Redacted Version

nationalgrid

Measuring our gas network outputs

Service Risk Framework - May 2018

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1. Introduction

The foundation of the NGGT NOMs Methodology is the Service Risk Framework (SRF). This consists of a set of measures that in totality describes the service performance requirements of the asset base from the perspective of National Grid Gas Transmission (NGGT), its customers and stakeholders. All assets on the network either directly or indirectly contribute to the delivery of one or more of the measures within the SRF.

The impact of an asset failure on one or more of the measures within the SRF provides a consistent method of assessing and articulating the consequence of asset failure and ultimately its associated monetised risk value. The event trees, or risk maps (as described in the main Methodology[1]) provide the linkages and factors for each asset event through to the consequence of that event in terms of the impact on one or more of the SRF measures.

The social (external to NGGT) service valuations contained within this document were developed by consultants experienced in regulatory economics and business planning, who have undertaken similar valuations for the UK water industry over a several price reviews. Private (internal) valuations were undertaken using NGGT-specific data, with any gaps filled using the knowledge and experience of asset experts. **Private valuations are confidential to NGGT and will be redacted from the version of this document submitted for public consultation**. All service valuations are in 2016 prices (unless otherwise stated).

The SRF contains service valuations arising from the direct costs of an asset failure and excludes secondary costs, e.g. impact on share value; legal costs etc. The Pipelines and Sites models share the same SRF to ensure that service risk measures valuations are assigned and treated consistently across the NGGT asset base. Condition and non-condition related costs are included to allow the Methodology to be used for Monetised Risk reporting and for Risk Trading (investment planning and optimisation) applications.

The SRF forms a major section of the main Methodology[2]; Sections are repeated and expanded in this document to enable this to be read as a stand-alone document.

2. Service Risk Framework Principles

2.1 Purpose

The purpose of the SRF within the Methodology is to provide a consistent method of assessing the value of a consequence of failure, and by definition the value of service (or lack of service) provided, which forms the basis of the monetised risk process. Monetised risk provides a common "currency" with which to consistently communicate and assess risk associated with the risk potential and cost of operating, maintaining and improving our assets. The structure of the SRF has been designed in such a way so that it supports monetised risk reporting and strategic, tactical and operational expenditure decision making for both capital and operational investments. The SRF both articulates how the asset base will perform and how both capital and operating expenditure will impact on:

- the monetised risk inherent in the asset base and thereby facilitating the mandatory reporting against safety, environmental, reliability and financial commitments;
- the service that customers and stakeholders expect and value, thereby providing the basis for undertaking Cost Benefit Analysis (CBA) and identifying future investment requirements and strategies;
- the performance of NGGT against relevant regulatory or other commercial objectives, and the impact on society as a whole (e.g. carbon footprint)

2.2 Process for Developing the SRF

The SRF has been developed from two perspectives:

- a top down approach looking at the requirements and expectations of National Grid and its stakeholders for the performance of the asset base; and
- a bottom up analysis of the assets contained within the asset base and the consequences of their failure.

Using a top-down and bottom-up approach as ensured that performance against the measures within the SRF represents the broad range of requirements that stakeholders expect from the asset base as well as the network's ability to deliver them.

[1] Methodology for Network Output Measures, Version 0.8, March 2018, Section 4 (Pipelines) and Section 5 (Sites)
[2] Methodology for Network Output Measures, Version 0.8, March 2018, Section 2.3 and Appendix B

3. Service Risk Measures

Service risk measures are primarily used in the reporting of risk and in the formulation and justification of expenditure requirements. The monetary value of risk provides a consistent basis to value the benefits or dis-benefits of expenditure options across different asset classes, enabling meaningful comparison and facilitating the application of consistent decision making and expenditure selection.

It is essential that the service risk measures cover all of the aspects of risk presented by the asset base. For NGGT, these service risk measures have been categorised into five categories, namely:

- Safety
- Environment
- Availability and Reliability
- Financial
- Societal and Company

Each of the service risk measures is articulated in terms of a range of severities to appropriately and consistently capture the impacts experienced.

The SRF consists of 13 measures grouped into five categories as shown in the Figure 1 below.

Category	Service Risk Measure
Safety	Health and Safety of the General Public and Employees
	Compliance with Health and Safety Legislation
Environment	Environmental Incidents
	Compliance with Environmental Legislation and Permits
	Volume of Emissions
	Noise Pollution
Availability and Reliability	Impact on Network Constraints
	Compensation for Failure to Supply
Financial	Shrinkage
	Impact on Operating Costs
Societal and Company	Property Damage
	Transport Disruption
	Reputation

Figure 1 NGGT Service Risk Categories and Measures

3.1 Safety

Safety risk includes the impact of asset failure on the health and safety of our employees and the general public. This also covers the cost of compliance with the legislation relating to health and safety.

3.2 Environment

Environment risk includes the cost of compliance with environmental legislation and the environmental permits we hold for some of our sites. The category also includes potential penalties due to failure to comply with legislation, the social impact of noise pollution events caused by our assets when they fail and the carbon impact of greenhouse gases emitted.

3.3 Availability and Reliability

Availability and Reliability risk covers our ability to receive and provide gas from and to our customers and any contractual or statutory compensation we may be required to pay if we fail to do so.

3.4 Financial

Financial risk includes the direct financial consequences of the failure of the asset base including, repair and maintenance costs, shrinkage and direct compensation payments.

3.5 Societal and Company

Societal and Company risk includes the potential wider impacts to society of our asset base such as the societal value of transport disruption and the indirect costs of damage to public assets. Reputational damage is not directly considered, although it is considered indirectly as part of defining the Gross Disproportionality Factor (see Section 4.5).
The treatment and valuation of risk for each of the service risk measures is discussed in subsequent sections.

3.6 Service Risk Valuations

All service risk valuations have been split into Private or Social categories. Some service risk measures have both Private and Social valuations, some only Private and some only Social (Figure 2).

Category	Service Risk Measure	Private	Social
Safety	Health and Safety of the General Public and Employees	Y	Y
	Compliance with Health and Safety Legislation	Y	-
Environment	Environmental Incidents	Y	Y
	Compliance with Environmental Legislation and Permits	Y	-
	Volume of Emissions	-	Y
	Noise Pollution	Y	Y
Availability and Reliability	Impact on Network Constraints	Y	-
	Compensation for Failure to Supply	Y	Y
Financial	Shrinkage	Y	-
	Impact on Operating Costs	Y	-
Societal and Company	Property Damage	-	Y
	Transport Disruption	-	Y
	Reputation	Y	-

Figure 2 Private and Social service risk valuations by Service Risk Measure

Private or internal, service risk valuations refer to the valuation of risks which are directly incurred by NGGT, such as cost of compliance or legal costs.

Social, or external, service risk valuations refer to the valuation of risks, which are not directly incurred by NGGT and are borne by society as a whole. These valuations were developed in consultation with specialist regulatory economists and are largely based on UK Government data sources[3,4] or through study of similar, published

[3] https://www.gov.uk/guidance/ecosystems-services

valuations from actual events in related industries. A generic approach towards social external risk valuation using the concept of “Value Transfer” is shown in Appendix A.

4. Safety

Ensuring that NTS risks are managed to yield a level of safety risk that is acceptable for all customers and stakeholders is paramount. The Methodology offers the potential to assess Safety risk to an individual asset level, providing a powerful capability for risk quantification and investment targeting. Figure 3 presents an overview of the Safety service risk valuations.

