Bord Gáis Networks

Report
on
Gas Quality arrangements
in
Republic of Ireland

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Table of Contents

EXECUTIVE SUMMARY 3
1. Introduction, Background and Scope 5
1.1 Introduction 5
1.2 Background 6
1.3 Scope of Review 7
2. Existing Gas Quality Arrangements 8
2.1 Existing Gas Quality Entry Specifications 8
2.1.1 Inch Entry Point 8
2.1.2 Moffat Entry Point 8
2.2 Existing Gas Quality Monitoring Arrangements 9
2.2.1 General 9
2.2.2 Inch Entry Point 9
2.2.3 Moffat Entry Point 10
3. Recent industry developments regarding Wobbe limits 11
3.1 GB gas market 11
3.2 EASEE-gas 12
3.3 Future European Gas Quality Standard 13
4. Identification of problem and options for resolution 14
4.1 Is gas quality an issue in Republic of Ireland? 14
4.1.1 Gas Appliances 14
4.1.2 Power Generation 15
4.2 Options for resolution 16
4.3 Cost of downstream option 16
4.4 Cost of upstream option 18
4.5 Upstream option - operational issues. 19
5. Proposed revised arrangements for Entry Points 20
5. 1 Change of Quality Specification of Natural Gas at Entry Points and Offtake Points 20
5.2 Change of Measurement arrangements for Entry Points 21
5.2.1 Industry best practice 21
5.2.2 Current situation to be modified 21
5.2.3 Revised Model for Measurement Arrangements 22
5.2.4 Entry Point Arrangements 23
6. Conclusions and Recommendations 25
6.1 Conclusions 25
6.1.1 Gas Quality Specification 25
6.1.2 Gas Quality Measurement Arrangements 25
6.2 Recommendations 26
6.2.1 Gas Quality Specification 26
6.2.2 Gas Quality Measurement Arrangements 26
6.2.3 Entry Point Arrangements 27
Appendix 1 : Range of Wobbe Index 28
Appendix 2: Gas Quality Comparison Matrix 29

EXECUTIVE SUMMARY

This report summarises the findings of a recent gas quality review undertaken by Bord Gáis Networks (BGN). The report presents a number of recommendations for consideration by the CER.

The review has addressed three main questions:

- What is the most suitable gas quality specification to be applied in Republic of Ireland?
- How should potential deliveries of Non-Compliant Gas be dealt with?
- What gas quality monitoring arrangements should be put in place at Republic of Ireland Entry Points to ensure that gas quality specifications are complied with?

Gas quality presents an important safety issue as quality variation has implications for the operation of all gas appliances due to changes in combustion performance. At high Wobbe Index (WI) limits, incomplete combustion can occur and appliances tend to emit higher levels of carbon monoxide (CO) and consequently present increased risk of injury by CO poisoning. At low WI, flame lift can occur and flames can become unstable and may detach or even extinguish, leading to emission of unburned gas.

Currently gas quality specifications are included in the Code of Operations and the Connected Systems Agreements (CSA's). At Moffat there are no gas quality provisions within the CSA, but all gas entering the BGE Network at Moffat is required to compliant with GB's Gas Safety (Management) Regulations (GS(M)R). The WI range contained in the Inch CSA is aligned with that contained in the GS(M)R. The WI range contained within the default specification of the Code of Operations is significantly wider than the Inch CSA and GS(M)R ranges.

Although work has been undertaken by EASEE-gas to develop a harmonised gas quality specification for Europe, this has not been concluded and has run into opposition from a number of countries. Importantly, work carried by the UK Government has concluded that no changes will be made to the GS(M)R gas quality specifications up to and beyond 2020.

Research undertaken by our technical consultants has concluded that the Code of Operations WI range is too wide, and that gas delivered to the limits of this range could lead to safety issues within Republic of Ireland. BGN therefore recommends that changes are made to the Code of Operations gas quality specification so that it is aligned with the WI range contained within the GS(M)R. Similarly, any future CSA's for new Entry Points should also be aligned with the GS(M)R WI range.

In order to ensure that gas delivered to consumers in Republic of Ireland can be safely combusted, our consultants have assessed two options:

- The **downstream option** would adjust or replace downstream appliances to be able to accept the wider WI ranges proposed for example by EASEE gas.

- The **upstream option** would where necessary require gas treatment immediately prior to gas being delivered to the Transportation System. This would ensure that gas quality is compliant with the required gas quality standards.

A cost based analysis of the options reveals that the upstream option is the most cost efficient by a considerable amount. In addition, there are significant risks with the downstream option in that a number of appliances may be overlooked. To date typical appliances on the gas market can not operate satisfactorily over the full WI range of the Code of Operations specification.

BGN recommends therefore that Non-Compliant Gas should where necessary be dealt with by gas treatment and processing. BGN further recommend that nitrogen ballasting of Non-Compliant Gas is carried out by the Upstream Operator(s) where required.

This report also examines the arrangements that are in place to monitor gas quality at Entry Points. BGN have concluded that the current arrangements at both Inch and Moffat are not by modern standards sufficiently robust to ensure that Non-Compliant Gas is not delivered into the Transportation System.

The report recommends a revised set of arrangements that are in line with best industry practice based on independent measurement of gas quality by both the upstream and downstream operators. This revised set of arrangements would apply to both existing and new Entry Points.

1. Introduction, Background and Scope

1.1 Introduction

This report summarises the findings of a recent gas quality review undertaken by Bord Gáis Networks (BGN). The report presents a number of recommendations for consideration by the CER and interested industry parties.

