

***IGE/TD/12 Edition 2
Reprint with Amendments
Communication 1757***

Pipework stress analysis for gas industry plant



*Founded 1863
Royal Charter 1929
Patron: Her Majesty the Queen*



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SECTION 1 : INTRODUCTION

This Reprint with Amendments of IGE/TD/12 Edition 2 incorporates Amendments as issued in January 2005. The opportunity has also been taken to include additional enhancements such as IGEMs address. It is essential that owners of the original Recommendations i.e. those published in 2003 (Communication 1681), update those Recommendations with the January 2005 Amendments (which are available to download from IGEM's website) but it is not essential for those Recommendations to be updated with the enhancements.

For information, the enhancements have been made to 1.3. 1.3 (Note), 1.4, 2.3, 2.4, 2.6, 4.5, 5.6.2, 7.1, 7.1 (Note), 7.3.1, 8.3.3, 9.2.1, A2.2.1, A2.2.2 A5.2.1, A5.2.3, A5.2.4 and A5.7

The Amendments have been made to 2.1 (4th Bullet), 5.2.1, 8.5.7.1, A2.3, A3.3.1, A3.3.2, A3.3.3.1, A3.3.3.2, A4.10.2, A4.10.4 and A8.2.1

1.1 In 1975, the Institution of Gas Engineers (IGE) published IGE/TD/9 for offtakes and pressure regulating installations (PRIs) operating at pressures exceeding 7 bar. Within IGE/TD/9, Section 9 and the associated Appendix 4 on pipework design and stressing outlined methods for the calculation of stresses within a piping system. IGE/TD/9 has been superseded by IGE/TD/13.

In 1985, IGE published IGE/TD/12 (Edition 1), extending the scope of these methods to cover a wider application than that given in IGE/TD/9. Amendments to IGE/TD/12 (Edition 1) were issued in 1990.

This edition of IGE/TD/12, which supersedes Edition 1 (which is now obsolete), has been drafted by a Panel appointed by the Institution of Gas Engineers and Managers' (IGEM's) Gas Transportation Committee, subsequently approved by that Committee and published by the authority of the Council of IGEM. It reflects improvements and developments through calculation and analysis.

1.2 The aim of these Recommendations is to ensure that piping systems are designed to withstand the stresses within them and to ensure that forces and moments applied to connected equipment and support structures are considered.

1.3 This edition provides a revised content and improved structure compared to Edition 1. Sections on stress calculation equations, stress concentration factors (SCFs) and fatigue are now presented in appendices. Sections on pressure testing and construction have been excluded since these aspects are more appropriate to IGEM/TD/13. A worked example using the guidance on stresses, SCFs and fatigue is now included. This provides greater clarity on the sustained, shakedown and fatigue assessments.

Note: Although IGEM/TD/13 covers only PRIs, it may be deemed appropriate to use it for construction and testing of other installations.

1.4 Although much of the technical content of Edition 1 has been retained, there are a number of important changes:

- design for creep conditions is no longer considered. The revised scope is controlled by a limit placed on the maximum design temperature
- pipework stress analysis is now based on the use of a matching wall thickness for both flexibility and stress calculations. This reflects common practice in other codes
- the fatigue assessment now adopts the weld classification system and material S-N curves of PD 5500 and BS EN 1993-1-9.

