Guidelines for the management of access fittings for pressurised systems

energy institute

GUIDELINES FOR THE MANAGEMENT OF ACCESS FITTINGS FOR PRESSURISED SYSTEMS

First edition

August 2020

Published by
Energy Institute, London
The Energy Institute is a professional membership body incorporated by Royal Charter 2003
Registered charity number 1097899

The Energy Institute (EI) is the chartered professional membership body for the energy industry, supporting over 23 000 individuals working in or studying energy and 200 energy companies worldwide. The EI provides learning and networking opportunities to support professional development, as well as professional recognition and technical and scientific knowledge resources on energy in all its forms and applications.

The EI's purpose is to develop and disseminate knowledge, skills and good practice towards a safe, secure and sustainable energy system. In fulfilling this mission, the EI addresses the depth and breadth of the energy sector, from fuels and fuels distribution to health and safety, sustainability and the environment. It also informs policy by providing a platform for debate and scientifically-sound information on energy issues.

The EI is licensed by:
– the Engineering Council to award Chartered, Incorporated and Engineering Technician status, and
– the Society for the Environment to award Chartered Environmentalist status.

It also offers its own Chartered Energy Engineer, Chartered Petroleum Engineer, and Chartered Energy Manager titles.

A registered charity, the EI serves society with independence, professionalism and a wealth of expertise in all energy matters.

This publication has been produced as a result of work carried out within the Technical Team of the EI, funded by the EI's Technical Partners. The EI's Technical Work Programme provides industry with cost-effective, value-adding knowledge on key current and future issues affecting those operating in the energy sector, both in the UK and internationally.

For further information, please visit **http://www.energyinst.org**

The EI gratefully acknowledges the financial contributions towards the scientific and technical programme from the following companies:

ADNOC
BP Exploration Operating Co Ltd
BP Oil UK Ltd
Chevron North Sea Ltd
Chevron Products Company
Chrysaor
CLH
ConocoPhillips Ltd
DCC Energy
Drax Group
EDF Energy
EDPR
ENI
E. ON UK
Equinor
ExxonMobil International Ltd
Innogy
Ithaca Energy
Intertek
Kuwait Petroleum International Ltd
Nexen CNOOC
Neptune Energy
Ørsted
Phillips 66
Qatar Petroleum
Repsol Sinopec
RWE npower
Saudi Aramco
Scottish Power
SGS
Shell UK Oil Products Limited
Shell U.K. Exploration and Production Ltd
Siemens Gamesa Renewables
Spirit Energy
SSE
TAQA Bratani
Total E&P UK Limited
Total UK Limited
Tullow Oil
Uniper
Valero
Vattenfall
Vitol Energy
Woodside
World Fuel Services

However, it should be noted that the above organisations have not all been directly involved in the development of this publication, nor do they necessarily endorse its content.

ISBN 978 1 78725 197 7

Published by the Energy Institute

Hard copy and electronic access to EI and IP publications is available via our website, **https://publishing.energyinst.org**.
Documents can be purchased online as downloadable pdfs or on an annual subscription for single users and companies.
For more information, contact the EI Publications Team.
e: **pubs@energyinst.org**

CONTENTS

Contents continued

LIST OF FIGURES AND TABLES

Page

Figures

Table

FOREWORD

Integrity management of access fittings is taken care of within an asset's integrity management system; however, there have been no guidelines on the maintenance of these access fittings until now. The Energy Institute (EI) *Guidance for corrosion management in oil and gas production and processing* details the recommended practice for undertaking corrosion management of generic pressure systems; however, this does not outline the specific requirements relating to specialist equipment such as access fittings. A requirement was identified to develop a document to provide technical guidance which captures industry good practice and knowledge of the management of access fittings as part of the overall integrity management of the pressure system.

Access fittings tend to be used to hold corrosion monitoring equipment or enable chemical injection to the process piping of the pressure systems. There tend to be a significant number spread across the plant and many are located in safety critical systems, so the maintenance of these fittings is key to the assurance of integrity in order to maintain safe operations of an asset. As discussed in EI *Guidance for corrosion management in oil and gas production and processing,* primary pressure retention is of the utmost importance to operators for reasons of personnel safety, environmental aspects and business justification.

Members of the Corrosion Management Committee (CMC) have formed a dedicated sub-group to develop these guidelines, with technical drafting and editing by William Ritchie of Lloyd's Register. Many thanks to all those who have contributed to this valuable set of guidelines.

