
-------------------	------------------------------	-----------

1. INTRODUCTION

1.1 SCOPE

This new DEP specifies requirements and gives recommendations for the design, engineering, material supply inspection, site erection, start-up and performance testing of both vapour absorption type and vapour compression type chillers.

This specification is applicable to chillers intended for use in oil, gas and chemical plants. Excluded from the scope of this DEP are:

- a) Chillers intended for air conditioning applications.
- b) Special processes such as liquefaction of natural gas.

Guidance regarding chilled fluid loop design is outside the scope of this DEP.

This is a revision of the DEP of the same number dated February 2013; 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 authorised access to DEPs does not for that reason constitute an authorisation 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 which 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 which manufactures or supplies equipment and services to perform the duties specified by the Contractor.

The **Principal** is the party which initiates the project and ultimately pays for its design and construction. The Principal will generally specify the technical requirements. 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
Design Class	Design Class is a categorization defining fit-for-purpose facilities developed through Value Improvement Processes (VIPs) during a project Front End Development (FED) phase.
Process Safety	Process Safety is the management of hazards that can give rise to major accidents involving the release of potentially dangerous materials, release of energy (such as fire or explosion) or both.

1.3.3 Abbreviations

Term	Definition
AHRI	Air Conditioning, Heating and Refrigeration Institute
ANSI	American National Standards Institute
API	American Petroleum Institute
ARI	American Refrigeration Institute (obsolete organization – merged with AHRI)
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
BS	British Standards Institute
CFC	Chloro-Fluoro Carbon refrigerant
COP	Coefficient of Performance
CRN	Canadian Registration Number
CUI	Corrosion Under Insulation
DCS	Distributed Control System
DEP	Design and Engineering Practice
DSR	Design Safety Review
EEMUA	Engineering Equipment and Materials Users' Association
EN	European Standard
FED	Front End Development
FLD	Functional Logic Diagrams
GA	General Arrangement
GWP	Global Warming Potential
HAZOP	Hazards and Operability Study
HBR	Hydrogen bromide
HCFC	Hydro-Chloro-Fluoro-Carbon refrigerant
HFC	Hydro-fluoro-carbon refrigerant
IEC	International Engineering Consortium
IIAR	International Institute of Ammonia Refrigeration

Term	Definition
IPF	Instrumented Protective Function (safeguarding by instrumentation)
ISO	International Standards Organization
LiBR	lithium bromide
LiOH	Lithium hydroxide
O&M	Operation and Maintenance
ODP	Ozone Depletion Potential
OEL	Occupational Exposure Limit
PEFS	Process Engineering Flow Schemes (also known as Process and Instrumentation Diagrams, P&IDs)
PFS	Process Flow Schemes, also known as PFD
PLC	Programmable Logic Controller
SI	International System units of measure
UL	Underwriters Laboratories
USC	US Customary units of measure
VAR	Vapour Absorption Refrigeration
VCR	Vapour Compression Refrigeration
VFD	Variable Frequency Drive
VIP	Value Improvement Processes

1.4 CROSS-REFERENCES

Where cross references to other parts of this DEP are made, the referenced section number is shown in brackets (). Other documents referenced in this DEP are listed in (9).

1.5 SUMMARY OF MAIN CHANGES

This DEP is a revision of the DEP of the same number dated February 2013. The following are the main, non-editorial changes.

Section/Clause	Change
All	Restructured and clarified requirements, enforced shall/should

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. DESIGN AND ENGINEERING

2.1 GENERAL

1. This DEP specifies requirements for industrial chillers as typically encountered in oil refineries, chemical plants and gas plants.
 - a. It specifies requirements for both vapour absorption and vapour compression type chillers.
2. The Manufacturer/Supplier shall obtain local code stamps and certificates needed.
3. The Chiller package should be engineered as a modularized (standardized) package.
4. The Chiller package shall be made suitable for its required area classification.
5. Sufficient space and access shall be provided for inspection, cleaning, removal and maintenance of such parts as filters, compressors, tube bundles, evaporators and condensers.
6. Vendor recommended maintenance and inspection envelopes shall be detailed in the GA drawings.
7. The chiller location (outdoor or indoor) shall be decided based on the site requirements.
 - a. For outdoor installation chiller shall be designed taking into account of the site specific outdoor conditions (both ambient hot and cold conditions).
 - b. The design shall be proven in industry, robust and capable of 4 years' continuous operation with not less than 4 years between major overhauls.
8. Reliability requirements may dictate a spare chiller if the consequences of failure are severe.

