Introduction

Task Group co-chair introduced the work proposed to address the issue raised.

1. Annex A cannot be used for axial strains in excess of 0.5%, regardless of whether such strains are due to construction, e.g., due to reeling of offshore flow lines or pipelines (hereafter referred to as “pipelines”) or in-service conditions.
2. For offshore pipelines an ECA (Engineering Critical Assessment) is typically done when the pipeline is to be reeled, to determine suitable weld acceptance criteria that take into account possible tearing or tear fatigue of weld imperfections due to the applied plastic strains.
3. Regardless of the results of the ECA, workmanship criteria (Section 9) must still be applied (due to Regulatory requirements) if strains exceed 0.5% (e.g. a maximum length of 1 inch for surface (interacting) imperfections, and a maximum length of 2 inches for buried imperfections, and the associated accumulation rules, even if the ECA were to show longer lengths can safely be allowed.
4. This has led as a minimum to confusion on some projects, sometimes after contract award, where pipe-lay contractors with European installation experience are used to using DNV OS F 101. This standard will allow for longer lengths than typical workmanship criteria for strains in excess of 0.5%, if certain conditions are met.
5. There is a desire to either modify Annex A or provide a new Annex to allow longer lengths of weld indications (subject to agreed limits) when installation strains exceed 0.5% provided adequate analysis is done and appropriate materials properties are obtained and testing is done to support the results of the analysis.
6. Whilst there is an interest to also consider in-service strains > 0.5%, such consideration falls outside the remit for this Task Group because the number of variables to be considered increases significantly and it is doubtful that this could be addressed for either an addendum to API 1104 21st Edition or API 1104 22nd Edition.
7. Initial work was done by the Task Group to prepare a draft “Option 4” to Annex A to address installation strains > 0.5%. This initial draft is included as a word file in the Minutes (Attachment B).

**Discussions**

1. It became clear early on during the discussions that it is better to provide a new Annex D to API 1104 to address this topic than to try and modify the language of the existing Annex A. Main reason is that if there are regulatory questions about this issue that cannot be resolved in a timely manner, DOT regulations that incorporate Annex A by reference could possibly drop Annex A altogether because of the unresolved issue. The Task Group will rewrite the draft as Annex D.

2. Onshore pipeline owners see a need to address installation strains > 0.5% as well. Therefore Annex D will not restrict itself to offshore pipelines only.

3. There was general consensus that a weld ECA is actually required for those welds where installation strains are expected to exceed 0.5%. This is not a current requirement in API 1104.

4. Much discussion revolved around how prescriptive the requirements in Annex D should be. While it may be tempting to refer to existing (European) standards that addressing installation strains > 0.5%, the update schedule for those standards is not aligned with the update schedule of API 1104, so the risk exists that reference made to such standards or sections therein may be outdated. Nevertheless, it was recognized that general guidance may be given that such standards are available for consultation. There was also general consensus that there is precedent for not being overly prescriptive, as is now also the case for Option 3 in Annex A. It was also recognized that pipe material and girth weld qualification and ECA analysis methods need to be consistent.

5. Questions were raised as to whether the allowable length being restricted by the lengths imposed under Section 9 is really the main problem. The challenge raised was whether the existing imperfection interaction rules (Figure A-11) caused unnecessary repairs or perhaps supplemental owner imposed interaction rules were the main cause.

6. As a follow-up on discussion item 5, installation contractors were asked to work with AUT contractors to consolidate possible existing data bases to identify the main causes of what they consider to be unnecessary weld repairs or cut-outs: workmanship length/height limitations; interaction rules in standards, or owner imposed supplemental imperfection interaction rules.

7. Timing for changes was discussed. Consensus was that the work should be completed and issued for review to main committee by Quarter 4 of 2016 so that Annex D could be issued either as Addendum to API 1104 21st Edition or incorporated into 22nd Edition.