The review has addressed three main questions:

- What is the most suitable gas quality specification to be applied at Republic of Ireland Entry Points and Offtake Points.
- How should potential deliveries of Non-Compliant Gas be dealt with?
- What gas quality monitoring arrangements should be put in place at Republic of Ireland Entry Points to ensure that gas quality specifications are complied with?

In addressing these questions BGN have taken account of safety considerations relating to gas quality and events such as emergency situations in which certain gas quality specifications may be relaxed.

Section 2 presents the existing gas quality arrangements for the gas market.

Section 3 examines recent developments in Europe, concerning Wobbe limits

Section 4 contains a summary of a technical review of Irish gas appliances and presents options for the resolution of Non-Compliant Gas being delivered to Republic of Ireland.

Section 5 presents the proposed revised arrangements to apply in terms of gas quality specification and measurement and monitoring arrangements.

Section 6 contains our conclusions and recommendations.

1.2 Background

Gas quality has increasingly become an important issue in the context of the European gas market. As the liberalisation process gathers pace, security of supply becomes an increasingly important issue and as indigenous gas resources are depleted, the European gas market will become increasingly dependent on gas from a number of sources. In the near future the gas supplied to Ireland will be made up of a combination of indigenous gas and imported pipeline gas and potentially LNG.

Gas from different sources varies in gas quality. Gas quality refers to the elements that compose the gas and importantly to the energy value that is derived when the gas is burnt. Some gas that is produced has a high calorific value and some a low calorific value. It is not possible to safely burn high calorific value gas in an appliance that has been designed for low calorific gas and vice versa.

In the GB gas market this issue was identified in 2003 and the Department of Trade and Industry (DTI) launched an in-depth review of gas quality issues. This review was undertaken as the quantity of imported gas was forecast to increase significantly over the forthcoming 5-10 years and there were concerns that imported gas, including Norwegian pipeline gas and LNG, with a higher Wobbe Index (WI) would cause safety concerns if it was allowed to enter the transportation system untreated. This is of significance to the Republic of Ireland gas market since gas delivered through the Interconnectors will be compliant with the GB gas quality specifications which in turn must comply with the Gas Safety (Management) Regulation 1996 (GS(M)R). Therefore, all gas delivered to Republic of Ireland from the GB market must comply by law with the ranges specified in the GS(M)R. GS(M)R gas is classified as having a narrow WI.

In addition to work undertaken in the GB market, gas quality has also received significant attention on a European wide basis. Work has been focussed in order to improve cross border trade and to enable gas to flow from one pipeline operator's system to another with ease. The European Association for the Streamlining of Energy Exchange (EASEE-gas) has led this work and has developed a number of Common Business Practices (CBPs). This is discussed further in Section 3.

In the Republic of Ireland gas market, the future arrival of Corrib gas and future potential LNG importation facility at Shannon provide sufficient justification to consider the most appropriate arrangements for gas quality in Ireland.

This review is of significance since gas quality variation has implications for the operation of all gas appliances due to changes in combustion performance. At high WI, incomplete combustion can occur and appliances tend to emit higher levels of carbon monoxide (CO) and consequently present increased risk of injury by CO poisoning. At low WI, flame lift can occur and flames can become unstable and may detach or even extinguish, leading to emission of unburned gas.

There are safety concerns, therefore, regarding CO emissions, which might occur, should the existing Irish gas appliance population operate under wider Wobbe Index Limits than current GS(M)R thresholds.

1.3 Scope of Review

The review has focussed on two main areas:

- Gas quality specification – existing and future limits; and
- Gas quality monitoring procedures – are the current arrangements sufficiently robust?

Gas quality specifications at each Entry Point have been considered as part of the review. The findings of the DTI report regarding the potential for unsafe combustion in GB appliances if "wide Wobbe" gas entered the GB system was considered in the context of Irish appliances. Independent advice was sought with regard to this important issue. The default specification in the Code of Operations was reviewed and a high level consideration was given to the potential to ballast wide Wobbe gas at entry with Nitrogen.

The review has also consisted of an investigation into the current operational arrangements at Moffat and Inch for the monitoring of gas quality and an assessment made of the adequacy of such arrangements against current operational practice in the GB and European gas industries.

Discussions have been held with Marathon and National Grid to aid the review at each of the existing Entry Points. In particular, the approach to monitoring of gas quality on each side of the Connected System Point has been reviewed and the appropriate level of interaction between the two operators has been considered.

The review has also considered the appropriate arrangements which might apply in the event of gas being tendered outside of the agreed gas quality specification.

2. Existing Gas Quality Arrangements

This section describes the current gas quality arrangements both in terms of the gas quality specification and the arrangements that are in place to monitor gas quality at Entry Points.

2.1 Existing Gas Quality Entry Specifications

There are a large number of parameters associated with gas quality including Wobbe Index, Sulphur, Oxygen, Carbon dioxide, Hydrocarbon dew point, Nitrogen and water content. The full range of parameters and components is contained in Appendix 2 of this document. The focus of this report is the Wobbe Index (WI) and the acceptable range of WI that can be accepted into the Irish system.

The gas quality specification for gas entering the BGN Network in the Republic of Ireland is addressed in various documents including the BGE Code of Operations and the Connected Systems Agreements (CSA's). Whereas the specifications contained within the Code of Operations are general, those contained within the CSA's are Entry Point specific.

The Code of Operations contains provisions which apply in the absence of a particular specification being agreed at Entry Points to the BGE network. The Code of Operations Quality Specification for Natural Gas at Entry Points (detailed in Appendix 2), specifies a wide WI range with a lower limit of 45.7 MJ/m³ and a higher limit of 54.7 MJ/m³ . This range originates from the standard EN437:2003 (Test gases, Test pressures, Appliance categories). This limit has remained unchanged since the Code of Operations was first published.