Category	Service Risk Measure	Severity
Safety	Health and Safety of the General Public and Employees	Minor Injury / Near Miss
		Lost Time Injury / Reversible Injury
		Major Injury / Irreversible Injury
		Fatality
	Compliance with Health and Safety Legislation	Increased Reporting
		Improvement Notice
		Prosecution

Figure 3 Health and Safety Service Risk Categories and Measures

4.1 Health and Safety of the General Public and Employees

This is the risk of causing personal injury or illness to members of the general public or our employees and is expressed as the number of people at risk of death or injury in each severity band. Asset investments can impact on the health and safety of the general population or employees, such as reduction in the frequency of sickness, accidents and injuries. The defined severity bands align with current health and reporting within NGGT[5] and the structure in which the Health and Safety Executive (HSE) define and value risk of injury and illness[6].
The severity bands are classified as:

- Minor injury / near miss / negligible
- Lost time injury / HSE letter of concern / reversible injury
- Major injury / RIDDOR reportable / irreversible injury
- Fatality / HSE enforcement notice

All the severity bands within this measure are assessed based on the expected number of individuals impacted based on the probability of failure and consequence of failure for individual assets.

4.2 Compliance with Health and Safety Legislation

There are costs to National Grid of non-compliance with relevant health and safety legislation. Through internal NGGT stakeholder engagement we have developed different levels of consequence which result from a failure to comply with legislation. The implication of non-compliance can range from increased reporting through improvement notices to prosecution, as below.

- Increased reporting (minor breach of compliance will result in the requirement to report more frequently and / or to a more granular level of detail)
- Improvement notice (a more severe breach, or a repeated breach will result in the HSE issuing an improvement notice)
- Prosecution (the most severe punishment the HSE can deliver would be to prosecute NGGT)

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https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/191500/Accounting_for_enviornomental_impacts.pdf

5 NGGT Management Procedure (T/PM/INS/8)

6 Managing the Integrity of Safety Instrumented Systems

4.3 Private (Internal to NGGT) Safety Risk Valuations

The Private Safety costs were identified through a study of historic incident investigations[7], over a 5 year period. This records the time spent and the seniority of all individuals involved in the investigations. This allowed a unit cost per investigation to be assigned. This initial analysis was reviewed with business experts to produce a final view of costs per investigation. Death in Service compensation costs is also assumed for fatalities, but this is a worst case scenario as a private cost will only apply to NGGT employees. Values applied are shown in Table 1, broken down by incident category:

Incident Category	Private Risk Value (per event)
Minor injury / near miss / negligible	Values not published
Lost time injury / HSE letter of concern / reversible injury	Values not published
Major injury / RIDDOR reportable / irreversible injury	Values not published
Fatality / HSE enforcement notice	Values not published

Table 1 Private Safety valuations by severity type

Legal costs arising from failure to comply with Health and Safety legislation, along with associated damage to reputation and shareholder value, have not been quantified and can be assumed to form part of the Gross Disproportionality Factor (see Section 4.5).

4.4 Social (External to NGGT) Safety Risk Valuations

Investments (or no investment) can impact on the health and safety of the general public or employees. There are a range of techniques that have been used to place a value on accidents and the ensuing injuries. The literature[8,9,10] covers both fatal and non-fatal injuries. The main methods are:

- Cost of injury (as employed by the HSE)
- Willingness to pay (as employed in the health sector)
- Compensation (as offered by the legal system)
- Consumer behaviour methods
- Market valuation approaches
- Compensating wage differentials

The HSE recommends a Cost of Injury (COI) approach. The HSE valuation also includes an estimate for human cost, the subjective costs of pain and suffering experienced by the individual and their family and friends, which compensates for the main criticism applied to the pure COI approach. The HSE cash valuations of avoiding health and safety impacts have been adapted for use in the Methodology as shown in Table 2[11]:

Severities	Units	Value
Minor injury / near miss / negligible	Vol. of employees / general public	£400
Lost Time Injury / HSE letter of concern / Reversible Injury	Vol. of employees / general public	£30,000
Major Injury / RIDDOR reportable / Irreversible Injury	Vol. of employees / general public	£300,000
Fatality / HSE Enforcement Notice	Vol. of employees / general public	£1,900,000

Table 2 Applied societal valuations for death and injuries

The Methodology calculates the expected numbers of death and injuries based on asset-level risk assessments. The £1.9 million value for a fatality is assumed to apply to loss of a single life, which is then multiplied by the expected numbers of fatalities to give an overall value of monetised risk. This valuation is further multiplied by a Gross Disproportionality Factor (see Section 4.5).

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[7] Incident Reporting and Investigation Procedure (NGUK/SHE/INV/1)
[8] "The costs to Britain of workplace accidents and work-related ill health in 1995/96", HSE
[9] "Highways Economic Note no. 1 2002", DfT
[10] J. Hopkin and H. Simpson, (1995), "Valuation of road accidents", Transport Research Laboratory Report 163, DfT
[11] HSE CBA website in 2003 prices: http://www.hse.gov.uk/risk/theory/alarpcheck.htm. These have been inflated to 2016 prices using RPI

4.5 Gross Disproportionality Factor

NGGT can reasonably choose not to carry forward investment where health and safety investment would be grossly disproportionate to the benefits. This is applied in the form of a Gross Disproportionality Factor (GDF), which is applied as multiplier to the societal Safety valuations (Table 2). As HSE do not provide any specific guidance as to the appropriate GDF to use, we have chosen a value in line with the Gas Distribution and Electricity Transmission networks - a value of ten (10) is used for both employees and the general public.

As our Methodology allows the Individual Risk (IR) - the probability of a person being killed by asset failure in a single year – to be calculated at a single asset level, the opportunity exists to define the GDF at asset level, using the modelled IR value to derive the GDF[12]. The impact of this assumption will be tested and may be included in future revisions of the Methodology. The impact of using a different GDF for NGGT employees and the general public will also be assessed.

4.6 Property Occupancy

The number of members of the general public resident is a property at the time a fire or explosion consequence occurs is highly sensitive in the calculation of Safety service risk. The ONS recommends an average occupancy of 2.3 for domestic properties. Clearly a property will not be occupied for 24 hours per day, 365 days per year. As such an average occupancy value of 1.63 has been estimated (see Appendix D). Industrial and commercial property occupancy has not been specifically assessed at this stage, as the data to split property counts between domestic and industrial/commercial is not currently available. This assumption will be tested for sensitivity and may be included in further revisions of the Methodology.

Estimation of numbers of employees on site in the event of a fire or explosion has been estimated using historic work volumes and typical job times, but these assumptions have significantly less impact on Safety risk than for the general public.

5. Environmental

The risk of negative environmental impact is also a key consideration when considering the consequences of asset failure. Figure 4 provides an overview of the Environmental service risk valuation categories.

Category	Service Risk Measure	Severity
Environment	Environmental Incidents	Category 4 Incident
		Category 3 Incident
		Category 2 Incident
		Category 1 Incident
	Compliance with Environmental Legislation and Permits	Increased Permit Costs
		Increased Reporting
		Improvement Notice / Prohibition Notice
		Prosecution
	Volume of Emissions	Carbon Dioxide Emissions (Combustion)
		Carbon Dioxide Emissions (Other)
		Other Greenhouse Gas Emissions
	Noise Pollution	Noise Pollution

Figure 4 Environmental Service Risk Categories and Measures

[12] National Grid Quantified Risk Assessment (QRA) document (T/SP/G/36)

5.1 Environmental Incidents

The volume and severity of environmental incidents can be thought of as the key performance metric in the evaluation of Environmental service risk.