8. A large portion of the audience wished to be active participants in the work of the Task Group and a sign-up sheet was circulated (see Attachment A, first column, all attendees with “M” next to their name). The Co-Chairs warned
that such a large group may become inefficient if members do not respond in
timely fashion to circulated drafts or queries and that a time limit would be
set for requested contributions and comments.

**Action Items**

1. Task Group Co-Chairs will issue Minutes of Meeting to FM Subcommittee Co-
Chairs for review and issue to participants (by Feb 1, 2016).

2. Sub Task Group will address Item 6. Under Discussion. Volunteers: Paul
Moore, Robert Robinson, Cody Prentice and Robert Bates (not on sign-up
sheet but attending from AUT sub Committee). Paul Moore to inform Task
Group of date to complete.

3. Attendees as they wish to get in contact with Co-Chair Robin Gordon whether
they wish to participate in second sub task group to address supplementary
materials requirements (e.g. limitations on pipe yield stress in excess of
SMYS) and mechanical testing (e.g. strain aged testing, full scale welded pipe
tests) for Annex D. By Feb 28, 2016.

4. Task Group will redraft Option 4 as Annex D (as straw man for further work).
By March 31, 2016.

Attachment A – List of Attendees
# RECORD OF MEETING ATTENDANCE

**Group:** Fracture Mechanics

**Annex A**

**Chairperson(s):** Frank Kopp, Robin Gost

**Meeting:**

**Time:** 0800-1200  
**Date:** 1/21/2016

Committee members should make changes to their contact information on the roster provided. Visitors adding names to the roster will not automatically become members of the committee.

<table>
<thead>
<tr>
<th>Name (please print clearly)</th>
<th>Company/Email</th>
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<tbody>
<tr>
<td>W. Kopp</td>
<td>Consultant. <a href="mailto:kopp@gmail.com">kopp@gmail.com</a></td>
</tr>
<tr>
<td>M. Reul</td>
<td>Micromaxury, <a href="mailto:r.reul@micromaxury.com">r.reul@micromaxury.com</a></td>
</tr>
<tr>
<td>M. Chakrabarti</td>
<td>AWS, <a href="mailto:m.chakrabarti@aws.com">m.chakrabarti@aws.com</a></td>
</tr>
<tr>
<td>M. Yung</td>
<td>CRES, <a href="mailto:yung@cres-america.com">yung@cres-america.com</a></td>
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<tr>
<td>M. Aro</td>
<td>coming, <a href="mailto:Aro@coming.com">Aro@coming.com</a></td>
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<tr>
<td>M. Zhao</td>
<td>Shell, T. <a href="mailto:Zhao@shell.com">Zhao@shell.com</a></td>
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<td>DEFJET, <a href="mailto:m.anderson@defjet.com">m.anderson@defjet.com</a></td>
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<td>V. Zickler</td>
<td>Exon, <a href="mailto:V.Zickler@exon.com">V.Zickler@exon.com</a></td>
</tr>
<tr>
<td>M. Rogers</td>
<td>PIECES Group, <a href="mailto:geoffr.rogers@pieces.com">geoffr.rogers@pieces.com</a></td>
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<tr>
<td>V. Morris</td>
<td>Tech, <a href="mailto:v.morris@tech.com">v.morris@tech.com</a></td>
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<tr>
<td>M. Slaven</td>
<td>Trajan, <a href="mailto:E.Slaven@trajan.com">E.Slaven@trajan.com</a></td>
</tr>
<tr>
<td>M. Lee</td>
<td>CHYRON, <a href="mailto:m.lee@chyron.com">m.lee@chyron.com</a></td>
</tr>
<tr>
<td>J. Pruce</td>
<td>SEEY, <a href="mailto:J.Pruce@ce.com">J.Pruce@ce.com</a></td>
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<td>CEM, <a href="mailto:M.Rogers@cem.com">M.Rogers@cem.com</a></td>
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<td>M. Kopp</td>
<td>FH OIL, <a href="mailto:M.Kopp@fhoil.com">M.Kopp@fhoil.com</a></td>
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<td>M. Richardson</td>
<td>BP, m. <a href="mailto:richardson@bp.com">richardson@bp.com</a></td>
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<td>Shell, <a href="mailto:M.Burns@shell.com">M.Burns@shell.com</a></td>
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**THIS FORM MUST BE RETURNED TO API STAFF**