2.1.1 Inch Entry Point

The Inch Connected Systems Agreements (CSA), which was implemented in May 2006, specifies a narrower WI range than that which is specified in the Code of Operations. It has a lower limit of 47.2 MJ/m^3 and a higher limit of 51.41 MJ/m^3. This range of WI is identical to the GS(M)R range.

2.1.2 Moffat Entry Point

The Moffat CSA does not contain a detailed gas quality specification for gas entering the BGE network at Moffat. BGN are currently discussing a proposed gas quality specification with National Grid (NG) which will be amended to the Moffat CSA. This specification includes a proposed WI range of 47.2 - 51.41 MJ/m³.

The GB GS(M)R specifies a normal WI range of 47.2 - 51.41 MJ/m³, which is narrower than the BGE Code of Operations specification. Therefore gas entering the

BGE network at Moffat should by law be compliant with the narrower GS(M)R WI specification.

In addition to the standard WI range, the GS(M)R specifies a wider Emergency WI range of 46.5 - 52.85 MJ/m³. This would apply in the event that a gas emergency occurred in Great Britain and would permit GB Shippers to tender gas at Moffat within the wider GS(M)R – Emergency Wobbe Index range.

2.2 Existing Gas Quality Monitoring Arrangements

2.2.1 General

Gas Quality monitoring equipment usually consists of a gas chromatograph (Chromat). A gas chromat is a chemical analysis instrument for separating chemicals in a complex sample. A gas chromatograph uses a flow-through narrow tube known as the column, through which different chemical constituents of a sample pass in a gas stream at different rates depending on their various chemical and physical properties. As the chemicals exit the end of the column, they are detected and identified electronically.

Chromat specifications vary from fiscal applications to Gas Quality applications. A C6 chromat is only used to calculate the calorific value of the gas. A C9 or C9+ chromat is necessary if a detailed gas analysis is required.

2.2.2 Inch Entry Point

Marathon is responsible for installation, calibration, operation, maintenance and repairs to the fiscal meters and the chromatograph equipment at the Inch Entry Point.

Marathon own and operate two gas chromatographs (chromats) at Inch, and provide repeat signals to BGN. These chromats do not measure all the gas quality constituents as detailed in the Inch Connected Systems Agreement (CSA) gas quality specification. Some of the constituents are measured by manual sampling.

Marathon measures some gas quality constituents at Inch, C1 to C6+, Carbon dioxide and Nitrogen. BGN does not currently operate any gas quality monitoring equipment at Inch.

Marathon provides C1 to C12 measurements offshore (Carbon dioxide, Nitrogen, Hydrocarbon dew point) and provides these as repeat signals to BGE. BGE does not have any contractual right to witness the maintenance and upkeep of this equipment.

The CSA requires Marathon to advise BGN as soon as it becomes aware that the gas being made available at the Entry Point does not meet the required specification.

BGN currently have no control of the Marathon gas quality instruments and rely on Marathon to maintain and calibrate the instruments.

Unlike the metering equipment, there are no contractual obligations on Marathon contained in the CSA regarding the standard of gas quality measurement equipment to be used at Inch. The metering accuracy detailed in the Inch CSA is concerned with Volume Flow Rates and Energy Flow Rates and does not cover gas quality signals.

2.2.3 Moffat Entry Point

Moffat and Beattock are two offtakes from the National Grid system in the Moffat area, which feed the two sub-sea Interconnector pipelines.

National Grid (NG) only measures the Calorific Value (CV) of the gas at Moffat using a C6 chromat. The CV is a measure of the energy content of the gas and is used for fiscal or custody transfer purposes. National Grid does not measure any gas quality parameters at Moffat.

BGN perform CV measurement at Beattock using a C6 chromat.

At Moffat / Beattock, the risk of failure to meet the GS(M)R specification is low, since this is a statutory requirement in GB, however there is a risk due to the absence of comprehensive measurements by a chromat, in that some components may exceed the entry specifications as defined in the Code of Operations.

BGN are currently unable to confirm gas quality at the Moffat / Beattock Entry Point in the absence of appropriate equipment being installed.

3. Recent industry developments regarding Wobbe limits

This section sets out the gas quality issue in the wider context of GB and European developments. Currently there is no agreement on a European wide basis regarding gas quality standards. There are many European work-streams, with various proposals for future gas quality standards. Some of these work-streams are looked at below.

3.1 GB gas market

In 2003 the DTI commenced a review of the gas quality arrangements in the UK. This was in light of forecast future dependence on imported gas of a higher WI. The process entailed two phases. The first phase, concluded that future gas imports may be outside the GS(M)R acceptable range and so would not be suitable for direct supply to end users. The second phase commenced in 2004 and established that the costs of changing appliances in the UK would far outstrip the costs of gas treatment prior to delivery into the gas Transportation System. In 2004 the UK Government announced that there would be no change to the GS(M)R until at least 2020 in order to provide regulatory certainty for those import projects that were underway.

In 2006 the UK Government consulted on the future arrangements post 2020 based on two options:

- No change (beyond 2020) to the GS(M)R at the cost of having to process the gas to bring it within GS(M)R limits; and

- At some time after 2020, adjust the gas quality specifications at the cost of having to check and potentially replace up to 45 million appliances in 22 million households so that they are capable of burning higher WI gas.

In November 2007 the UK Government published its response to the consultation and has proposed that the 'no change' approach is adopted. The conclusion has been influenced by an impact assessment that puts the net benefit of the 'no change' option in the range £1.5bn – 14bn with a best estimate of £8bn (NPV, 2005). The risks for increased gas prices and security of supply were assessed to be small.

The Government's conclusion is that no changes will take place to the GS(M)R at least until around 2020, and further that it is not considering any changes post 2020.