There is potential for some failure of assets and materials to impact the environment. The type, scope and scale of these impacts are segmented into four categories[13] with Category 4 being having the lowest impact and Category 1 the highest.

Severity	Trigger
Category 1	• Significant environmental harm or damage • Formal written notification of enforcement action from a regulatory authority • Regulators and similar bodies taking an active involvement in our activities as a result of the incident
Category 2	• Results in actual environmental harm or damage, but • Prosecution or enforcement action by a regulatory body or adverse public perception is deemed unlikely
Category 3	• A near miss • An incident which under different circumstances had the potential to cause harm or damage to the environment
Category 4	• A condition that left unattended could lead to an incident. • Includes third party activities outside of our control that have the potential to impact upon our assets or property

Table 3 Environmental incident categories

5.2 Compliance with Environmental Legislation and Permits

Some sites, mostly compressor stations, have environmental permits which set the permitted levels of emissions. If these levels are breached then an increased cost of the environmental permits may result and financial penalties may arise from non-compliance penalties with relevant environmental legislation. The implication of non-compliance can range from increased reporting through improvement notices to fines. Working with internal business expert non-compliance severities have been categorised as follows:

- Increased permit costs
- Increased reporting
- Improvement notice / prohibition notice
- Prosecution

5.3 Volume of Emissions

The Department for Business, Energy and Industrial Strategy (DBEIS)[14] provides the carbon values for use in UK public policy appraisal. These are split into traded and non-traded values and show an increasing societal value of carbon emissions over time (carbon “inflation”).
Traded values cover the impact of government policies on emissions in the traded sector, (i.e. those sectors covered by the EU Emissions Trading System (EU ETS)). For emissions in sectors not covered by the EU ETS (i.e. the non-traded sector) a non-traded price of carbon is used.

Consultations with internal and external carbon experts have confirmed that CO2 emissions arising from unburned natural gas are to be considered non-traded. Burned fuel gas would fall under EU ETS and be considered traded; fuel gas is not currently considered within the Methodology. The use of grid electricity to run a compressor is considered traded, but these CO2 emissions are accounted for by the electricity supplier.

We have assumed that all unburned gas is 100% methane, with a Global Warming Potential of twenty-five (25)[15]. This is a conservative assumption and may be changed in the future to account for the actual mixture of gases in the NGGT network. As this will vary in both time and space based on the prevailing supply and demand conditions, estimating a typical gas composition will be complex and only worthwhile if there is a material impact on monetised risk (see Section 9).

5.4 Noise Pollution

In normal operation and through condition-related asset failure, assets may cause a noise nuisance and as such impact customers in close proximity. We consider both private costs, the investigation of noise complaints, and societal costs, the disruptive impact of noise on individuals close to noise-emitting assets.

[13] Environmental Guide (NG/UK/SHE/INV1)
[14] Carbon Valuation in UK Public Policy Appraisal: A Revised Approach, 2015 update uplifted to 2016 prices using RPI
[15] Ecometrica (April 2017), https://ecometrica.com/

The Department for Environment, Food and Rural Affairs state that noise pollution must be considered. Liaison with business experts indicated that investment decisions are made to remedy incidents of noise on sites.

5.5 Private (Internal to NGGT) Environmental Risk Valuations

Environmental incidents

Private costs of environmental incidents were estimated through analysis of 5 years' worth of historic environmental incidents and validated with business experts. Calculated private costs per incident are shown in Table 4:

Incident Category	Private Risk Value (per event)
Category 1	Values not published
Category 2	Values not published
Category 3 (Near Miss)	Values not published
Category 4 (Incident)	Values not published

Table 4 Environmental incident private service valuations

Compliance with environmental legislation and permits

Every site has a site permit. Failure to comply with the permit does not directly result in a fine, but it will result in the permit cost increasing the following year. Cross-industry estimates have been used to estimate the private costs of failure to comply with Environmental Legislation as per Table 5 below. These estimates have come from a variety of case studies applicable to relevant UK industries, such as the Water sector:

Incident Category	Private Risk Value (per event)
Increased permit costs	Values not published
Increased reporting	Values not published
Improvement notice	Values not published
Prosecution	Values not published

Table 5 Legislation and permitting compliance private service valuations

Noise pollution

An average, private cost of (value not published) to investigate a noise pollution event has been estimated in consultation with business experts.

5.6 Social (External to NGGT) Environmental Risk Valuations

Environmental incidents

The societal value of environmental incidents was quantified using a series of case studies reviewed by our specialist consultants using their cross-sector experience. These studies largely relate to the size of penalties awarded for various degrees of environmental damage, across the oil and water sectors. The general principle applied was that when setting fines, judges will account for a range of factors and principles but the scale of fines will be guided by the determination of the offence category. Guidance is provided on the two elements of the decision; Culpability and Harm based on how easily could a pollution incident have been avoided and what was the scale of impact which resulted.

The combination of Culpability and Harm gives rise to the following valuations (shown in Table 6) which are based on the severity scales defined in Section 5.1.

Incident Category	Social Risk Value (per event)
Category 1	£1,000,000
Category 2	£130,000
Category 3 (Near Miss)	£30,000
Category 4 (Incident)	£0

Table 6 Environmental incident societal service risk valuations

Volume of emissions

As per Section 5.3, the non-traded carbon valuations have been applied as per Figure 5. The Central value has been used (Low and High values will be used for sensitivity analysis) which corresponds to £64 per tonne of CO_2e in 2017. These valuations are updated annually by DBEIS and any material changes may require an update to the Methodology (see Section 9). Private costs of emissions are also considered as part of shrinkage valuations (Section 7.1).

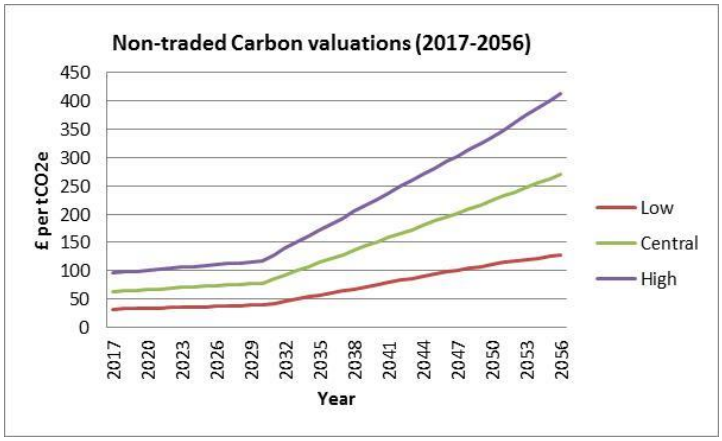

Figure 5 Carbon valuation by year (non-traded) (source: DBEIS[16])

Noise pollution

The assessment of noise pollution was undertaken by our specialist consultants, using a DEFRA-sourced noise valuation modelling tool[17] assuming the noise source is a diesel generator. This was necessarily a generalised assessment, as site-specific acoustic surveys for the whole NGGT asset population were not available and the relatively low valuation of noise social costs does not justify more extensive surveys. A value of £3,000 per event is assumed for the social value of noise nuisance based on the above analysis and assumptions.

Where known noise nuisance issues exist and acoustic surveys are available, the Methodology is flexible enough to accommodate site- and event-specific data.