API standards meetings are open to all interested parties. By participating in the notification process and signing this form, you agree: (1) to fully comply with API's policies and procedures governing standards and contract content, (2) that notes hundred and approved by API, (3) to provide any materials submitted by the participant for use in the standards (including creation of any derivative work), and (4) you will not provide any materials that will violate the rights of any third parties including, but not limited to, patents, copyrights, trade secrets, and trademarks, (5) to disclose the existence of any potential technologies in the materials (as provided) and (6) you will not retain or record any recordings or API meetings. All costs incurred in connection of all persons being present.

Attachment B

Annex A API 1104 -  
Option 4 - installat
Updated Task Group Objective and suggested draft addition of Option 4 to Annex A API 1104 (21st Edition) for installation axial strains in excess of 0.5%.

By F. Kopp 10/30/2015 (incorporates comments compiled by Amir Bahrami, Young Yi Wang (9-28 2015)

**Objective**

Task Group (TG) to investigate the addition of Option 4 in Annex A in order to address applications that experience high strain events during installation, such as in offshore reeling.

**Charge:**

Determine the validity of use of API 1104 Annex A, through the development of a new Option 4, in cases of high strain installation methods, such as reeling, to allow for the extending of the length limitations imposed by API 1104 under high strain conditions while meeting the regulatory requirements.

**TG Considerations:**

- Current regulations require the use of API 1104 for pipeline and flowline welding and NDE. However, API 1104 does not explicitly provide guidelines for developing high strain installations where such strains can exceed 0.5%.

- Evaluate and clarify the difference in high strain events between those happening at a known time case (specific known conditions during installation) and those occurring at unknown time cases (a random event during service).

- Determine any additional concerns, testing, documentation, calculations etc. as may be required to allow the use of Annex A for installations when installation strains exceed 0.5%.

- Propose supplemental language for Annex A to allow for applications experiencing high strain during installation.

**Approach**

The Task Group recognizes that the task to supplement Annex A for design strains in excess of 0.5% for both installation and in-service conditions is much more complex than to separate the task into two parts: 1) update the Annex to allow axial strains in excess of 0.5% for installation only, and 2) consider the impact of updating the Annex or creating a new Annex for axial strains during installation and in-service conditions.

The primary reasons for reduced complexity of updating the Annex to allow only installation axial strains in excess of 0.5% are:

1. The number of variables that impact determination of allowable flaw sizes when axial strains exceed 0.5% is greatly reduced if only installation conditions are considered:
   a. No need to consider variability in internal or external environment on crack growth properties.

Comment [FK1]: I did not include the suggestion “not pressurized” because SS-7 and perhaps Technip wish to preserve option of low pressurization of clad pipe. Longitudinal stresses due to such pressurization will be very low and should have insignificant impact on strain field at welds.

Comment [FK2]: I don't agree with the proposed language which implies that length and depth limitations of Section 9 must remain – what then is the point of this task force?

Comment [FK3]: Completely take in-service conditions off the table.
b. Effect of significant bi-axial strain conditions due to combined axial strain and internal or external pressure can be ignored.

2. There are existing standards, such as DNV OS F101 and DNV F 108 that already address installation strains greater than 0.5% in considerable detail. Installation contractors already have extensive experience in using these standards.