This is a significant development in relation to the Republic of Ireland gas market as it confirms that the gas quality specifications specified within the GS(M)R will remain in place for the foreseeable future. This means, in effect, that gas delivered via the Interconnectors will conform to the GS(M)R standards.

3.2 EASEE-gas

EASEE-gas (European Association for the Streamlining of Energy Exchange) through its Working Groups provides a structured platform where industry participants discuss the harmonisation and simplification of business processes by developing Common Business Practices (CBP's).

The current thrust of the EASEE-gas recommendations to the Madrid Forum[1] and the EU Commission is to harmonise the normal range currently specified at national level (with implementation by 2010). The range proposed in the EASEE-gas CBP 2005/001-01 is 46.45 – 54.00 MJ/m³. The EASEE-gas CBP 2005/001-01 applies only to cross-border points and it is understood that the intention of the CBP is that, if CBP compliant gas is tendered for delivery at a cross-border point it should be accepted. Each individual national authority (or TSO as the case may be) should then decide if further processing / blending of the compliant gas is required before delivery to the end user.

It is understood that Spain has expressed its opposition to the CBP in that it believes the WI range is too narrow and will affect its LNG supply options. The UK, however, is concerned that the WI limit is too wide (outside GS(M)R limits) and that the safe operation of appliances will be compromised. The EASEE-gas recommended limits are wider than the Inch CSA limits but narrower than the default Code of Operations limits.

Appendix 1 illustrates the variation of WI range between the BGE Code, UK GS(M)R (Normal and Emergency) , the EASEE-gas CBP , Inch CSA.

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[1] European Gas Regulatory Forum of Madrid was set up to discuss issues regarding the creation of a true internal gas market. The participants are national regulatory authorities, Member States, the European Commission together with groups representing transmission system operators, gas suppliers and traders, consumers, network users, and gas exchanges. The Forum convenes once or twice a year in Madrid

3.3 Future European Gas Quality Standard

With mandate M/400 of 16th January 2007 the EU Commission invited CEN (the European Committee for Standardisation**)** to draw up European standards for gas quality parameters for high calorific value gas (H-gas[2]). The National Standards Authority of Ireland (NSAI) is a member of the CEN group and has to date represented Ireland.

This mandate aims to set standards for gas quality through a forward-looking approach. This means that the possibility is recognised that not all existing appliances will be able to cope with the defined standards, since these standards are to be based on the results of both a testing programme and a cost-benefit analysis[3].

This mandate recognised the necessity to evaluate, in a first phase, the impact of changes in gas quality on the behaviour of appliances falling under Directive 90/396/EEC in terms of safety, efficiency and environmental impact. In order to evaluate this impact the mandate proposed the following work programme for this phase 1 with the objective of creating an overview of:

- the existing population of gas appliances falling under Directive 90/396/EEC that are certified for H-gas;
- the current certification rules;
- the installation and inspection rules and practices; and
- the behaviour of domestic appliances (falling under Directive 90/396/EEC) in terms of safety, efficiency and environmental performance, handling different gas qualities.

In August 2007 a call for tender for the execution of this phase 1 work programme was issued. This call for tender was prepared by CEN/BT WG 197, the CEN group responsible for the execution of phase 1of mandate M/400.

Currently the phase 1 programme is awaiting the allocation of funding by the European Commission.

It is estimated that phase 1 will take two years to complete. This will then be followed by Phase 2 of the programme which will see the writing of the new gas quality standard by the relevant CEN technical committee.

(i)

[2] The West European market for natural gas historically developed on the basis of the Groningen field. This field happens to produce gas containing a considerable percentage of nitrogen. It is called L-gas (Low-calorific gas). Later on gas from other sources including Norway, Algeria and Russia entered the European market, all containing far less nitrogen. They were collectively called H-gases (High-calorific gases), although between them they show substantial differences in composition.

[3] Ref: European Commission Mandate to CEN (M/400) Annex 1 : Phase 1

It would be appropriate to review the outcome of this standardisation work when complete and to assess its implications, if any, for the Irish market. Any decision in relation to the implementation or otherwise of this European gas quality standard is likely to remain at a national level within the E.U.

4. Identification of problem and options for resolution

Gas quality is an important issue facing the Republic of Ireland gas industry. Gas from the Corrib gas field and future potential LNG imports may have a wider range than gas delivered from the Interconnectors and Inch. This section examines whether this will cause a problem for Republic of Ireland.

This section further looks at the impact of gas being delivered which has a wider WI range than at present and addresses two possible solutions.

4.1 Is gas quality an issue in Republic of Ireland?

4.1.1 Gas Appliances

Gas quality variation has implications for the operation of all gas appliances due to changes in combustion performance.

The UK Department of Trade and Industry (DTI) Gas Quality Programme 2006 identified safety concerns, particularly CO emissions, which might occur should existing GB appliances operate under wider Wobbe index limits than current GS(M)R thresholds.

Advantica were commissioned by Bord Gáis Networks (BGN) to produce a report on the "Impact of Gas Quality on Appliances". This report indicated the effects that widening the WI range would have on the combustion performance of appliances in Ireland.

The conclusions of the Advantica research are based on a comparison of UK and Irish domestic gas appliances and the results of test work performed on a representative sample of appliances by Advantica and others as part of the UK DTI Gas Quality Programme. The test results can be seen in a series of reports on the UK Government website.[4]

The main conclusions of the Advantica report were that:

- The Irish and UK gas boiler and water heater appliance populations are comparable in type with similar leading manufacturers and models; and

(i)

[4] http://www.berr.gov.uk/files/file20965.pdf

- Safety concerns as identified by the UK Government sponsored appliance test work (e.g. CO emissions) are equally applicable to the Irish gas appliance population and as such the Code of Operations Natural Gas Quality Specification for Entry and Offtake Points absent changes in the appliance population, should be aligned with the GS(M)R limits of Wobbe Index (47.2 – 51.41 MJ/m3).