6. Availability and Reliability

Availability and Reliability risk encompasses our ability to receive and provide gas from and to our customers and any contractual or statutory compensation we may be required to pay if we fail to do so. The elements of the Availability and Reliability service risk measures are shown in Figure 6.

Category	Service Risk Measure	Severity
Availability and Reliability	Impact on Network Constraints	Direct Financial Valuation
	Compensation for Failure to Supply	

Figure 6 Availability & Reliability Service Risk Categories and Measures

6.1 Impact on Network Constraints

The Gas Transmission network is designed to meet the supply and demand requirements of our shippers and customers respectively. Depending upon the location and timing of restrictions in asset availability then differing constraints are placed upon the network.

This measure is assessed directly in financial terms based on the purpose and utilisation of the asset and the selected supply and demand scenario.

6.2 Compensation for Failure to Supply

There is defined compensation for failing to supply gas to Gas Transmission or Distribution Network (GDN) customers. These costs include:

- Compensation for failure to supply under the Uniform Network Code
- Entry capacity buy-back under Uniform Network Code
- Exit capacity buy-back under Uniform Network Code

[16] https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal
[17] Defra (2014) https://www.gov.uk/guidance/noise-pollution-economic-analysis#noise-modelling-tool

There are also costs associated with the reconnection of those customers should disconnection occur (these are borne by the GDNs).There are considerable Safety consequences associated with the inability to supply gas to vulnerable customers. These are not directly considered as part of our Methodology. An approach to evaluate this risk, without under- or over-estimating the impact, will be discussed with the GDNs as part of future Methodology improvements.

Appendix E provides further detail on the method and calculations used.

6.3 Social (External to NGGT) Availability & Reliability Risk Valuations

The Availability and Reliability service risk measures described in Sections 6.1 and 6.2 are modelled in combination as social costs, external to our monetised risk calculation tools (see the Consequence of Failure report[18]). In practice, these risk values are a combination of private and social costs. As the payment of compensation sums to customers for loss of supply is infrequent (1 event in the last 10 years), and of relatively low direct cost, all loss of supply service valuations are assumed to be indirect and valued in terms of societal impact.

The valuation approach for Availability and Reliability is complex and is summarised in Appendix E. Approaches have been developed to estimate the value loss at all Entry and Exit Points, Compressor and Pipelines/AGIs using a consistent approach. This approach has taken account of the resilience benefits offered by our Compressor fleet. Valuing service risk has required some simplification of the Uniform Network Code (UNC) guidelines and the use of default values where inputs are highly dynamic in time and location (e.g. the cost of buying back capacity).

The most significant cost in the analysis is the compensation of domestic consumers. The number of consumers at each distribution Exit Point is calculated by dividing the proportion of booked capacity at an offtake with respect to the total volume of booked capacity. The number of connected homes is taken from the total number of domestic meters installed in the UK and split between Exit points based on the proportion of annual average site flow to total NTS flow. This is aligned with a UK Transmission and UK Distribution harmonised standard for network planning assumptions[19].

The compensation value is taken as £30 per day with a reconnection cost of £32 per customer.
As these costs are not directly incurred by NGGT these are assumed to be the societal valuations of disruption, rather than direct financial costs. We have assumed that as the supply loss would be caused by failure of NGGT assets, then this would not constitute double-counting with Gas Distribution Networks. Numbers of downstream customers have been estimated using the average volume of gas passing through each Exit point (domestic only).

Neither the costs to society of a power station customer being unable to produce electricity as a result of a gas outage, or the Safety consequences of customers being without gas for extended periods, have been considered at this stage but could be included in the future. These costs are potentially very large and, if included, would have a material impact on monetised risk and required levels of investment to manage risk.

Further discussions are required to ensure that this high impact, low probability risk is reflected in the levels of investment allowed for the NTS and how the benefits of these investments are recognised.

7. Financial

Financial risk includes the direct financial consequences of the failure of the asset base. These costs are directly incurred by NGGT in the daily operation and maintenance of the NTS.

A distinction must be made between Reactive costs, which form part of the baseline monetised risk (i.e. the costs of reactively managing the network, including planned survey and maintenance activity) and Proactive costs, which are costs incurred through proactive investments to manage risk and meet stakeholder expectations.

Reactive costs form part of the Financial service risk valuation process below. Proactive costs are considered when developing options for future investment planning, and risk trading between asset classes, which fall outside the scope of this document. The elements of the Financial service risk measures are shown in Figure 7.

[18] Section 7 and Appendix A
[19] Planning and Network Analysis Requirements for the Evaluation of Security of Supply (T/PM/NP/15)

Category	Service Risk Measure	Severity
Financial	Shrinkage	Direct Financial Valuation
	Impact on Operating Costs	

Figure 7 Financial Service Risk Categories and Measures

7.1 Shrinkage

Shrinkage is the difference between the quantity of gas, as energy, measured entering and leaving the NTS, after taking account of line-pack change (stored gas within the NTS). It has two components

- Own Use Gas
- Unaccounted for Gas

Own Use Gas (OUG) is the energy that we use within the NTS to transport gas through the system. The main component of OUG is compressor fuel where we use gas generators. Unaccounted for Gas (UAG) is the balance between total shrinkage and OUG.

The Methodology is sufficiently flexible to account for all of these Shrinkage elements. However, we have not used OUG within the baseline monetised risk assessment. This is to avoid the possibility of overwhelming condition-related risks, as fuel gas shrinkage costs in particular are very high and are largely driven by operational, rather risk-based decisions (i.e. to maintain acceptable pressures at offtakes). We recognise this limits the potential of the model to value emissions-driven investments and may be included at a later date.

Some UAG is estimated directly as the volume of gas lost through leak failure modes (leakage), minus the small volume of gas that is burned as a result in a fire or explosion consequence (refers to Consequence of Failure[20] report). This is directly modelled in the Methodology. Other smaller losses are considered to be constant over time, are not generally impacted by investment and therefore ignored.

7.2 Impact on Operating Costs

This measure includes the direct costs of routine operation and maintenance of the NTS, including statutory works such as PSSR and pipeline inspections.

7.3 Private (Internal to NGGT) Financial Risk Valuations

Shrinkage

A private value for the loss of unburned gas through leakage and shrinkage has been assessed using a wholesale gas price of £0.46 per therm[21] which equates to £0.015 per KWh. This equates to a value of £0.17 per cubic metre, assuming 1 cubic metre of gas provides 11.06 kWh of energy. Clearly wholesale values change over time and these simplistic valuations will be tested for sensitivity and continuously reviewed.

Impact on operating costs

Costs are categorised differently for the Sites and Pipelines risk models.
For Sites, costs are based on 102 Units, based on ISO14224[22]. All NGGT assets are grouped into one of these 102 Units. These Units will be used as our basis for future risk modelling and investment planning.
Costs are broken down into 3 categories:

- **Type A**: The equipment fails in such a way that the activity/work required to return the equipment item to a functioning state does not extend the equipment's useful life or improve its overall condition
- **Type B**: The equipment fails in such a way that the activity/work required to return the equipment item to a functioning state does improve its overall condition such that it returns to a condition of "functionally sound", so extending the equipment's useful life
- **Type C**: The equipment fails in such a way that it has to be replaced with a new equipment item

[20] Consequence of Failure Supporting Document, Section 9

[21] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/672802/QEP_Q317.pdf page 30 (September 2017)

[22] ISO 14224:2016 Petroleum, petrochemical and natural gas industries - Collection and exchange of reliability and maintenance data for equipment

Appendix B lists the 102 Units and which of the costs categories (Type A, B or C) are used for each.