See (2.3.17) for details and guidance on VAR chillers.

Safety, ease of operation, inspection, maintenance, repair and cleaning are of major importance.
9. The Manufacturer shall give full details of the chemical and physical properties of the construction materials.
10. Industry proven technology shall be applied:
 - a. to comply with the requirements for the emission of pollutants to the environment;
 - b. for the optimization of energy efficiency.
11. The Contractor shall define the chilling requirements such as:
 - a. chilled fluid supply temperature, (chilled fluid outlet from evaporator);
 - b. expected chilled fluid return temperature (chilled fluid inlet to evaporator);
 - c. minimum and maximum chilled fluid flows;
 - d. site data required by the Supplier for chiller design.
12. The chiller duty margin and sparing philosophy shall be based on the selected design class for the project.
 - a. Refer to the design class table in DEP 00.00.07.92-Gen.

2.2 TECHNOLOGY SELECTION CONSIDERATIONS

1. Absorption chillers shall be used where a source of heat (either steam or waste heat) and cooling water is located nearby.
2. Direct fired VAR chillers can be applied where additional power required for VCR chillers could be constrained.

Remote applications for VARs are possible, but will result in increased piping costs.

3. Pressure of steam supply shall be chosen by the Contractor and approved by the Principal, optimizing availability of various pressure levels and energy efficiency aspect from impact of steam pressure to COP.
4. Vapour compression chillers shall be used where there is no ready source of heat (either steam or hot water)

Absorption chillers can add to the overall energy efficiency as they can be driven by waste heat and do not require a compressor. However, they do require larger amounts of cooling water than a VCR chiller.

5. Water cooled condensers shall be used in VAR chillers.
 - a. Either air cooled or water cooled condensers are acceptable in VCR chillers.
6. VAR shall not be considered for floating / offshore projects as barge motions will impact performance.
7. VAR units shall be horizontal at all times in order to avoid severe performance loss.

2.3 VAPOUR ABSORPTION CHILLERS

2.3.1 Performance/sizing basis

1. VAR chillers shall be sized to produce the required chilled fluid temperature when:
 - a. the cooling water temperature is at its highest, and
 - b. heating supply temperature (either steam or hot water) to the generator is at its lowest.
2. Tubes shall be in the fully fouled condition.
3. Refer to DEP 20.21.00.31-Gen. for requirements of Fouling factors for cooling water and steam side of exchangers
4. Refer to section 4 of DEP 20.21.00.31-Gen. for fouling factors for refrigerant.
5. The VAR shall meet the turndown requirements specified by the Contractor.
6. For turndown requirements:
 - a. cooling water shall be assumed to be at its coolest temperature;
 - b. the heating supply temperature (either steam or hot water) to the generator shall be at its highest;
 - c. Tubes shall be in the clean (non-fouled) condition.
7. Single effect chillers should be chosen from a reliability perspective.
8. Double effect chillers may be applied but only when proven track record can be demonstrated by the selected Supplier.

The life of an absorption chilling unit is greatly impacted by management of corrosion of the components, good design and O&M practices.

9. A 20 year design life should be considered.
10. The Supplier design shall be reviewed with respect to achievable asset life.

2.3.2 Refrigerant type

1. Demineralised water shall be used as a refrigerant and lithium bromide (LiBr) shall be used as an absorber.
2. Use of other refrigerant-absorber pairs may be considered only if the Supplier demonstrates them as proven technologies.
3. Use of alternate refrigerant-absorber pairs requires approval from the Principal.
4. Requirements provided below (section 2.3.3) are applicable to water-lithium bromide systems only.