Advantica also make the observation that customer CO awareness campaigns will not have an impact on the safety level with respect to the gas quality issue. The typical individual domestic gas consumer will have no knowledge of the effects of gas quality changes on the performance of their gas appliance. They will have no means of monitoring gas quality changes and so if, as demonstrated by the DTI tests, the appliance cannot tolerate or adjust to gas quality changes, then potentially hazardous levels of CO will be produced.

Advantica concluded that generally the test gases within the GS(M)R range of Wobbe numbers from 47.2 to 51.4 MJ/m3 resulted in acceptable appliance operability.

Increasing the Wobbe number of the gas used almost certainly increases the emission levels of carbon monoxide. Where Wobbe number gases in excess of 53MJ/m^3 were tested, exponential increases in CO emissions were seen.

4.1.2 Power Generation

Gas quality is also increasingly becoming an issue for power station operators as the latest generation of gas turbines are more sensitive to changes in gas quality.

Enquiries have been received by the Transporter in relation to gas quality specification and provision of gas quality signals in real time.

It is understood from these discussions that the new generation of gas turbines are sensitive to gas quality variation, and that the combustion parameters of natural gas may have a significant effect on these turbines.

It is also understood that equipment (e.g. active controllers) can be installed in the power plant to manage the change in gas specification.

The primary issue for the power generators and turbine manufacturers appears to be variation of CV and not necessarily the range itself. If there is a variation in the CV, the turbine load may need to be reduced, while adjustments are made to the control system for gas composition variations.

BGN propose that the views of industry be sought, regarding the need to introduce provision of real time gas quality signal info from the Transporter to the power stations, together with an outline of the type of information which may be relevant.

4.2 Options for resolution

Having identified the sensitivity of domestic gas appliances to variations in WI range, the Advantica research considers the costs of various methods of dealing with gas with a wider WI range.

There are two options identified:

- The **downstream option** is to adjust or replace downstream appliances to be able to accept the wider Wobbe Index ranges proposed for example by EASEE gas; and

- The **upstream option** is to perform gas treatment immediately prior to gas being delivered to the Transportation System to ensure that gas tendered for delivery complies with the required gas quality Entry Specification.

4.3 Cost of downstream option

The Advantica Report undertaken for BGN, on the impact of gas quality on gas appliances considers the costs of various methods of dealing with the use of gas with a wider Wobbe Index range beyond the GS(M)R limits.

The cheapest intervention would be an appliance adjustment at approximately €32 million for the appliance population. However this method is only likely to be satisfactory for a limited number of appliance types.

The cost of burner / component refits was also considered at a cost in the region of €150 million for the population. However there are significant drawbacks with this approach in that it would be difficult to agree modifications procedures with the appliance manufactures in respect of ageing appliances. Also significant additional costs would also be incurred in logistics and training to support such a programme. The likely effect on manufacturer's warranties and specific appliance safety risks would significantly limit the application of this option.

From a safety stand point the preferred option to deal with the gas quality issue at the appliance level is to replace the appliances of concern. Advantica have estimated the cost of this approach at €1.157 Billion.

Weighing up these issues Advantica put forward a scenario which seems to best approximate the likely cost of an appliance programme. This scenario would be to adjust a proportion of appliances (say 20%) where this is a relatively easy operation and to replace all other appliances (60%) – with the assumption that some 20% of appliances may not require adjustment or replacement. The cost of this exercise would be some **€876million.**

There would be significant costs associated with managing the safe implementation of the downstream option. A conversion programme may include:

- Identifying appliances to be changed.
- Ensuring availability of suitable replacement appliances.
- Ensuring that all appliances have been changed.
- Ensuring availability of skilled gas installers for nationwide conversion.

The most crucial part of implementing the down stream option would be to ensure that all appliances have been changed. If appliances are missed then there is a health and safety risk from such non-compliant appliances.

Undertaking a programme of visiting each customer would engage a significant number of industry operatives over an extended period. Such a programme may also damage the image of Natural Gas in the eyes of consumers and the general public.

The appliance testing programme to be undertaken as part of the European Commission mandate to CEN, over the next two years, may identify further appliance safety issues associated with those appliances conforming to the requirements of the Gas Appliance Directive. This scenario would require additional expenditure to complete the downstream option.

Boilers on the market today including modern high efficiency boilers do not operate at full efficiency over a wide range of WI. Boilers are adjusted in the factory and /or at the time of installation to suit the local gas specification.

Hence the completion of a downstream project may not lead to a complete solution as there would be residual safety concerns including possible unidentified appliances of concern and a cost in the reduced efficiency of domestic appliances.

4.4 Cost of upstream option

The **upstream option** would require gas treatment, prior to entry to the Transportation System to ensure that gas tendered for delivery complies with the required gas quality Entry Specification.

Two broad approaches are adopted in various countries to modify the WI of a given gas at an Entry Point / Terminal.

- Blending / Co-mingling; and
- Ballasting with Nitrogen.

The blending approach requires that a suitable separate gas stream is available to mix with the high WI stream to produce a gas within the WI limit criterion. In practice, availability of separate, suitable streams is rare and consequently it is difficult to ensure high reliability of mixed product quality.

Ballasting with nitrogen has emerged as a proven method where WI correction must be catered for. The process involves the injection of nitrogen into the main gas stream to both modify heating value and molecular weight in the on-spec gas product.

