API Ballot ID #6452
SC5 TGLP

Work Item Number	4258
Title of Work Item	Modification of API 5L Annex G for CO_2 Service
Ballot Revision Level	1
Type of Ballot (Initial, Comment, Comment resolution (reference API ballot#), 1st Re-ballot, 2nd Re-ballot, etc.)	Initial
Submitter Name(s)	Martin Connelly
API Document Modified	API 5L 46th Edition + Errata 1
Impacted Documents	None
Revision Key	Current API text = black Deletions = ~~red strikethrough~~ Additions = underlined red

Work Item Charge: Update API 5L 46th Edition + Errata 1, Annex G to permit appropriate use of API 5L for CO_2 transmission, taking into account CO_2 phase (gas or dense phase_

Ballot Rationale: The rapid emergence of CO_2 projects utilising API 5L as a base line pipe specification requires that, where appropriate, API 5L remains a suitable and predominant base specification with provision for appropriate use with CO_2. Currently, API 5L has no content that recognises the use of API 5L line pipe as suitable for CO_2 service, and this omission is considered to be a deterrent to the use of API 5L in this capacity. Additionally, several requests from API and API members to the TGLP to address the CO_2 trend within their specifications has been made.

Ballot Text: See below.

Annex G
(normative)

PSL 2 Pipe with Resistance to Ductile Fracture Propagation

G.1 Introduction

G.1.1 This annex specifies additional provisions that apply for PSL 2 pipe that can be CVN impact tested (see Table 22) and is ordered with resistance in the pipe body to ductile fracture propagation in natural gas and gas phase CO_2 pipelines [see 7.2 c) 55)]. This annex also provides guidance on determining CVN impact values for the arrest of ductile pipe fractures.

NOTE 1 A combination of sufficient shear-fracture area and sufficient CVN absorbed energy is an essential pipe- body property to ensure the avoidance of brittle fracture propagation and the control of ductile fracture propagation in gas pipelines (see 9.8.2.2).

NOTE 2 It is important that the user take appropriate steps to ensure that the operating parameters, including gas composition and pressure, of any gas pipeline to which the requirements of this annex apply are comparable or consistent with the test condition on which the respective guidance method was established; application of the guidance methods to pipeline conditions outside of the validity of the respective method can result in a nonconservative assessment of the resistance of the material to running fracture.

NOTE 3 A gas phase CO_2 pipeline is a pipeline that, at all times, operates in the gas phase. It is important that the user takes appropriate steps to ensure that the requirements in this annex are applicable to the pipeline

G.1.2 The guidance methods described in G.7 to G.10 for determining the pipe body CVN absorbed energy values necessary to control ductile fracture propagation in buried onshore gas pipelines originate and are supported by extensive theoretical and test work conducted mainly, or exclusively, on welded line pipe. If use is made of these methods to determine the CVN absorbed energy values required to control ductile fracture in seamless pipe, the user should exercise caution with respect to the calculated values obtained and verification by full-scale burst testing (see G.11) may be required.

G.2 Additional Information to Be Supplied by the Purchaser

G.2.1 The purchase order shall specify which of the following provisions apply for the specific order item:

a) CVN minimum average absorbed energy value (based on full-size test pieces) for each test, or

b) CVN minimum average absorbed energy value (based on full-size test pieces) for the order item.

G.2.2 The purchase order shall also specify:

a) CVN impact test temperature, and

b) DWT test temperature [for $D \geq 508$ mm (20.000 in.) only].

G.3 Acceptance Criteria

G.3.1 For each CVN impact test of the pipe body of pipe with $D < 508$ mm (20.000 in.), the average shear fracture area shall be ≥ 85 % based on the test temperature specified in the purchase order.

G.3.2 If the purchase order specifies provision G.2.1 a), the average (of a set of three test pieces) shall not be less than specified in the purchase order based on full-size test pieces and the test temperature specified in the purchase order.

G.3.3 If the purchase order specifies provision G.2.1 b), the average (of all tests performed on the order item) absorbed energy for the order item shall not be less than specified in the purchase order based on full-size test pieces.

G.3.4 For each DWT test of the pipe body, the average shear fracture area shall be ≥ 85 % based on the test temperature specified in the purchase order.

NOTE The DWT test is customarily specified by users when ordering pipe for gas pipeline service; when the shear area in the DWT test is ≥ 85 %, the test provides assurance that the steel fractures in a predominantly ductile manner at the test temperature; in order to determine the resistance of the line pipe to running fracture under service conditions, it is important that the steel be assessed further using one of the guidance methods described in this annex within the limits of its validity.

G.3.5 If subsize CVN specimens are required to be used, the provisions of 9.8.1.1 apply.

G.4 Test Frequency

G.4.1 For welded pipe with D < 508 mm (20.000 in.), CVN testing of the pipe body shall be carried out at the frequency given in Table 18.

G.4.2 For welded pipe with D ≥ 508 mm (20.000 in.), CVN and DWT testing of the pipe body shall be carried out at the frequency given in Table 18.

G.5 Pipe Markings and Inspection Documents

G.5.1 In addition to the pipe markings required in 11.2, the PSL designation shall be followed by the letter "G" to indicate that Annex G applies.

G.5.2 In addition to the requirements of 10.1.3.2, the inspection document shall include the following:

a) the DWT and CVN (as applicable) test temperature(s),

b) the minimum average absorbed CVN energy value for each test, and

c) the minimum average absorbed CVN energy value for the order item.

G.6 Guidance for Determining CVN Absorbed Energy Values in ~~Buried Onshore~~ Natural Gas Pipelines

G.6.1 Sections G.7 to G.11 describe five approaches that may be adopted for determining the pipe body CVN absorbed energy values to control ductile fracture propagation in buried onshore gas pipelines. For each of the approaches, details concerning the range of applicability are given.

NOTE It is not intended that this annex exclude other approaches to be adopted by the designer of the pipeline.

G.6.2 The CVN absorbed energy value derived by the approaches described in G.7 to G.11, or a higher value, can be specified either as a minimum value for each test or as a minimum average value for the order item.

NOTE 1 The predicted length of fracture propagation is longer if the derived CVN value is specified as a minimum average absorbed energy value for the order item rather than as a minimum average absorbed energy value for each test (see reference [12] for additional information).

NOTE 2 The requirements herein were developed for buried onshore pipelines transporting lean gas; these requirements might be conservative for buried offshore pipelines.

G.6.3 The approaches in G.7, G.8 and G.10 shall not be applied to unburied onshore pipelines.

The remainder of sections G.7 through G.11 are intended to be unchanged.

G.12 Guidance for Determining CVN Absorbed Energy and DWTT Shear Area Values in Gas Phase CO_2 Pipelines

G.12.1 This section advises the purchaser of restrictions in the application of this annex when specifying material for use in gas phase CO_2 pipelines.

G.12.2 For determining CVN absorbed energy, only the methods defined in G.9 and G.11 are permitted. For DWTT, the requirements of G.3.4 shall apply.

G.13 Guidance for Determining CVN Absorbed Energy and DWTT Shear Area Values in CO_2 Pipelines with Potential for Operating at Denser Phases than Gas

G.13.1 This section advises the purchaser of restrictions in the application of this annex when specifying material for use in denser than gas phase CO_2 pipelines.

G.13.2 Specialist advice shall be sought. G.11 is permitted.

NOTE 1 An example method is given in DNV-RP-F104.