3. Many companies and contractors already have considerable experience conducting materials testing and fracture mechanics analyses for installation strains in excess of 0.5% to determine allowable imperfection sizes for welds, but have to restrict allowable lengths of such imperfections to those imposed by Section 9 of API 1104, even if the analyses and testing showed longer imperfection lengths were allowable.
Proposed Draft Changes to Annex A – Installation Axial strains greater than 0.5%

Section A.1 General

Change the last section in the third paragraph from:

Option 3 is provided primarily for those cases where fatigue loading exceeds the limit established for the first two options. Option 3 is not prescriptive and its consistency could be significantly less than Options 1 and 2. Option 3 should only be exercised, when necessary, by skilled practitioners with demonstrated knowledge of fracture mechanics and pipeline load analysis. With these three options this current revision of the appendix should provide a more complete approach to determine inspection and acceptance limits for imperfections.

To:

Options 3 and 4 are provided primarily for those cases where fatigue loading exceeds the limit established for the first two options and/or installation strains exceed 0.5%. Options 3 and 4 are not prescriptive and their consistency could be significantly less than Options 1 and 2. Options 3 and 4 should only be exercised, when necessary, by skilled practitioners with demonstrated knowledge of fracture mechanics and pipeline load analysis. With these four options this current revision of the appendix should provide a more complete approach to determine inspection and acceptance limits for imperfections.

Change the fifth (5th) restriction to use of the Annex from:

• Maximum axial design strain no greater than 0.5%.

To:

• Maximum axial design strain no greater than 0.5%, except under the conditions allowed in Option 4 (A.5.1.6).

Additional Section A.5.1.5
A.5.1.5 Determination of Acceptable Imperfection Size by Option 4 – Installation Strains in Excess of 0.5%.

A.5.1.5.1 General

Option 4 is identical to conditions and requirements of Option 3, except that the restriction on maximum allowable axial design strain of 0.5% as listed in Section A.1 is lifted for installation strains only. If approved by Company, this allows Annex A to also be used in particular for reeled flowlines and pipelines where installation strains will typically exceed 0.5%, provided supplementary requirements in Section A.5.1.5 are met. Another case where installation strains may exceed 0.5% include so-called J-tube pulls where the pipeline or flowline is pulled into a prefabricated curved section of riser pipe attached to an offshore structure.

Guidance Notes (foot notes)

1. This section only addresses the materials manufacture, subsequent welding and NDE of pipe subjected to axial installation strains in excess of 0.5%. Other considerations, such as buckling or wrinkling of pipe subjected to high strains are outside the scope of this standard. Guidance for such limit states can be found in Recommended Practice API RP 1111 or DNV OS F101.

A.5.1.5.2 Determination of strain level at welds and number of plastic strain cycles

Procedures for establishing actual strain levels at welds and the number of cycles of plastic strain that welds may experience during installation (or subsequent recovery) are outside the scope of this Standard. However, both the level of plastic strain and the number of high-strain cycles are critical parameters and the responsible party shall demonstrate by analysis, and if considered necessary, by actual testing, that both parameters are well understood.

A.5.1.5.3 Supplementary Requirements for Line Pipe (and other fittings??)

Guidance: See Section 7 Construction I 300 Supplementary Requirements for Line Pipe for Plastic Deformation in DNV OS F101 (p 136, 137)

A.5.1.5.4 Supplementary Requirements for Weld Procedure Qualification Testing

This section can address strain ageing and subsequent testing of full scale welds, require full scale reeling trial with welds and NDE pre- and post-reel. Can potentially address optional replacement of CTOD testing using SENB specimens with CTOD testing using SENT specimens.

A.5.1.5.5 Supplementary Requirements for Fracture Mechanics Analysis

Strain based assessments with installation strains exceeding 0.5% during installation shall be carried out in accordance with BS 7910 assessment Level 3B or equivalent.


A.5.1.5.6 Allowable Imperfection Size

Any limitations on height or length“ Tricky since this will be subjective. Of interest: read the Guidance note at bottom of page 301 (Section B1010) in Appendix D (NDE) of DNV OS F101 – implies one should actually use workmanship criteria for production welds, regardless, and only allow larger lengths for repair welds.

Renumber Existing Section A.5.1.5 to A.5.1.6

A.5.1.6 Transverse Planar Imperfections