This guidance provides principles and good practice associated with the integrity management of intrusive access fittings. The document covers the life cycle from the design, application, registration and safe handling of the different types of fittings through to abandonment/removal. The types of degradation which can be expected are detailed as well as methods of monitoring and the maintenance required.

This document is not intended as a guide to the specifics of handling or actuating access fittings, as those details should be provided by the original equipment manufacturer (OEM).

Although it is anticipated that following this publication will assist those involved in the integrity management of intrusive access fittings, the information contained in this publication is provided as guidance only. While every reasonable care has been taken to ensure the accuracy of its contents, the EI, and the technical representatives listed in the acknowledgements, cannot accept any responsibility for any action taken, or not taken, on the basis of this information. The EI shall not be liable to any person for any loss or damage which may arise from the use of any of the information contained in any of its publications.

The above disclaimer is not intended to restrict or exclude liability for death or personal injury caused by own negligence.

Suggested revisions are invited and should be submitted to the Technical Department, Energy Institute, 61 New Cavendish Street, London, W1G 7AR.

Elspeth Allen
Steering Group Chair

ACKNOWLEDGEMENTS

The EI wishes to record its appreciation of the work carried out by the following individuals over the project duration:

Emmanuel Alenkhe	ConocoPhillips/Chrysaor
Elspeth Allen (chair)	Repsol-Sinopec
Ismenia Alvarez	Apache
Louise Atkin	HSE
Fran Chalmers	PIM
Farhat Choudhary	Saudi Aramco
Alistair Crichton	Marathon/RockRose Energy
Peter Hilton	Shell
Stephen Tate	Total
Konstantinos Vatopoulos	Aramco Overseas
Edward Whyte	BP

Technical drafting and editing: William Ritchie and Stuart Hamilton, Lloyd's Register.

Additional thanks are extended to Graham Aitken of ICR and Dean Smith of Cosasco®

This new first edition guidance was coordinated and managed by Dr Cameron Stewart, EI, Upstream Technical Manager.

1 INTRODUCTION

1.1 PURPOSE OF DOCUMENT

This guidance provides principles and good practice associated with the integrity management of intrusive access fittings. As a high-level overview, the following sections will outline:

– Section 1: Access fittings' design, applications and principles of safe handling.
– Section 2: Key stages of the access fitting life cycle.
– Section 3: Degradation threats specific to these devices.
– Section 4: The integrity management process.
– Section 5: Methods of monitoring and maintenance.

The guidance covers intrusive access fittings for corrosion and erosion monitoring, chemical injection and fluid sampling in all systems, but excludes fittings for instrumentation and process control which should be managed within their own scheduled maintenance strategy. The guidance also excludes non-intrusive devices such as ultrasonic testing (UT), subsea monitoring units and acoustic probes and data collection devices. In addition, it does not consider the validity and analysis of data which should be considered within the overall integrity management of the system to which they are installed. This document is not intended as a guide to the specifics of handling or operating access fittings, as those details should be provided by the OEM.

1.2 GENERAL

Access fittings are specialised components that can provide a conduit into an online pressurised system without the need to isolate or disassemble the vessel or piping arrangement. The components are used to gather information relating to the degradation potential of pressure systems by process and utility fluids, or to modify the internal environment by the injection of specialist chemicals. Typically, these access fittings (normally two inches in diameter) are installed in groups of two or three at the same location to facilitate the gathering of different data types, e.g. coupon, probe, bio-probe, etc.). Within the oil and gas industry they have been applied to wide-ranging pressure systems handling challenging process conditions in respect of high pressure, high temperature or a highly corrosive internal medium.

For a medium-sized asset, there may be in excess of 60 access fittings that have been designed to provide corrosion monitoring, sampling and chemical injection functionality; for older assets these are likely to be in varying states of usage and condition as a function of their time-in-service, physical location and servicing history. It has been suggested by service companies that it would not be uncommon for 20 to 30 % of access fittings within an asset's inventory to have incomplete or absent records of servicing history, or to be retired from their intended purpose and since been omitted from regular servicing. Each of these locations is considered a site for potential loss of containment, and maintaining the integrity of such fittings must extend beyond the functional use of the device. As discussed in EI *Guidance for corrosion management in oil and gas production and processing*, primary pressure retention is of the utmost importance to operators for reasons of personnel safety, environmental aspects and business justification.