2.3.3 Refrigerant quality

1. Lithium molybdate shall be added to the water-lithium bromide solution as a corrosion inhibitor.
2. Chromates shall not be chosen as they are carcinogens.
3. If the Supplier proposes an alternative corrosion inhibitor, the Supplier shall demonstrate that it is a industry proven technology and that the chiller performance is not adversely affected.
4. Alternative corrosion inhibitors require the approval of the Principal.
5. The chiller design shall include the provision for sampling of lithium bromide solution.
6. Sample take off assemblies shall be in accordance with Shell standard detail drawing S 31.900.
7. Continuous fast loops shall be provided to ensure all samples are fresh and to minimize refrigerant losses when sample is drawn.
8. Refer to "sample systems" section of DEP 32.31.50.10-Gen. for sampling methods.
9. If a fast loop is not possible, the sample station shall include a connection to drain so that stale refrigerant in the sample line can be disposed of before a sample is collected.
10. Use of sampling pumps is to be avoided (i.e., process pressure shall be used to deliver sample to the sample bottle).

Refer to Shell standard detail drawing S 38.037 or S 38.038 for sample cabinets.

11. Side stream filtration shall be included in design for removal of particulates from the system.
 - a. Refer to section (2.3.14) for details.
12. When calculating VAR performance, credit shall not be taken for performance additives (such as octyl alcohols).
13. The Supplier shall provide acceptable ranges of LiBr solution concentration at the sampling location for the specific operating conditions applicable to the chiller.
14. The Supplier shall provide maximum/minimum lithium bromide quality specs (for items such as, but not limited to:
 - a. min / max concentrations of corrosion inhibitor;
 - b. min /max concentration of additive for alkalinity control (LiOH, HBr);
 - c. maximum allowable copper concentrations;
 - d. min /max concentrations of any performance additions (octyl alcohols);
 - e. maximum allowable iron concentrations;
 - f. min /max pH;
 - g. min /max m-alkalinity.

15. The Supplier shall recommend a regular sampling and analyses programme for lithium bromide solution to ensure that the concentration of corrosion inhibitor, alkalinity and deposits are analysed and controlled.

2.3.4 Interfaces

2.3.4.1 Heat source

2.3.4.1.1 Direct fired

1. Refer to DEP 30.75.10.30-Gen. design and specification requirements of Direct fired heater tubes.

2.3.4.1.2 Indirect fired

1. Steam supply temperature shall not exceed 175 °C (347 °F).
2. Steam can be either superheated or at dry saturated conditions.
3. Contractor to provide Supplier with steam conditions including minimum and maximum enthalpies as well as steam pressure.
4. If hot water is used as a heating medium, the hot water supply temperature shall not exceed 130 °C (266 °F).
5. If the supply temperatures exceed these maximum limits, means to reduce the temperature shall be provided (either by a de-super heater or hot water mixing loop).
6. The lowest acceptable heat source condition is 100 kPag (15 psig) steam; 90 °C (194 °F) hot water.
7. Steam pressures for the chiller should be used close to the available pressure of the steam source.

Higher steam pressures result in higher COPs.

2.3.4.2 Cooling water

1. Selected metallurgy for the condenser and absorber cooling tubing shall be based on available cooling water quality.
 - a. Metallurgy selection shall be subject to approval from the Principal.
2. The Contractor shall provide to the Supplier the cooling water chemistry quality specifications.

Cooling water chemistry is considered in the design of chiller components.

2.3.4.3 Instrument air

1. Minimum allowable operating pressure, and design conditions, of all air actuators on valves on the chiller skid shall be consistent with site requirements.
 - a. The Contractor shall provide to the Supplier site requirements for valve actuators.

2.3.4.4 Electrical and instrumentation

1. All equipment (instrumentation, motors and controls) shall be designed to the required electrical area classifications of the area where the skid is to be installed.
2. The Contractor shall provide to the Supplier the standard voltage levels that are available at the site.
3. All Instrumentation shall be compatible to the type of DCS to which it will be connected.
4. The critical operating parameters indications and alarms shall be displayed as minimum in the DCS.
5. Control with local PLC shall be acceptable.