Absent specific information from Upstream Operators, it is not possible to accurately estimate the scale and therefore the cost of nitrogen ballasting that might be required. Two independent estimates were obtained by BGN in relation to a nitrogen ballasting facility. One estimate indicates that construction of such a facility on a brown field site capable of a 1000 tonnes/day (2 x 50% units) would be an order of magnitude cost of £13m Sterling. This size of plant may not be appropriate in Ireland depending on the actual quantity of gas being produced; however it is provided to indicate the scale of expenditure which may be necessary.

A further estimate was obtained which includes provision and operation of a Nitrogen Ballasting Facility. The costs for such a service (to cover capital, energy, operating costs, labour and maintenance) were in the order of €12 million per year. Additional costs would also be incurred which would include civil works, provision of 6.6 KVA electricity cables, security, supply of meter and signals and supply of gas for vaporisers etc. This estimate also relates to a facility capable of 1000 tonnes/day.

Based on the estimates provided, it is clear that the preferred option, in terms of overall cost, is to deal with the issue of Non-Compliant Gas by gas treatment and processing.

In addition, the technical uncertainty of the downstream solution due to the current appliance capabilities also supports the use of the nitrogen ballasting solution.

4.5 Upstream option - operational issues.

Normal practice is for the Upstream Operator to carry out ballasting / processing. This could possibly be done upstream of the onshore Entry Point although more normally, it is carried out onshore where the facilities can usually be constructed at a lower cost.

There are operational issues in terms of which party controls the flow and which party adds the nitrogen. If the Upstream Operator controls the flow, it is operationally preferred that that the Upstream Operator would ballast the gas. The onshore operator (Transporter) is unlikely to have upstream information sufficiently in advance of the Gas Day and as a result if the onshore operator were to ballast the gas, the processing plant would need to be on standby as a back up, just in case flows increased during the Gas Day.

The Upstream Operator, however, will have sufficient notice from its customers about any changes to flow rates, which may require additional processing plant, including nitrogen facilities, to be started.

If the onshore operator were to carry out nitrogen ballasting, an additional set of gas quality instruments would be required to be installed after the nitrogen ballasting. There would also be a set of gas quality instruments before the nitrogen ballasting, and a control loop between the two sets of instruments, to ensure that the gas being delivered meets the gas quality Entry Specification. This is not considered efficient.

Operationally it is rarely a good idea for the processing activities to be split between two operators. This is generally regarded as inefficient and may also lead to safety issues. Where there is one operator, there will be effort to make the plant as efficient as possible overall, but where there are two operators each operator will try and make his plant as efficient as possible without regard to the efficiency of the other plant.

Communications are also more difficult where there are two operators and an increased level of bureaucracy is implemented to avoid any contractual arguments. This also leads to reduced efficiency.

For these reasons BGN have concluded that any gas treatment processing should be carried out by the Upstream Operator before gas is delivered to the Transportation System.

5. Proposed revised arrangements for Entry Points

In this section we present our proposal to amend the gas quality specification contained within the Code of Operations and how the gas quality measurement arrangements can be amended to reduce the risk that Non-Compliant Gas is delivered to the Transportation System.

5. 1 Change of Quality Specification of Natural Gas at Entry Points and Offtake Points

The work conducted by Advantica has demonstrated that there is a potential safety risk if gas is allowed to enter the Bord Gáis Transportation System at the WI limits currently specified in the default Code of Operations gas quality Entry Specification (45.7 MJ/m^3 to 54.7 MJ/m^3).

BGN recommends that the default gas quality Specification in the Code of Operations for both Entry and Offtake points should be aligned with the narrow WI range 47.2 – 51.41 MJ/m^3.

BGN also recommends that consideration should be given to an Emergency Gas Specification in Republic of Ireland.

In the event that a gas emergency occurred in Great Britain, GB Shippers could tender at Moffat with a GS(M)R – Emergency Wobbe Index range (46.5 – 52.85 MJ/m^3). BGN believe it may be appropriate to accept such gas into the downstream system as the alternative may be to refuse to accept delivery of such gas which itself may cause operational difficulties for the Republic of Ireland Transportation System.

5.2 Change of Measurement arrangements for Entry Points

5.2.1 Industry best practice

Industry best practice has shown that the most robust model for gas quality measurement at custody transfer points / Entry Points is for both the upstream party and downstream party to independently measure gas quality.

The Health and Safety Executive (HSE) have suggested that companies are responsible for demonstrating compliance with safety legislation without completely relying on information or measurements from other companies. In GB, National Grid now rely on their own measurements at entry and throughout the National Transmission System (NTS) to demonstrate to the HSE that they are operating as an RPO and at all times complying with GB Legislation.

5.2.2 Current situation to be modified

Currently gas quality measurement at Republic of Ireland Entry Points is not considered to be sufficiently robust as both upstream and downstream parties cannot independently measure gas quality. Hence, there is no mechanism at Republic of Ireland Entry Points for early detection downstream, if upstream gas quality measurement signals were incorrect.

When current gas quality arrangements are assessed in line with modern practice then there is an unacceptable risk that Non-Compliant gas could enter the Transportation System. This could occur due to a number of reasons:

- failure of a chromat;
- failure of a repeat signal;
- incorrect maintenance calibration of an instrument; and
- incorrect alarm settings.

5.2.3 Revised Model for Measurement Arrangements

In order to make improvements to the current situation, BGN propose the following at each Entry Point:

1. The upstream party measures gas quality parameters with primary instruments (Chromatographs) to ensure that they comply with the gas quality specification.

2. The upstream party supplies the downstream party with repeat signals for gas quality parameters.

3. The downstream party, so as to ensure that Natural Gas delivered to, or tendered for delivery at an Entry Point will comply with the specification for Natural Gas entering the Transportation System (Entry Specification), and to ensure they are acting as an RPO will perform independent measurement of the gas quality with a secondary instrument.

