

DEP SPECIFICATION

DESIGN OF MULTIPLE-PIPE SLUG CATCHERS

DEP 31.40.10.12-Gen.

February 2019

DESIGN AND ENGINEERING PRACTICE

DEM1



© 2019 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.

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	4
1.4	CROSS-REFERENCES	7
1.5	SUMMARY OF MAIN CHANGES.....	8
1.6	COMMENTS ON THIS DEP	8
1.7	DUAL UNITS.....	8
1.8	NON NORMATIVE TEXT (COMMENTARY).....	8
2.	GENERAL DESIGN ASPECTS	9
3.	HYDRAULIC DESIGN	9
3.1	GENERAL.....	9
3.2	SLUG CATCHER SIZE.....	9
3.3	SLUG CATCHER GEOMETRY AND COMPONENTS	9
4.	MECHANICAL DESIGN.....	10
4.1	GENERAL.....	10
4.2	MAXIMUM ALLOWABLE OPERATING PRESSURE	10
4.3	DESIGN FACTOR FOR HOOP STRESS	11
4.4	OTHER STRESS.....	11
4.5	SUPPORTS AND ANCHORS	11
4.6	MATERIAL SELECTION	12
4.7	INTERNAL/EXTERNAL CORROSION PROTECTION.....	12
4.8	OVERPRESSURE PROTECTION	12
4.9	MAINTENANCE.....	13
4.10	EMERGENCY DEPRESSURISATION.....	13
4.11	MISCELLANEOUS	14
5.	SAFETY RELATED DESIGN ASPECTS.....	14
6.	REFERENCES	17

APPENDICES

APPENDIX A	FIGURES.....	19
-------------------	---------------------	-----------

1. INTRODUCTION

1.1 SCOPE

This DEP specifies requirements and gives recommendations for design of multiple-pipe slug catchers to be installed on land.

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 2017; 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 designing multiple-pipe slug catchers, as part of pipeline systems related to oil and gas production and gas handling facilities. 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
Bottle, primary	Pipe-type part of a multiple-pipe slug catcher for separation of the fluid and storage of the liquids, sloping down under small angle(s) from the lower end of the downcomer to the liquid outlet header (see Figure 2).
Bottle, secondary	Pipe-type part of a multiple-pipe slug catcher for storage of the liquids only, sloping up from the liquid outlet header, and ending at the gas risers (see Figure 2b).
Downcomer	Vertical or steeply sloping pipes of a multiple-pipe slug catcher between the inlet header and the primary bottles (see Figure 2).
Entrance length	The section of a primary bottle from the inlet to the gas risers.
Gas outlet header	Part of a multiple-pipe slug catcher on top of and connecting all risers for collection of the outgoing gas streams (see Figure 2).
Gas riser	Vertical pipe on top of a bottle, through which gas exits (see Figure 2).
Inlet header	Part of a multiple-pipe slug catcher in which the fluid is evenly distributed before entering the downcomers and in which fluid flow conditions are further improved for separation (see Figure 2). Also called distribution header.
Liquid outlet header	The lowest part of the multiple-pipe slug catcher, in which the liquid is collected for export. Also called liquid header.
Separator	Equipment for separating gas and liquids or various liquids of a mixed fluid.
Slug catcher, multiple-pipe type	Slug catcher, made of several parallel pipe bottles.
Slug catcher, parking-loop type	Slug catcher, where the separator is located apart from the storage part. The separator can be a vessel type and the storage part is made of pipeline material, which can be located away from the separator.
Slug catcher, vessel type	Slug catcher of limited dimensions and capacity, where separator and storage parts are combined within one or a combination of vessels.
Slug catcher	Part of a multiphase pipeline system for separation of the gas and liquid phases and for temporary storage of the liquids.
Splitter	Inlet of a multiple-pipe slug catcher in which the fluid stream is split up for even distribution over the inlet header (see Figure 2).

1.3.3 Symbols and abbreviations

1.3.3.1 Symbols

A	Cross-sectional area
C _w	Drag coefficient
d	Diameter of droplet, m (ft)
D	Diameter, m (ft)
H	Hold-up fraction
g	Gravity constant, m/s ² (ft/s ²)
L	Length, m (ft)
m	Number of risers per bottle
n	Number of bottles
V	Velocity, m/s (ft/s)
Vol	Volume, m ³ (ft ³)
Q	Gas flow rate, m ³ /s (gal/s)
Re	Reynolds number

Greek symbols

η	Dynamic viscosity, N.s/m ² (cP)
λ	Load factor, m/s (ft/s) or Volumetric fraction of liquid in two-phase flow
θ	Angle between bottle and horizontal plane
ρ	Density, kg/m ³ (lb/ft ³)

1.3.3.2 Subscripts

b	Bottle
buffer	Buffer
C	Constrictor
G	Gas
IH	Inlet header
int	Intercept
L	Liquid
goh	Gas outlet header
loh	Liquid outlet header
outlet	Outlet
pb	Primary bottle
pipeline	Pipeline
R1	First riser on a bottle (from inlet)

R2	Second riser on a bottle (from inlet)
riser	Riser
s	Settle
sb	Secondary bottle
SC	Slug catcher
SG	Superficial gas
SL	Superficial liquid

1.3.3.3 Abbreviations

Term	Definition
BLEVE	Boiling Liquid Expanding Vapour Explosion
CFD	Computational Fluid Dynamics
Dbottle	Internal diameter of the multiple-pipe slug catcher bottles
Ddowncorner	Internal diameter of the downcorner
Dgoh	Internal diameter of the gas outlet header
Doutlet	Internal diameter of the gas outlet
Driser	Internal diameter of the gas risers
dP	Differential Pressure
GTL	Gas-To-Liquids
HEMP	Hazards and Effects Management Process
KHI	Kinetic Hydrate Inhibitor
LNG	Liquefied Natural Gas
MAOP	Maximum Allowable Operating Pressure
MEG	Mono Ethylene Glycol
PSV	Pressure Safety Valve
SGV	Sphere-generated Volume
SMYS	Specified Minimum Yield Strength

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 (6).