2.3.5 Generator/condenser vessel

1. Refer to DEP 31.21.01.36-Gen. for the design requirements of the generator/condenser vessel.
2. Refer to DEP 31.21.01.30-Gen. for requirements of design and fabrication of generator/condenser vessel.
3. For all operating scenarios, the skin temperature of the generator tubes shall not exceed 110 °C (230 °F) for both the clean and fouled condition to prevent the chemical decomposition of LiBr.
4. Protection against carryover of LiBr to condenser shall be provided to prevent contamination of the refrigerant.
 - a. A demister between generator and condenser is an acceptable device.
5. The Supplier shall submit design details of the separator device to substantiate separation performance for approval from the Principal.

2.3.5.1 Thermal design

1. Refer to DEP 20.21.00.31-Gen. for the requirements of the fouling factors to be applied when defining the thermal design of the system.
The DEP 20.21.00.31-Gen. does not specify fouling factors for LiBr solutions.
2. The Supplier shall propose a fouling factor for the LiBr solution to the Principal.
 - a. Both the Principal and Supplier shall agree on a fouling factor to use for LiBr solution.

2.3.5.2 Materials of construction

1. Materials of construction shall be subject to approval by the Principal.

Typical materials of construction are listed below

<i>Shell</i>	<i>carbon steel</i>
<i>Generator tubes</i>	<i>stainless steel</i>
<i>Condenser tubes</i>	<i>see (2.4.7)</i>
<i>Collecting pans / spray nozzle / demister</i>	<i>stainless steel</i>

2.3.5.3 Mechanical design

1. The indirect fired tubes shall have, as a minimum, design conditions equal to the system to which it is connected (either steam or hot water).
2. The design conditions for the condenser tubes shall, as a minimum, be equal to the design conditions of the cooling water system to which it is connected.
3. The shell shall come equipped with overpressure protection (either rupture disks or ASME section VIII Div. 1 certified relief valve) as per ASHRAE 15.
4. The outlet of the overpressure protection device shall be routed to a safe location away from people's access.
Safe location is dependent upon the fire and health hazard of the refrigerant, as well as density relative to air.
5. If refrigerant has a high fire hazard, then the vent should be located away and downwind from ignition sources.

6. If refrigerant has high health hazard, then the vent should be located away and downwind from high occupancy areas.
 7. ASME section VIII Div. 1 code shall be followed for mechanical design of the generator and condenser vessels.
 8. Codes other than ASME may be used for design as required by local regulations / authorities.
 - a. Codes other than ASME shall be approved by the Principal.
 9. The shell shall be rated for full vacuum conditions.
- 2.3.5.4 Appurtances
1. Condenser tubes and indirect fired tubes shall have end connections equivalent to the piping specifications to which they are attached.
 2. Level gauges and level transmitters shall be included to provide clear indication of solution and refrigerant levels in the condenser and generator respectively.
- 2.3.5.5 Certification
1. The exchanger/vessel shall be code stamped.
 2. Exchanger/vessel shall be registered and certified by the requirements of the local jurisdictional authority.
- 2.3.6 Evaporator / absorber vessel**
1. Refer to DEP 31.21.01.36-Gen. for the design requirements of the evaporator / absorber vessel.
 2. Refer to DEP 31.21.01.30-Gen. for requirements of design and fabrication of evaporator / absorber vessel.
- 2.3.6.1 Thermal design
1. Refer to DEP 20.21.00.31-Gen. for the requirements of the fouling factors to be applied when defining the thermal design of the system.

The DEP 20.21.00.31-Gen. does not specify fouling factors for LiBr solutions.
 2. The Supplier shall propose a fouling factor for the LiBr solution to the Principal.
 - a. Both the Principal and Supplier shall agree on a fouling factor to use for LiBr solution.
- 2.3.6.2 Materials of construction
1. Materials of construction shall be subject to approval by the Principal.

Typical materials of construction are listed below

<i>Shell</i>	<i>carbon steel</i>
<i>Evaporator tubes</i>	<i>stainless steel</i>
<i>Absorption tubes</i>	<i>see (2.4.6.2)</i>
<i>Collecting pans / spray nozzle</i>	<i>stainless steel</i>