The design of access fitting assemblies will typically include static and moving parts, mixed metallurgy and non-metallic components at sealing arrangements. These features facilitate the actuation of the devices under pressurised conditions, but introduce a level of complexity to the piping system which increases the required diligence for their integrity management; however, this may not be fully considered by the operator or captured by their integrity management system. Additionally, the integrity management life cycle of such devices may extend beyond the operational period for which they were designed, since special consideration may need to be given to the increased susceptibility to damage mechanisms, or elevated degradation rates, at sites that are no longer required.

1.3 OVERVIEW

Access fittings are designed for service tasks such as chemical injection, sampling of internal fluids and the insertion of corrosion monitoring devices. Their assembly systems comprise static, movable and removable parts for pressure retention and to enable specialist features such as isolation from the main internal environment, insertion and removal of internal devices, pressure let-down and maintenance or decommissioning activities.

Many thousands of retrieval operations are conducted safely every year across upstream and downstream process facilities worldwide and incidents associated with them during operation and servicing are very rare; however, due to the complexity of their design, and the potential for issues around seals and moving parts, the maintenance of access fittings requires special consideration. This is of particular concern on ageing or transferred assets where technology and safety standards have changed over the operating period. One such example is the type of protective heavy-duty covers (HDCs) being selected, which has widely moved from non-pressure-retaining components to those that are pressure-retaining and would normally be fitted with a pressure gauge and relief valve for identifying and venting internal pressure accumulation (i.e. from a leaking fitting). The newer design improves the safety associated with servicing and also allows the primary pressure retention of the fitting to be assured in the period between servicing by visual inspection.

Engineering principles and recommended practice for undertaking corrosion management of generic pressure systems is provided within EI *Guidance for corrosion management in oil and gas production and processing*; however, this does not outline the specific requirements relating to specialist equipment. In order to provide a basis for integrity management specific to access fittings, it is important to understand the typical way in which they are intended to operate and the key features of their design. This section gives a brief overview of the main components that make up an access fitting system, their design features and a brief overview of the devices that can be used in conjunction with them. It also describes the principles for their safe handling during their service life.

1.4 ACCESS FITTING COMPONENTS

Access fitting systems typically comprise the following five main components:

- body;
- plug assembly;
- protective cover;
- service valve (required for online retrieval), and
- retrieval tool (required for online retrieval).

The body of an access fitting is permanently attached to the piping or vessel, and provides the primary barrier for pressure retention in conjunction with a fully-seated plug assembly. In hydrocarbon systems, the body is attached either by full-penetration butt-welding or by a flanged connection; in non-hydrocarbon systems, a threaded connection may also be considered. Bodies can incorporate a side-tee port to allow for the connection of ancillary components that provide additional functionality. The body includes external threading for the mounting of either a protective cover or a service valve, and a two-inch internal bore into which a plug assembly is inserted.

Figure 1: Drawing of a mechanical access fitting configuration. A solid plug assembly is threaded into a weldable access fitting body. Drawing courtesy of Cosasco®

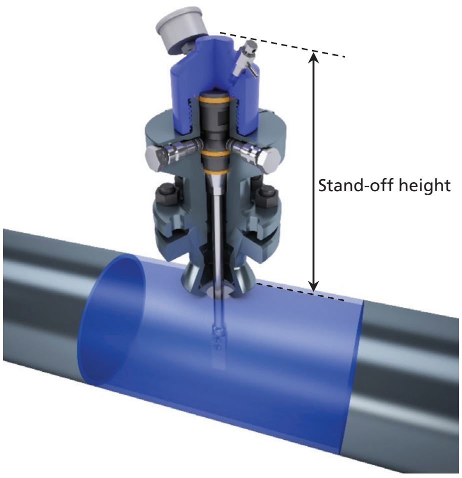

Figure 2: Drawing of a hydraulic access fitting configuration. A solid plug assembly fitted with a coupon holder and two strip corrosion coupons is inserted into the main line through a flanged access fitting body and branched piping connection. The body is fitted with a heavy-duty pressure-retaining cover and the stand-off height is indicated. Drawing courtesy of Cosasco®

The plug assembly is a retrievable component that holds the chosen internal device and when fully seated within conventional bodies acts as the primary seal from the process environment; for bodies fitted with a side-tee port, this seal is made by a shut-off valve attached to the port via a nipple, or by inserting a pipe plug when the port is not in use. Plugs are either solid or hollow arrangements depending on the chosen device to be installed within the fitting. Mechanical plugs are inserted into the body by a threaded connection, whilst hydraulic plugs are driven in by hydraulic back-pressure and then secured with locking pins. Currently, mechanical access fittings are used to a much greater extent than hydraulic types. Although hydraulic fittings may overcome most issues related to seized plugs, this trend of mechanical fitting dominance has continued in most recent projects.