4. If the repeat signals (from primary instruments) differ from the secondary instrument readings, then the downstream party will be made aware via a software alarm, and may arrange for appropriate action including a calibration check on the secondary instrument. A request to check calibration and provide results on the upstream instrument may also be submitted to the upstream party.

5. The procedures would be covered by agreed Local Operating Procedures (LOP's) between the operators. Procedures may cover the following areas:

    - repeat signals;
    - instrument accuracy;
    - measurement range and uncertainties,;
    - sampling frequency;
    - specified limits to trigger a notification alarm; and
    - Arrangements in the event that gas was being tendered outside of specified tolerance levels.

6. All the components detailed in the relevant Entry Specification should be measured at each Entry Point by both Operators.

7. BGN will request validation rights for all gas quality signals and in particular would require such rights if an instrument is deemed to be the primary instrument.

8. Calibration checks on gas quality measurement equipment will need to be witnessed on a regular basis and at the very least occasional audits of the calibration checks will be required.

Application of the above model ensures that both the Upstream Operator and downstream operator can independently monitor the primary instruments and action could be taken if one of the instruments measures close to or exceeds the agreed limit. Each operator will be responsible for calibration of their own instruments.

In order to comply with industry best practice, BGN recommend that the revised model for gas quality measurement is implemented for each Entry Point serving the Republic of Ireland.

For the avoidance of doubt, it is proposed that that the above model would be implemented at all Entry Points, including new Entry Points.

5.2.4 Entry Point Arrangements

BGN recommend that industry rules / Entry Point arrangements are developed to ensure as far as possible the consequences of Non-Compliant gas being delivered at an Entry Point are fully specified. This would involve detailed procedures which would be invoked in the event of Non-Compliant gas being delivered at an Entry Point e.g. A procedure to allow the Transporter to restrict gas flows into the Transportation System if any of the gas quality measurement limits are breached.

BGN recommend that at each Entry Point, Local Operating procedures should be put in place and agreed to include:

1. Limits and timings at which gas quality alarms will be triggered
    i. Limits for each gas quality parameter should be defined and procedures to follow if any excursion of a gas parameter from a defined limit.

2. Confirmation and Validation of gas quality signals / data.
    i. Procedure to verify primary and secondary gas quality signals.

3. Notifications.
    i. Any excursion of a gas quality parameter that is greater than a defined ‘limit’ will result in all relevant effected parties being notified.

4. Curtailment.
    i. Curtailment limits for each gas parameter should be defined and based on excursion duration.
        - Where Non-Compliant excursions are intermittent
        - Where Non-Compliant excursions are continuous

5. Mitigation Steps.
    i. For each gas quality parameter, possible mitigation actions that could be carried out to reduce the risk should be defined.
    ii. Mitigation limits for each gas quality parameter should be defined and based on excursion duration.
        - Where Non-Compliant excursions are intermittent
        - Where Non-Compliant excursions are continuous

6. Reinstatement.
    i. The injection of gas can be reinstated once the gas quality is brought to the applicable limit.

6. Conclusions and Recommendations

6.1 Conclusions

The following summary conclusions are made on the basis of this report.

6.1.1 Gas Quality Specification

- There is a potential safety risk if gas is allowed to enter the Bord Gáis Transportation System at the WI limits currently specified in the default Code of Operations gas quality Entry Specification (45.7 MJ/m^3 to 54.7 MJ/m^3). Accordingly consideration should be given to changing the WI limits contained within the Code of Operations so that they are in alignment with the GS(M)R WI limits;

- It will be necessary to consider solutions to the issue of gas being delivered to the Transportation System that is outside this revised narrower WI range and accordingly a 'downstream option' and an 'upstream option' have been identified.

- Based on estimates provided of for both the upstream and downstream options, it is clear that the preferred option is to deal with the issue of Non-Compliant Gas by gas treatment and processing – the 'upstream option'.

- The downstream option may not lead to an acceptable solution due to technical uncertainty of current appliance capabilities and residual safety concerns including possible unidentified appliances of concern and a cost in the reduced efficiency of domestic appliances.

- Any gas treatment and processing required should be carried out by the Upstream Operator prior to gas being delivered to the Transportation System largely for operational reasons.

6.1.2 Gas Quality Measurement Arrangements

- Current gas quality measurement arrangements at Inch and Moffat / Beattock do not conform with good practice followed in other countries

- Currently Gas Quality measurement at Republic of Ireland Entry Points is not considered to be sufficiently robust as both upstream and downstream parties cannot independently measure gas quality and therefore revised arrangements are required.

6.2 Recommendations

6.2.1 Gas Quality Specification

Based on the potential safety issues of accepting gas outside GS(M)R WI limits, BGN recommends that:

- the gas quality specifications for Entry and Offtake Points should be aligned with the GS(M)R limits of Wobbe Index range (47.2 – 51.41 MJ/m^3);
- the Wobbe Index range (47.2 – 51.41 MJ/m^3) should apply at all new Entry and Offtake Points;
- the default Gas Quality Specification in the Code of Operations for both Entry and Offtake Points should to be aligned with the Wobbe Index range (47.2 – 51.41 MJ/m^3);
- gas destined for the Republic of Ireland market with a higher than acceptable WI limit should be treated by nitrogen ballasting prior to delivery to the Transportation System to ensure compliance with the gas quality Entry Specification;
- Consideration should be given to an Emergency gas quality specification in line with the GS(M)R Emergency WI range (46.5 – 52.85 MJ/m^3) . This would apply under emergency situations either in the GB or Republic of Ireland markets.