- 1.5 A new section has been included on resolving code stress exceptions. This includes guidance on branch flexibility modelling and on "design-by-analysis" (DBA) using three-dimensional finite element (FE) modelling.
- 1.6 Materials and methods of analysis are subject to continuous evolution and it is intended to review these Recommendations from time to time. Regard will be paid to the publications and findings of appropriate organisations with which IGEN maintains liaison.
- 1.7 These Recommendations reflect the need to ensure adequate reliability and continuity of supply at pressures that are safe for the downstream system and equipment.
- 1.8 These Recommendations do not attempt to make the use of any method or specification obligatory against the judgement of the responsible engineer. Where new and better techniques are developed and proved, they should be adopted without waiting for modification of these Recommendations. Amendments to these Recommendations will be issued when necessary and their publication will be announced in the Journal of the Institution and other publications as appropriate.
- 1.9 The primary responsibility for compliance with legal duties rests with the employer. The fact that certain employees, for example "responsible engineers", are allowed to exercise their professional judgement does not allow employers to abrogate their primary responsibilities. Employers must:
- (a) Have done everything to ensure, so far as is reasonably practicable, that there are no better protective measures that can be taken other than relying on the exercise of professional judgement by "responsible engineers".
 - (b) Have done everything to ensure, so far as is reasonably practicable, that "responsible engineers" have the skills, training, experience and personal qualities necessary for the proper exercise of professional judgement.
 - (c) Have systems and procedures in place to ensure that the exercise of professional judgement by "responsible engineers" is subject to appropriate monitoring and review.
 - (d) Not require "responsible engineers" to undertake tasks which would necessitate the exercise of professional judgement that is beyond their competence. There should be written procedures defining the extent to which "responsible engineers" can exercise their judgement. When "responsible engineers" are asked to undertake tasks that deviate from this, they should refer the matter for higher review.
- Note: The responsible engineer is a suitably qualified, competent and experienced engineer or a suitably qualified, competent and experienced person acting under his or her supervision, appointed to be responsible for the application of all or part of these Recommendations.*
- 1.10 Requests for interpretation of these Recommendations in relation to matters within their scope, but not precisely covered by the current text, may be addressed to Technical Services, IGEN, IGEN House, High Street, Kegworth, Derbyshire, DE74 2DA, email: general@igem.org.uk, and will be submitted to the relevant committee for consideration and advice, but in the context that the final responsibility is that of the engineer concerned. If any advice is given by or on behalf of IGEN, this does not imply acceptance of any liability for the consequences and does not relieve the responsible engineer of any of his or her obligations.

SECTION 2 : SCOPE

2.1 These Recommendations cover the stress analysis and calculation of loadings for welded and flanged pipework used in gas industry installations on pipelines.

In general, an installation on a pipeline comprises one or more of the following:

- compressor station
- line valve
- branch connection
- meter installation (see also IGE/GM/8 or IGE/GM/4, as appropriate)
- multi-junction station with or without in-line metering and which may include pig traps and/or line valves
- overhead pipe crossing
- pigging station
- PRI controlling gas flow and/or pressure from one system to another
- terminal
- other offtakes.

2.2 These Recommendations apply to pipework (as outlined in Sub-Section 2.1) on land, including water crossings. For pipework offshore, additional or alternative guidance may be required. However, many of the recommendations will remain valid.

Note: Offshore pipework is on the seaward side of the low water mark or special boundaries drawn at bays and estuaries.

2.3 These Recommendations are entirely dependent upon the application of other relevant codes and standards, appropriate to the system being designed, for example IGEM/TD/1, IGEM/TD/13, etc., to ensure overall plant integrity.

Note: The information covering materials (pressure testing and construction) is included to qualify the stress analysis recommendations and draw attention to important areas of consideration.

2.4 These Recommendations are entirely dependent upon the correct selection of materials compatible to the appropriate duty. These Recommendations are not intended for general application to pipelines, which are covered by IGEM/TD/1, IGE/TD/3 and IGE/TD/4 respectively. Where larger diameter pipework is above ground for a significant distance, these Recommendations may be relevant.

2.5 These Recommendations cover stress analysis for pipework carrying gas at a maximum operating pressure (MOP) not exceeding 100 bar and at a temperature between -25°C and 120°C inclusive.

Note: Specifically, these Recommendations apply to the range of conditions expected to be encountered in the types of plant specified in Sub-Section 2.1.

These Recommendations cover pipework handling 1st and 2nd family gases as defined in BS 1179, odourised or unodourised.

2.6 These Recommendations apply only to carbon and austenitic steels whose permanent elongation at tensile fracture at room temperature is greater than 14% when measured using the method outlined in BS EN ISO 6892-2.

Note 1: The use of pipe manufactured from non-metallic, cast metallic or other brittle material is not within the scope of these Recommendations.

Note 2: Materials operating above their creep threshold are not covered.

- 2.7 These Recommendations apply to pipework containing gas at a positive gauge pressure, i.e. internal pressure not less than external pressure.
- 2.8 Pipes with a diameter to wall thickness ratio (D/t) of less than 10 require special consideration.
- For pipes of D/t greater than 96, the possibility of buckling of the pipework needs to be considered.
- 2.9 All pressures are gauge pressures unless otherwise stated.