For Pipelines, assets were categorised as Primary (pipeline) or Secondary assets (e.g. cathodic protection) based on their function (refers to Probability of Failure[23] report). Costs were then allocated based on the activity carried out on the asset. Appendix C lists the cost categories used in the Pipelines model.

Private financial valuations are confidential to NGGT and are not included within this document. We propose that any costs that have a material impact on monetised risk will form part of the overall governance of the methodology (see Section 9).

7.4 Social (External to NGGT) Financial Risk Valuations

All Financial service valuations are costs directly attributable to NGGT, therefore social risk valuations are not relevant.

8. Societal and Company

Societal and Company risk covers the wider societal impacts of asset failure, such as the potential for transport disruption and damage to public property. The potential to include reputational damage is included, but is not valued in our current monetised risk models. Figure 8 shows the elements of the Social and Company service risk measures.

Category	Service Risk Measure	Severity
Societal and Company	Property Damage	Property Damage
	Transport Disruption	Minor Road
		Dual Carriageway / A Road
		Motorway
		Local Rail Services
		Mainline / Underground Rail Services
	Company Reputation	Local
		National

Figure 8 Social & Company Service Risk Categories and Measures

All the severity bands within this measure are assessed based on the expected number of incidents.

8.1 Property Damage

Property damage includes compensation payments made because of damage to homes and businesses resulting from fires and explosions. An assumed national average cost rebuilding the property has been used for this service valuation.

8.2 Transport Disruption

Transport disruption is typically quantified through quantification of time lost as a result of road works or delays to rail networks. This could be as a result of planned works or an asset failure causing an interruption.

Our specialist consultants have reviewed available literature on the social costs of transport congestion, which focuses primarily on road transport. This was the approach adopted by NERA[24] and used extensively in the UK water industry in the PR14 price control. The following categories have been used for valuing transport disruption:

- Mainline Rail (including London Underground)
- Regional train services
- Critical Transport - Motorway
- Dual Carriageway, A Road

[23] Section 1

[24] NERA (1998) 'The Environmental and Social Value of Leakage Reduction'. A report for UKWIR

- Minor Roads

8.3 Company Reputation

The wider impact of reputational damage has not been specifically valued within the Methodology. It is included as a placeholder should we wish to test the sensitivity of reputational damage as part of ongoing discussions with internal stakeholders and shareholders.

8.4 Private (Internal to NGGT) Societal Risk Valuations

All Societal and Company risk valuations are costs external to NGGT, therefore private cost valuations are not relevant. We have assumed the costs of damage to NGGT property is negligible and as such are not included as Private costs.

8.5 Social (External to NGGT) Societal Risk Valuations

Property Damage

The average UK house price in November 2016 was £217,928 based on the latest information available from the ONS[25] . The rebuild cost will typically be less than the market value of the home due to the value of the land, location, proximity to services[26]. Therefore a valuation of £150,000 per property damaged has been assumed based on 50% of the value of the property plus an uplift to include suffering caused to inhabitants and personal property damaged within the property.

Transport Disruption

The following transport disruption social valuations were applied based on the case studies and external valuation approach described in Section 8.2. The valuations are per day, but we have assumed a per-event value for our analysis.

Severity	Value
Mainline, London Underground	£2,000,000
Regional train services	£500,000
Critical Transport, Motorway	£180,000
Dual Carriageway, A Road	£3,000
Minor Roads	£300

Table 7 Transport disruption social values (per day, or per event)

9. Material Changes To Service Valuations

As the previous sections illustrate, there are many different service valuations, both private and social, within the NGGT Methodology. We plan to refine and improve these over time as new data and evidence is collected. We propose that only changes that are deemed sensitive, and by definition, material in terms of the impact on overall monetised risk, are communicated and agreed with Ofgem and trigger a change to the Methodology. An initial list of service valuations and assumptions that we believe, that if changed significantly, may breach the materiality threshold are listed in Table 8. The full list will be agreed following the agreement of materiality rules and thresholds with Ofgem and captured in future revisions of the Methodology.

[25] https://www.ons.gov.uk/economy/inflationandpriceindices/bulletins/housepriceindex/nov2016

[26] https://www.confused.com/home-and-lifestyle/home-maintenance/how-to-calculate-the-rebuild-cost-of-your-home

Service Risk Category	Service Risk Measure	Private or Societal	Description	Document Section
Safety	Health and Safety of the General Public & Employees	Societal	Fatality / HSE Enforcement Notice	4.4
			Property Occupancy	4.5
			Gross Disproportionality Factor	4.5
Environmental	Volume of Emissions	Societal	Non-traded value of carbon	5.6
Availability & Reliability	Compensation for Failure to Supply	Societal	Compensation of domestic customers (compensation and reconnection cost)	6.3

Table 8 Sensitive service risk measure valuations for materiality assessments

There are additional values and assumptions used in the Methodology, such as those used in Probability (PoF) and Consequence of Failure (CoF) calculations, which may also breach agreed monetised risk change materiality thresholds. These PoF and CoF values and assumptions are outside the scope of this document and treatment will be captured through subsequent revisions to the main Methodology document and supporting documents.

10. Document Control

Version	Date of Issue	Notes
1.0	3rd April 2018	Version for public consultation (redacted)
2.0	22nd May 2018	Final version for Ofgem acceptance (redacted)

APPENDIX A

GENERIC VALUE TRANSFER PROCESS FOR VALUING SERVICE RISK

1. Establish decision context	• Judge if value transfer is appropriate for evidence needs • Determine appropriate level of effort for analysis given time and resources available
2. Define policy good & affected population	• What is the scale, timing, significance of impact? • What evidence is available? • What are the key uncertainties?
3. Define and quantify change in policy good	• Define good to be valued • Define user and non-user populations • Collate impact and population data
4. Select monetary valuation evidence	• Review existing studies • Compare policy good and study context • Assess quality and approriateness for transfer
5. Transfer evidence and value good	• Consider selection criteria and rules of thumb to select study or studies and method e.g. unit value transfer, function transfer etc. • Follow steps for selected transfer method
6. Aggregation	• Aggregate with other linked costs and benefits • Aggregate over affected population • Select time frame and Green Book discount factors
7. Sensitivity analysis	• Target parameters affecting the value the most • Change one parameter at a time • Identify switching value or benefit threshold
8. Reporting	• Present results for decision-making • Ensure key assumptions and limitaions are reported • Ensure transparancy of analysis for scrutiny & review