6.2.2 Gas Quality Measurement Arrangements

Given the potential for Non-Compliant Gas to be delivered at Entry Points, BGN recommends that revisions to the gas quality measurement arrangements are made, as outlined in Section 5 and summarised below.

- The Upstream Operator will have two primary chromats, and will provide BGN with repeat signals for gas quality parameters.
- BGN will install a secondary chromat at each Entry Point, to verify the repeat signals from the Upstream Operator, and ensure compliance with the gas quality specification.
- At each Entry Point, Local Operating procedures will be put in place and agreed to include instrument accuracy, measurement range and sampling frequency etc.
- Ensure calibration checks on gas quality measurement equipment are witnessed on a regular basis and at the very least occasional audits of the calibration checks

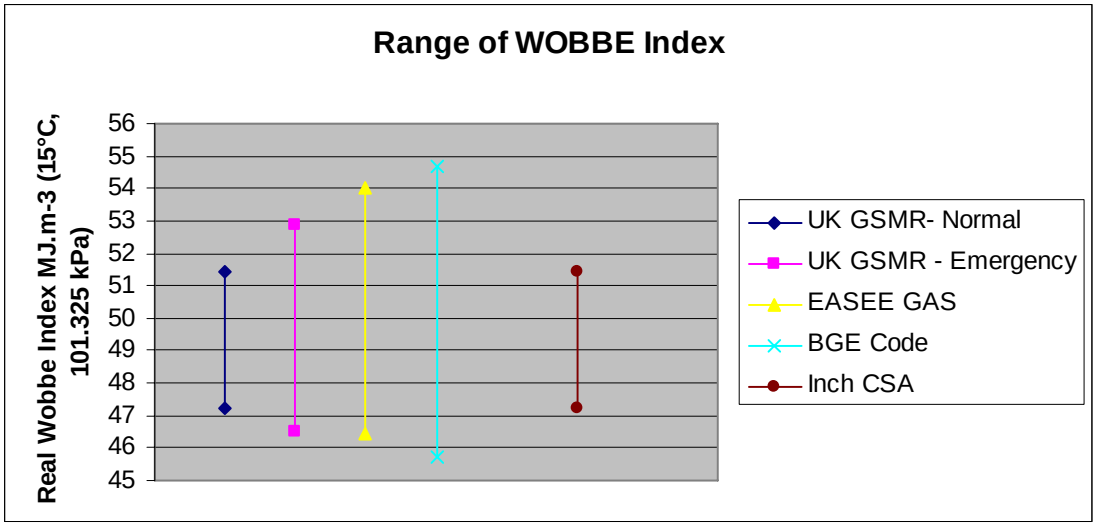
6.2.3 Entry Point Arrangements

- BGN recommend that industry rules / Entry Point arrangements are developed to ensure as far as possible the consequences of Non-Compliant gas being delivered at an Entry Point are fully specified.

- BGN recommend that at each Entry Point, Local Operating procedures will be put in place and agreed to include :

    - Limits and timings at which gas quality alarms will be triggered
    - Confirmation and Validation of gas quality signals / data.
    - Notifications.
    - Curtailment.
    - Mitigation Steps.
    - Reinstatement.

Appendix 1 : Range of Wobbe Index



		MJ/m3	MJ/m3
		Lower Limit	Upper Limit
UK GS(M)R - Normal		47.2	51.41
UK GS(M)R - Emergency		46.5	52.85
EASEE-gas CBP		46.45	54
BGE Code		45.7	54.7
Inch CSA		47.2	51.41

Figure 1. Wobbe Index range Comparison

Appendix 2: Gas Quality Comparison Matrix

Parameter		GS(M)R			Code of Operations (Republic of Ireland) Entry Points			Code of Operations (Republic of Ireland) Offtake Points		
		Unit	Min	Max	Unit	Min	Max	Unit	Min	Max
Gross (Superior) Wobbe Index	WI	MJ/m^3	47.2	51.41	MJ/m^3	45.7	54.7	MJ/m^3	45.7	54.7
Relative density	d	-	-	-	-	0.55	0.7	-	-	-
Total Sulphur	Total S	mg/m^3	-	50 (Note 2)	mg/m^3	-	50	mg/m^3	-	50
Hydrogen sulphide + Carbonyl sulphide	H_2S + COS (as S)	-	-	-	-	-	-	-	-	-
Mercaptans	RSH (as S)	-	-	-		-	-	-	-	-
Oxygen	O_2	mol %	-	0.2	mol %	-	0.1	mol %	-	0.1
Carbon dioxide	CO_2	-	-	-	mol %	-	2	-	-	-
Water dew point	H_2O DP	-	-	Note 1	-	-	-	-	-	-
Hydrocarbon dew point	HC DP	-	-	Note 1	°C at <=85 barg	-	-2	-	-	-
Hydrogen Sulphide	H_2S	mg/m^3	-	5	mg/m^3	-	5	mg/m^3	-	5
Hydrogen	H	mol %	-	0.1	-	-	-	-	-	-
ICF		-	-	0.48	-	-	-	-	-	-
SI		-	-	0.6	-	-	-	-	-	-
Nitrogen	N	-	-	-	mol %	-	5	-	-	-
Water Content		-	-	-	mg/m^3	-	50	-	-	-
Methanol	CH_3OH	-	-	-	-	-	-	-	-	-
Gross Calorific Value		-	-	-	MJ/m^3	36.5	47.2	-	-	-

Note 1: Shall be at levels that do not interfere with the integrity or operation of pipes or any gas appliance (within the meaning of regulation 2(1) of the (1994 GB) (1997 NI) Regulations) which a consumer could reasonably be expected to operate;

Note 2: including H2S