The cover is screwed onto the body, and in its simplest form will provide a barrier against accidental mechanical damage and reduce degradation of the plug assembly by the external environment. In addition to this, the selection of a heavy-duty pressure-retaining cover, fitted with a pressure gauge and a pressure let-down valve, would also provide secondary process containment in the event of the primary seal failing; selection of this arrangement should be considered good practice for all monitoring access fittings and for abandoned locations which may undergo extended periods between servicing. Protective covers can be made to include a centre hole to house an adapter that provides a connection between internal devices, such as probes, and external equipment such as logging devices, whilst ensuring pressure containment.

Figure 3: Drawing of a heavy-duty pressure-retaining cover mounted on an access fitting's body. The cover is fitted with a pressure gauge and bleed valve. Drawing courtesy of Cosasco®

A service valve is a portable piece of equipment that is used in conjunction with a retrieval tool in order to provide online service activities. One side of the valve is screwed onto the access fitting's body once the protective cover has been removed, and a retrieval tool may then be attached to the opposite side. A ball-type valve can then be opened, to give the retrieval tool access to the plug assembly and equalise pressure within the retrieval tool, or closed, to isolate the process environment from the tool-side chamber. The service valve is pressurised to process conditions during an online access fitting workover and will become part of the access fitting's primary barrier for pressure retention once the plug assembly has been unseated. The pressure within the service valve can be built up to provide back-pressure, or let-down, via a bleed valve on the tool-side chamber; a second bleed valve may be opened to bypass the service valve for pressure balancing. It is considered good practice to employ double block and bleed service valves where possible.

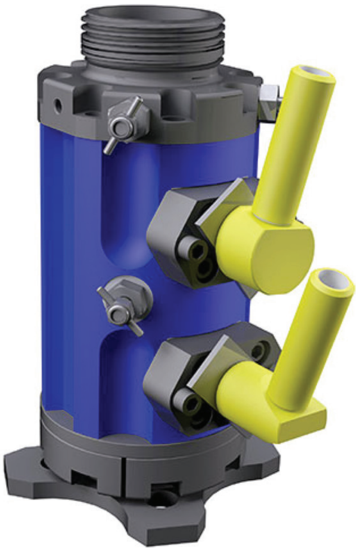

Figure 4: Drawing showing a double block and bleed service valve. Drawing courtesy of Cosasco®

Figure 5: Drawing of a retrieval tool, attached to a double block and bleed service valve, which in turn is attached to an access fitting body. Drawing courtesy of Cosasco®

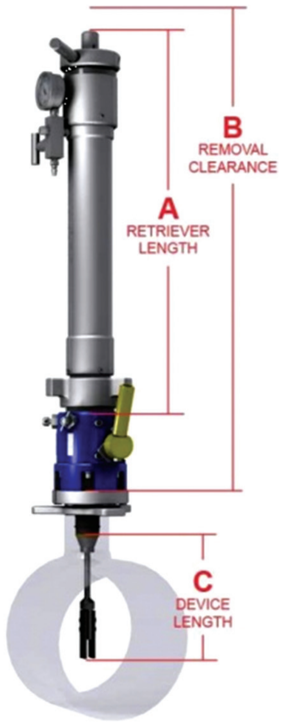

Figure 6: Illustration of retrieval tool lengths and clearance requirements for online access fitting services. Drawing courtesy of Cosasco®

Retrieval tools attach to service valves and are used to remove and insert internal devices from access fittings under normal process conditions. They comprise externally-controllable movable parts that can be made to enter the access fitting's body and attach to the plug assemblies, via their internal threading, allowing for the plugs to be removed or fitted. Once the plug assembly is removed from the body, the tool will make up part of the primary barrier for pressure retention until the service valve is moved to a closed position. The retrieval tool and service valve must be selected with a higher pressure rating than the pressure system and access fitting system, in order to withstand upset pressures during servicing; pressure capacities of 1 500, 3 600 or 6 000 psi are standard for this industry. A variety of retrieval tool sizes is available to accommodate the differing lengths of fitting devices and clearance requirements (typically in the range of 1 to 3 m) associated with a location; on account of their size and weight it is common practice to use a two-man team for online servicing. The retrieval tools may be designed to work with mechanical, hydraulic, or both types of access fitting systems.