APPENDIX B

UNIT LIST FOR SITES WITH COST TYPES

Unit Name	Unit Costs*			Type A	Type B	Type C
	Type A	Type B	Type C			
Civils - Buildings - Brick - -	Y	Y	Y	Minor repairs	Refurbishment	Whole replacement average size
Civils - Buildings - GRP - -	Y	Y	Y	Minor repairs	Refurbishment	Replacement
Civils - Drainage - - -	Y	Y	Y	Minor repairs	Section Replacement	Whole replacement 50m with de-watering
Civils - Ducting - - -	Y	Y	Y	Minor repairs	Section Replacement	Whole replacement 50m
Civils - Pathways - - -	Y	Y	Y	Minor repairs	Section Replacement	Whole replacement average size
Civils - Pits and Chambers - - -	Y	Y	Y	Minor repairs	Major Repairs/Re-life	Whole replacement average size
Civils - Roads - - -	Y	Y	Y	Minor repairs	Section Replacement	Resurfacing 100m2
Civils - Security - Barrier - -	N	Y	Y			Replacement
Civils - Security - Camera - -	N	N	Y			Replacement
Civils - Security - ISS Fence - -	Y	Y	Y	Minor repairs	Section Replacement	Whole replacement 100m
Civils - Security - ISS Gate - -	Y	Y	Y	Minor repairs	Section Replacement	Whole replacement motorised
Civils - Security - Non - ISS Fence - -	Y	Y	Y	Minor repairs	Section Replacement	Whole replacement 100m
Civils - Security - Non ISS Gate - -	Y	Y	Y			Replacement
Electrical (A.2.4) - Frequency converters - High voltage - -	Y	Y	Y	Thyristor Replacement single	Tyristor Bank Replacement	Whole Thyristor Drive Replacement
Electrical (A.2.4) - Frequency converters - High voltage - Input stage -	Y	Y	Y	Minor repairs	Refurbishment	Replacement
Electrical (A.2.4) - Frequency converters - Low voltage - -	Y	Y	Y	Minor repairs	Refurbishment	Replacement
Electrical (A.2.4) - Lighting and Small Power - - -	Y	Y	Y	Minor repairs	Section Replacement	Whole replacement average size
Electrical (A.2.4) - Power cables and terminations - - -	Y	Y	Y	Minor repairs	Section Replacement	Whole replacement average size
Electrical (A.2.4) - Power transformers - Dry - -	Y	Y	Y	Minor repairs	Refurbishment	Replacement Auxiliary Transformer
Electrical (A.2.4) - Power transformers - Oil immersed - -	Y	Y	Y	Minor repairs	Refurbishment	Replacement Auxiliary Transformer
Electrical (A.2.4) - Switchgear - High voltage air insulated - -	Y	Y	Y	Minor repairs	Refurbishment	Replacement HV Disconnector
Electrical (A.2.4) - Switchgear - High voltage gas insulated - -	Y	Y	Y	Minor repairs	Refurbishment	Replacement SF6 Gas Breaker
Electrical (A.2.4) - Switchgear - Low voltage - -	Y	Y	Y	Minor repairs	Refurbishment	Replacement LV Breaker MCC

Unit Name	Unit Costs*			Type A	Type B	Type C
	Type A	Type B	Type C			
Electrical (A.2.4) - Switchgear - Low voltage - Control protection and monitoring - Protection relay and interlock c	N	N	Y			Replacement
Electrical (A.2.4) - Switchgear - Oil and vacuum insulated - -	Y	Y	Y	Minor repairs	Refurbishment	Replacement HV OCB
Electrical (A.2.4) - Uninterruptible power supply - Dual UPS with standby bypass Rectifier supplied from emergency power Bypass from main power system - -	Y	Y	Y	Minor repairs	Refurbishment	Replacement
Electrical (A.2.4) - Uninterruptible power supply - Dual UPS with standby bypass Rectifier supplied from emergency power Bypass from main power system - Battery unit -	Y	Y	Y	Minor repairs	Refurbishment	Replacement
Mechanical (A.2.3) - Filters and strainers - - -	Y	Y	Y	Surface Defect Repair	Refurbishment	Replacement
Mechanical (A.2.3) - Heat exchangers - Plate fin - -	Y	Y	Y	Minor repairs	Refurbishment	Replacement
Mechanical (A.2.3) - Heat exchangers - Printed Circuit - -	Y	Y	Y	Minor repairs	Refurbishment	Replacement Typical GG Heat Exchange
Mechanical (A.2.3) - Heat exchangers - Shell and tube - -	Y	Y	Y	Minor repairs	Refurbishment	Replacement Preheater Typical
Mechanical (A.2.3) - Heaters and boilers - Electric heater - -	Y	Y	Y	Minor repairs	Refurbishment	Fuel Gas Preheater
Mechanical (A.2.3) - Heaters and boilers - HC-fired boiler - -	Y	Y	Y	Minor repairs	Refurbishment	Fuel Gas Preheater
Mechanical (A.2.3) - Onshore pipelines - Above Ground - -	Y	Y	Y	Minor repairs	Refurbishment minor coatings	Replacement paint coatings
Mechanical (A.2.3) - Onshore pipelines - Below Ground - -	Y	Y	Y	Minor repairs	Refurbishment Coating Repair	Replacement Sleeve
Mechanical (A.2.3) - Onshore pipelines - Cathodic Protection - Ground Bed -	N	N	Y			Replacement
Mechanical (A.2.3) - Onshore pipelines - Cathodic Protection - Rectifier -	Y	Y	Y			Replacement
Mechanical (A.2.3) - Onshore pipelines - Impact Protection - Marker Post -	N	N	Y			Replacement
Mechanical (A.2.3) - Onshore pipelines - Impact Protection - Sleeve -	Y	Y	Y	Minor repairs	Refurbishment trial repair method	Replacement £1m per km, 0.5 km sleeve considered
Mechanical (A.2.3) - Onshore pipelines - River Crossing - Major -	Y	Y	Y	Minor repairs	Refurbishment	Replacement
Mechanical (A.2.3) - Piping - Carbon steels - -	Y	N	N	Minor repairs	Refurbishment	Replacement

Unit Name	Unit Costs*			Type A	Type B	Type C
	Type A	Type B	Type C			
Mechanical (A.2.3) - Piping - Carbon steels - Cladding -	Y	Y	Y	Minor repairs	Refurbishment	Replacement large installation
Mechanical (A.2.3) - Piping - Carbon steels - Miscellaneous - Pipe support	Y	Y	Y	Minor repairs	Refurbishment	Replacement
Mechanical (A.2.3) - Piping - Stainless steels - -	Y	Y	Y	Minor repairs	Refurbishment	Replacement
Mechanical (A.2.3) - Pressure vessels - Coalescer - -	Y	Y	Y	Minor repairs	Refurbishment	Replacement
Mechanical (A.2.3) - Pressure vessels - Dryer - -	Y	Y	Y	Minor repairs	Refurbishment	Replacement
Mechanical (A.2.3) - Pressure vessels - General - -	Y	Y	Y	Minor repairs	Refurbishment	Replacement
Mechanical (A.2.3) - Pressure vessels - Pig trap - -	Y	Y	Y	Minor repairs	Refurbishment	Replacement
Mechanical (A.2.3) - Pressure vessels - Scrubber - -	Y	Y	Y	Minor repairs	Refurbishment	Replacement
Mechanical (A.2.3) - Pressure vessels - Separator - -	Y	Y	Y	Minor repairs	Refurbishment	Replacement
Mechanical (A.2.3) - Storage tanks h - Fixed-Roof - -	Y	Y	Y	Minor repairs	Refurbishment	Replacement
Rotating (A.2.2) - Blowers and fans - - -	Y	Y	Y	Minor repairs	Refurbishment	Replacement
Rotating (A.2.2) - Compressors - Centrifugal - -	Y	Y	Y	Minor repairs	Refurbishment	Replacement main process gas compressor
Rotating (A.2.2) - Compressors - Centrifugal - Power Transmission -	Y	Y	Y	Minor repairs	Refurbishment	Replacement
Rotating (A.2.2) - Compressors - Centrifugal - Shaft seal system -	Y	Y	Y	Minor repairs	Refurbishment	Replacement Oil or Dry Gas Seal
Rotating (A.2.2) - Compressors - Reciprocating - -	Y	Y	Y	Minor repairs	Refurbishment	Replacement
Rotating (A.2.2) - Compressors - Screw - -	Y	Y	Y	Minor repairs	Refurbishment	Replacement
Rotating (A.2.2) - Electric generators - Engine driven, e.g. diesel engine, gas engine - -	Y	Y	Y	Minor repairs	Refurbishment	Replacement standby power system high complexity
Rotating (A.2.2) - Electric generators - Gas-turbine driven - -	Y	Y	Y	Minor repairs	Refurbishment	Replacement
Rotating (A.2.2) - Electric motors - - -	Y	Y	Y	Minor repairs	Refurbishment	Replacement
Rotating (A.2.2) - Gas turbines - Industrial - -	Y	Y	Y	Minor repairs	Refurbishment	Replacement
Rotating (A.2.2) - Gas turbines - Industrial - Air intake -	Y	Y	Y	Minor repairs	Refurbishment	Replacement
Rotating (A.2.2) - Gas turbines - Industrial - Miscellaneous - Ventilation fan	Y	Y	Y	Minor repairs	Refurbishment	Replacement
Rotating (A.2.2) - Gas turbines - Industrial - Exhaust -	Y	Y	Y	Minor repairs	Refurbishment	Replacement
Rotating (A.2.2) - Gas turbines - Industrial - Starting system -	Y	Y	Y	Minor repairs	Refurbishment	Replacement
Rotating (A.2.2) - Pumps - Centrifugal - -	Y	Y	Y	Minor repairs	Refurbishment	Replacement
Rotating (A.2.2) - Pumps - Centrifugal - Power	Y	Y	Y	Minor repairs	Refurbishment	Replacement

