

Repurposing and design guidelines for carbon dioxide pipelines

REPURPOSING AND DESIGN GUIDELINES FOR CARBON DIOXIDE PIPELINES

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2 FOREWORD

Carbon Capture, Utilisation and Storage (CCUS) has been identified as a key technology which will enable the Energy Transition and contribute towards the ability to meet Net Zero greenhouse gas (GHG) emissions. One of the proposed solutions for CCUS is to utilise infrastructure (for the present case being considered, pipelines) to transport and inject captured carbon dioxide, through the repurposing of existing pipeline assets.

The repurposing of existing steel pipeline assets to transport anthropogenic carbon dioxide rich mixtures is an appealing option as it could potentially reduce infrastructure costs. However, the characteristics of some pipelines may be uncertain and require a wide range of detailed work and remedial actions to ensure they can be safely repurposed.

The repurposing of existing onshore and offshore pipeline assets and the associated ancillary items (e.g. above ground installations (AGIs), block valves, subsea isolation valves, ground anchors, mattresses etc.) involves detailed assessment of the design and construction requirements in order to ascertain their suitability for the transportation of carbon dioxide and their potential for operation in different conditions.

Repurposing can only be performed following a detailed assessment and demonstration that the existing pipeline assets and associated ancillary items are suitable and safe to be operated with carbon dioxide under different operating conditions (e.g. pressure levels, temperature conditions, chemical compatibility (e.g. items such as internal painting compatibility), integrity challenges (e.g. mitigating against the running ductile fracture failure mode when in service) etc.). The assessments require detailed technical information on the existing assets.

The purpose of this guideline is to present a proposed approach to repurposing of onshore and offshore pipeline assets for use as carbon dioxide pipelines. However, it also provides the reader with the steps that would be required for design of a new pipeline as the principles are the same. The following is discussed within this guideline:

- The present ‘state of the art’ with regards to design codes, standards and recommended practices that cover carbon dioxide pipelines, outlining the approaches available to demonstrate a pipeline to be fit for purpose for carbon dioxide transportation.
- Providing an outline for specific risk assessments that should be carried out to demonstrate the health and safety (H&S) risks posed by a repurposed pipeline is as low as reasonably practicable (ALARP) and acceptable.
- A process for establishing viability of candidate pipelines for repurpose for carbon dioxide transportation during the upfront stage of a project is outlined. At this stage, the focus should be on determining the high-risk items for the development, with a full technical assessment happening later in the project process.
- Repurposing of a pipeline will require data to be gathered and reviewed, particularly for vintage pipelines with a long service history. An outline of the required data to perform a repurposing exercise is provided.
- Details of the full technical assessment that should be performed to fully establish viability of the pipeline for use as a carbon dioxide pipeline are provided.

The following definitions are used in this guideline:

Phases of Carbon Dioxide	The fluid state above the critical pressure is referred to as the dense phase, while that above both critical pressure and temperature is referred to as the supercritical phase. Dense phase is an umbrella terminology and encompasses both supercritical state and liquid state.
Pure CO ₂	The term 'Pure CO ₂ ' describes the pure form of CO ₂ without any impurities.
Carbon Dioxide, CO ₂ or CO ₂ Stream	Within this guideline, the terms carbon dioxide, 'CO ₂ ' or 'CO ₂ stream' describe a stream of CO ₂ with impurities, such as water, etc. The level of impurities varies depending on the source and capture process.
Aqueous Phase	The presence of water which could be on its own or bound to another molecule.

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Suggested revisions are invited and should be submitted to the Technical Department, Energy Institute, 61 New Cavendish Street, London, W1G 7AR (e: technical@energyinst.org).