1.5 ACCESS FITTING DEVICES

Process operators are presented with a range of challenges relating to flow assurance, separation efficiency, and maintaining the integrity of the pressure systems that handle the fluids. The incorporation of access fittings provides a means to modify the internal fluids by injecting chemicals, or to gather information on either the fluids or their potential corrosivity with respect to the materials within the process pressure environment.

Devices installed within access fittings generally fall into the categories of probes, coupons and injection or sampling systems. Probes constitute a broad group of devices that can be used to indicate continuous online general corrosion and erosion rates, obtain biological samples (for determining type and quantity) and to indicate hydrogen ingress into metallurgy. Recorded data from probes can be extracted periodically by manual methods, or in some cases may be accessed in real time when coupled with a wireless network. Coupons are used for determining general and localised corrosion rates when periodically retrieved and may also be swabbed to determine microbial presence. Injection and sampling systems provide a conduit into the process piping or equipment which injects chemicals or extracts fluid samples for analysis.

1.6 PRINCIPLES OF ACCESS FITTING ENTRY

Online entry of access fittings should only be attempted by proven competent technicians. Competency is achieved through a combination of training and work experience in assistant roles with given equipment types, which should be documented by the service company and is assessed by them as part of a formal process. Training should ensure that the technician is familiar with all of the tools and devices that they will be handling and the working procedures that they will be following to carry out servicing and retrievals, including field health and safety hazards, such as confined space entry, pressure testing and working with hazardous fluids, etc.

The service valve and retrieval tool should be subject to routine maintenance and their integrity should be proven at defined intervals by visual inspection and pressure testing to design pressure. The testing interval should consider the number of uses since the last interval, ageing of components during long-term storage, accidental damage caused during transit or mishandling on-site, and the effects of fluid contaminants introduced during retrievals.

An access fitting system may only be serviced once the fitting has been evaluated, and the risks associated with its removal is subject to a formal risk assessment involving both the operator and the competent technician. The risk of process release during the workover should be as low as reasonably practicable (ALARP). If the risks cannot be reduced to ALARP, then online servicing is unsuitable and offline servicing should be performed. The following key safety critical measures should be considered before servicing is carried out:

– For online servicing, ensure that the plug assembly can hold a seal before removing the pressure-retaining cover by checking the pressure gauge, bleeding pressure (where above atmospheric pressure) and then monitoring pressure levels.
– For offline servicing, make sure that the process pressure system is purged and fully depressurised before the use of hand tools.
– Ensure that the pressure-retaining cover is vented before removing.
– For online servicing, ensure that a back-pressurisation technique is employed on the service valve before unseating the plug assembly.

The service provider working on the access fitting should provide advance written work instructions specific to the component type that they are dealing with, detailing each step involved with the planned work on an access fitting, and care should be taken to ensure that these are followed by the technician. These instructions will outline all health, safety and environmental concerns relating to the specific circumstances of the work and provide the operator with the opportunity to prepare a safe working environment for the technicians and other site workers. The operator shall notify the service company of any residual risk remaining after preparation of the safe working environment, such as potentially toxic contaminants within the process fluids, for example hydrogen sulfide (H_2S) or naturally occurring radioactive material (NORM), so that the technicians are provided with adequate personal protective equipment (PPE) and safety monitoring devices. The operator should advise the technicians on the current operating pressure, whether there are any known reasons that might cause pressure spikes within the line on the day of servicing, e.g. slug flow or other maintenance activities of that system.

1.7 ACCESS FITTING RELIABILITY

The reliability of an access fitting may be broadly defined as the probability of its maintaining primary pressure containment under specified environmental conditions for its service life. This parameter is closely related to the availability of access fittings, which describes the likelihood of an access fitting being in working condition at the point of a desired service interval. The implications of a process leak from an access fitting should be well understood, since the consequences of failure and credible damage mechanisms affecting the body should already be documented within an integrity management system for the adjacent process pressure piping or equipment; however, the implications of service equipment failing is more easily overlooked.