Unit Name	Unit Costs*			Type A	Type B	Type C
	Type A	Type B	Type C			
Transmission -						
Safety and control (A.2.5) - Control logic units - Computer - -	Y	Y	Y	Replacement Base Unit	Workstation Replacement	SCADA system replacement
Safety and control (A.2.5) - Control logic units - Programmable logic controller (PLC) - -	Y	Y	Y	Card Replacement	CPU Replacement	PLC Replacement 25 I/O £20k per I/O
Safety and control (A.2.5) - Control logic units - Relay - -	N	N	Y			Relay Replacement
Safety and control (A.2.5) - Control logic units - Single-loop controller - -	Y	Y	Y	Minor repairs	Refurbishment	Replacement CCC Controller or Similar
Safety and control (A.2.5) - Fire and Gas Detection - Flame - -	N	N	Y			Replacement
Safety and control (A.2.5) - Fire and Gas Detection - Heat - -	N	N	Y			Replacement
Safety and control (A.2.5) - Fire and Gas Detection - Hydrocarbon - -	N	N	Y			Replacement
Safety and control (A.2.5) - Fire and Gas Detection - Smoke/Combustion - -	N	N	Y			Replacement
Safety and control (A.2.5) - Fire and Gas Detection - Toxic Gas - -	N	N	Y			Replacement
Safety and control (A.2.5) - Fire-fighting equipment - - -	Y	Y	Y	Minor repairs	Refurbishment	Replacement water mist system
Safety and control (A.2.5) - Inert-gas equipment - - -	Y	Y	Y	Minor repairs	Refurbishment	Replacement N2 snuffing system
Safety and control (A.2.5) - Input devices - - -	N	N	Y			Replacement
Safety and control (A.2.5) - Input devices - Analyser - -	Y	Y	Y	Minor repairs	Refurbishment	Replacement Chromatograph
Safety and control (A.2.5) - Input devices - Displacement - -	N	N	Y			Replacement
Safety and control (A.2.5) - Input devices - Flow - -	N	N	Y			Replacement £10k per inch
Safety and control (A.2.5) - Input devices - Flow - Ultrasonic -	Y	Y	Y	Minor repairs	Refurbishment	Replacement
Safety and control (A.2.5) - Input devices - Level - -	N	N	Y			Replacement
Safety and control (A.2.5) - Input devices - Others - -	N	N	Y			Replacement
Safety and control (A.2.5) - Input devices - Pressure - -	N	N	Y			Replacement
Safety and control (A.2.5) - Input devices - Speed - -	N	N	Y			Replacement
Safety and control (A.2.5) - Input devices - Temperature - -	N	N	Y			Replacement
Safety and control (A.2.5) - Input devices - Vibration -	N	N	Y			Replacement

Unit Name	Unit Costs*			Type A	Type B	Type C
	Type A	Type B	Type C			
-						
Safety and control (A.2.5) - Valves - All - Actuator -	Y	Y	Y	Minor repairs	Refurbishment	Replacement
Safety and control (A.2.5) - Valves - All - Control and monitoring -	Y	Y	Y	Minor repairs	Refurbishment	Replacement
Safety and control (A.2.5) - Valves - Axial Flow - Valves -	Y	Y	Y	Minor repairs	Refurbishment	Replacement
Safety and control (A.2.5) - Valves - Ball - Control and monitoring - Solenoid valve	N	N	Y			Replacement
Safety and control (A.2.5) - Valves - Ball (Process) - -	Y	Y	Y	Minor repairs	Refurbishment minor coatings	Replacement
Safety and control (A.2.5) - Valves - Ball (Ancillary) - -	N	N	Y			Replacement
Safety and control (A.2.5) - Valves - Check - Valves -	Y	Y	Y	Minor repairs	Refurbishment minor coatings	Replacement
Safety and control (A.2.5) - Valves - Control - -	Y	Y	Y	Minor repairs	Refurbishment	Replacement
Safety and control (A.2.5) - Valves - PSV-Conventional - Valves -	Y	Y	Y	Minor repairs	Refurbishment	Replacement
Safety and control (A.2.5) - Valves - Slamshut - Valves -	Y	Y	Y	Minor repairs	Refurbishment	Replacement
Utilities c (A.2.11) - Air-supply equipment - - -	Y	Y	Y	Minor repairs	Refurbishment	Replacement air compressor package
Utilities c (A.2.11) - Heating/cooling media - Air Conditioning - -	Y	Y	Y	Minor repairs	Refurbishment	Replacement
Utilities c (A.2.11) - Heating/cooling media - Heater - -	Y	Y	Y	Minor repairs	Refurbishment	Replacement

* Y – Cost relevant to Unit type; N – Cost not relevant to Unit type

APPENDIX C

UNIT COST TYPES FOR PIPELINES

Intervention		**Maintain Survey**	**Maintain Routine Maintenance**	**Type A Repair (Proactive)**	**Type A Repair (Reactive)**	**Type B Refurbish / Overhaul**	**Type C New (Proactive)**	**Type C Replace (Reactive)**
Units		per year*	per year	per asset*	per asset*	per asset*	per asset*	per asset*
Pipeline	ILI	Y	N	N	Y	Y	N	Y
Pipeline	Other	Y	N	N	Y	Y	Y	Y
CP System		Y	N	Y	Y	Y	Y	Y
CP Test Post		N	N	Y	Y	Y	Y	Y
Impact Protection	Slab	N	N	N	N	N	Y	Y
Impact Protection	Nitrogen Sleeve	Y	N	Y	Y	Y	Y	Y
River Crossing	Major	N	N	Y	Y	Y	Y	Y
River Crossing	Other	N	N	Y	Y	N	Y	Y
Pipe Bridge		N	N	N	N	Y	Y	Y
Marker Post		Y	Y	N	N	N	N	Y

* Y – Cost relevant to Unit type; N – Cost not relevant to Unit type

APPENDIX D

ESTIMATION OF DOMESTIC PROPERTY OCCUPANCY IN THE EVENT OF AN EXPLOSION

		Source
UK Population	65600000	https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/articles/overviewoftheukpopulation/july2017
Children	17.70%	https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/articles/overviewoftheukpopulation/july2017
16 to 64 (Assumed Working)	57.70%	https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/articles/overviewoftheukpopulation/july2017
Aged 65 and over (Assumed retired)	24.70%	https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/articles/overviewoftheukpopulation/july2017
Unemployment Rate	4.30%	https://www.ons.gov.uk/employmentandlabourmarket/peoplenotinwork/unemployment
Unemployed	1627601.6	Calculation
Time in house during week	100	Calculation
Time in house during weekend	32	Calculation
Percentage of Time in House	78%	Calculation
Number of Unemployed in House	1276612.74	Calculation
Children and Aged 16 to 64 who are employed	47834798.4	Calculation
Time in House during week	75	Calculation
Time in house during weekend	32	Calculation
Percentage of Time in House	64%	Calculation
Number of Children and aged 16 to 64 who are employed in house	30401051.30	Calculation
Retired	16203200	Calculation
Time in house during week	100	Calculation
Time in house during weekend	32	Calculation
Percentage of Time in House	78%	Calculation
Number of Retired in House	12709014.05	Calculation
Average Number of Holidays Abroad	1.70	https://abta.com/assets/uploads/general/Holiday_Habits_Report_2017.pdf
(Assuming 1 = 7 days)	11.90	Calculation
Number of Holidays per week	0.23	Calculation

		Source
Total Number of Households	27227700	https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/families/adhocs/005374totalnumberofhouseholdsbyregionandcountryoftheuk1996to2015
Number of People Per Property	**1.63**	Calculation

APPENDIX E

CHARGES FOR CAPACITY FAILURES

For purposes of testing the Methodology we have considered national demand for a winter day, in combination with credible, localised supply scenarios (within licence obligations).

For determining the scenarios and levels of resilience to be applied for future investment planning and for future NOMs reporting (these scenarios may not be one and the same), further work is ongoing.

Valuations are applied based on the potential loss through asset failure of:

- Exit points (Distribution Network Offtakes, Industrial Customer and Power Stations)
- Entry Points (Terminals and Storage)
- Above Ground Installations (AGIs), including Compressor Sites
- Pipeline sections

The following calculations are used to determine the charges for loss of capacity where flat capacity has been booked by a Terminal or a distribution offtake, for compressors, where flat capacity is not booked, the assumption is made that the capacity lost by the compressor will be charged at the nearest entry or exit point.

Exit Points - Capacity Compensation (Distribution and Industrials)

This section describes the assumptions made in the valuation of compensation payments made to NGGT customers. The actual process and calculations is complex and have necessarily been simplified for the purposes of the Methodology. This section describes our interpretation of section J 3.5 of the Uniform Network Code (Liabilities under different contractual arrangements).

This section briefly summarises the different contractual arrangements which are in place with parties and the potential liabilities under them in respect to a failure in our obligation to deliver gas for Offtake in relation to pressure obligations.

The Uniform Network Code (UNC) are the contractual arrangements made with the Users of the network (i.e. Shippers, Distribution Networks and, under certain circumstances, Traders). Any breaches of our obligations to make gas available for offtake under section J 3.2 in the case of NTS System Exit Points, may result in compensation to be paid to the User as a result of section J 3.5.

For the purpose of investment planning, where we wouldn't have the nominated quantity at time of breach, the following simplified calculation has been used assuming a whole day's outage.

C x P x F where:
C is the fully Adjusted Available NTS Exit (Flat) Capacity held by the User at the NTS Exit Point at the time paragraph 3.5.1 is first applied;
P is the Weighted Average Price (WAP) for all accepted bids in respect of which NTS Exit (Flat) Capacity was allocated;
F is ten (10) for Firm NTS Exit (Flat) Capacity and five (5) for Off-peak NTS Exit (Flat) Capacity

Exit Points - Distribution Domestic Compensation Charges

For distribution offtakes, NGGT is liable for both Capacity Charges (mentioned previously) and Domestic Compensation Charges, this section summarises the methodology used to determine the expected compensation charges for a given offtake/exit point.

The internal document containing the methodology for this assessment is T/PM/NP/15; the calculation for compensation charges is as follows:

- Number of domestic customers x £30 compensation charge per day x number of incident days x 0.5 (customers being reconnected steadily over incident period) = Compensation Charges
- Number of domestic customers x £32 = Managing the incident charges
- Compensation Charges + Managing the incident charges = Total loss of supply costs.

Flow Swap Capability

Some distribution networks have the capability to take some or all of their gas demand from adjacent offtakes and transport this gas to consumers via the LTS network. Historically each of the four DN operators published flow swap capability and total volume flow swap capacity to NGT. They have since stopped publishing this data on the basis that NGGT should supply firm capacity at all offtakes and should not take into consideration flow swap capability.

However, for the purpose of valuing the asset and determining the asset risk in real terms it is necessary to consider the capability of the DN network to flow swap such that some of the largest consequential costs in our asset management system are suitably adjusted, and investment in offtakes that cannot flow swap are prioritised over those that can.

The table supplied by the GDN's is dated circa 2013, but little has changed since so is considered relevant for planning purposes.

Fatalities during Supply Loss

An estimate of the number of fatalities during failure of supply to consumers during winter, developing societal values of those estimated fatalities in order to value the asset and asset reliability during winter months, conversely evaluating the risk of any proposed systems that reduce the reliability i.e. installing an actuator to isolate the network if there is a leak preventing a fatality in the vicinity, versus the risk of that same valve closing spuriously during winter months causing public fatalities.

http://www.hse.gov.uk/gas/supply/nobel-denton-report.pdf

This is not currently implemented pending further discussions with Ofgem, HSE and Gas Distribution Networks.

Entry Points - Capacity Buyback

The following calculations were applied to value loss of supply at Entry points (Terminals) to account of the costs of buying back pre-booked capacity from gas shippers.

Section L 3.7.4 of the UNC states that we cannot be charged more than:

B (which is the greater charge rate of **R1** or **R2**) * (**U** (firm NTS Capacity) – **ADQI** (aggregate of users UDQI's for the day))
If we take the scenario as a whole day lost then **U-ADQI** becomes just **U**.
So the greater of **R1** and **R2** has been agreed as **R2** which is:
F2 (1.4) x (**M** (0.5 x weighted average price) + **N** (0.5 x the highest bid price))
The highest bid price has been agreed using the historical buyback auction price from St Fergus which was **1p per kWh** against a weighted average price of 0.05p per **kWh**, so 20 times the WAP.
For Entry Points the calculation simplifies to:
14.7 x WAP x firm NTS Capacity

Value of Gas Flow in the Network (AGIs and Pipelines)

It is assumed for simplicity of analysis that a loss of capacity of a pipeline section or AGI will result in a flow shortfall both upstream and downstream of the point of loss. This is explained in the Consequence of Failure report (Appendix C).

The gas flow rates are monetised by using the following calculation:

Value of contribution of Pipeline section or AGI = Total Capacity Loss x (Entry Point Consequence Cost (see Entry**) + Exit Point Consequence Cost** (see Exit)**)**