NGGT Network Asset Risk Metrics (NARM) Methodology

Service Risk Framework Supporting Document

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nationalgrid

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1. Introduction

The foundation of the National Grid Gas Transmission (NGGT) NARM 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 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 2016/17 prices (unless otherwise stated). These have been updated to a 2018/19 price base data for RIIO-2 NARM assessment.

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 Network Risk Outputs (NRO) reporting and for risk trading (investment planning and optimisation) applications.

The SRF forms a major section of the main Methodology2; Sections are repeated and expanded in this document to enable this to be read as a stand-alone document.

Changes to this document, since the originally published NOMs Methodology, are limited to changes made following completion of the Validation Report. These changes have already been incorporated into the Baseline Network Risk Output (BNRO) assessments carried out as part of the RIIO-2 submission and incorporated into the new RIIO-2 License Special Conditions 3.1 and 9.2. The use of the SRF valuations in long term monetised risk benefit calculations (LTRB) is discussed in the Long-Term Risk & Network Risk Outputs Supporting 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 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.

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[1] NGGT NARMs Methodology, Version 3.0, March 2021, Section 4 (Pipelines) and Section 5 (Sites)

[2] NGGT NARMs Methodology, Version 3.0, March 2021, Section 2.3 and Appendix B

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 services 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 (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.

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 the dimensions of risk inherent in 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 the five categories as shown in 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 Service Risk Framework 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 (internal to NGGT) or social (external to NGGT) 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. 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 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.

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

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

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. Our approach allows Safety risk to be assessed for individual assets, 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 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 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)

[5] NGGT Management Procedure (T/PM/INS/8)
[6] Managing the Integrity of Safety Instrumented Systems

- Prosecution (the most severe punishment the HSE can deliver would be to prosecute NGGT)

4.3. Private (Internal to NGGT) Safety Risk Valuations

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:

Table 1 Private Safety valuations by severity type

Incident Category	Private Risk Value (per event)
Minor injury / near miss / negligible	
Lost time injury / HSE letter of concern / reversible injury	
Major injury / RIDDOR reportable / irreversible injury	
Fatality / HSE enforcement notice	

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.

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]:

[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", Department for Transport
[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 were inflated to 2016 prices using RPI

We are cognisant that the last HSE valuations (2018)[12] are different to those used in this document, which uses the 1995 HSE study inflated to 2016/17 prices. As these valuations have been used extensively to date (for RIIO-1 NRO rebasing, RIIO-2 business plan submission and setting BNRO for RIIO-2) it is not possible to update these at this stage. This will be addressed in future versions of the Methodology, accompanied by a restatement of RIIO-2 BNRO targets.

Table 2 Applied societal valuations for death and injuries

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

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.

4.5. Gross Disproportionality Factor

We 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 an individual asset level, the opportunity exists to define the GDF at asset level, using the modelled IR value to derive the GDF13. At this stage we have assumed at worst-case scenario, whereby the value of a loss of life or injury is equivalent for our employees and the general public.

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 will be updated in future versions of the Methodology using Ordnance Survey Mastermap data, or other sources.

Estimation of numbers of employees on site, and in proximity to assets, in the event of a fire or explosion have been estimated using historic work volumes and typical job times.

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[12] HSE: Economics of Health and safety - Appraisal values or 'unit costs'
[13] National Grid Quantified Risk Assessment (QRA) document (T/SP/G/36)

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

5.1. Environmental Incidents

The volume and severity of environmental incidents are the key performance metrics in when valuing 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[14] with Category 4 being having the lowest impact and Category 1 the highest.

Table 3 Environmental incident categories

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

[14] Environmental Guide (NG/UK/SHE/INV1)

Severity	Trigger
	• 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

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 can 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 (BEIS)[15] 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)[16]. 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).

Again, we are aware that new valuations for the value of carbon emissions are available through BEIS and are updated annually[17]. As with the valuations of death and injury, the carbon emissions consequence values presented in this document have been used extensively to date and it is not possible to change without revising existing RIIO-1 and RIIO-2 NRO targets. This will be undertaken through future revisions to the Methodology and BNRO targets. It should be noted that traded and non-

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15 Carbon Valuation in UK Public Policy Appraisal: A Revised Approach, 2015 update uplifted to 2016 prices using RPI
16 Ecometrica (April 2017), https://ecometrica.com/
17 https://www.gov.uk/government/collections/carbon-valuation--2 & https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/794186/2018-short-term-traded-carbon-values-for-appraisal-purposes.pdf

traded emissions are now equivalent beyond 2030, and as such the choice of either will be immaterial for long-term investment planning and target setting.

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 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.

The Department for Environment, Food and Rural Affairs (DEFRA) 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

5.5.1. 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:

Table 4 Environmental incident private service valuations

Incident Category	Private Risk Value (per event)
Category 1	
Category 2	
Category 3	
Category 4	

5.5.2. Compliance with environmental legislation and permits

Every site has a permit and 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:

Table 5 Legislation and permitting compliance private service valuations

Incident Category	Private Risk Value (per event)
Increased permit costs	
Increased reporting	
Improvement notice	
Prosecution	

5.5.3. Noise pollution

An average, private cost of [redacted] to investigate a noise pollution event has been estimated in consultation with business experts.

5.6. Social (External to NGGT) Environmental Risk Valuations

5.6.1. Environmental incidents

The societal value of environmental incidents was quantified using a several case studies reviewed by our specialist regulatory 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 a pollution incident could 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 Table 4.

Table 6 Environmental incident societal service risk valuations

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

5.6.2. Volume of emissions

As per Section 5.3, the non-traded carbon valuations have been applied as per Figure 1. 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 2016/17. Private costs of emissions are also considered as part of shrinkage valuations (Section 7.1). This value is updated annually by BEIS, but to ensure the alignment of monetised risk valuations between RIIO-1 and RIIO-2, we have retained the value from the original NOMs Methodology. As with other major changes to valuations and assumptions, the timescales and process for updating will be agreed with Ofgem.

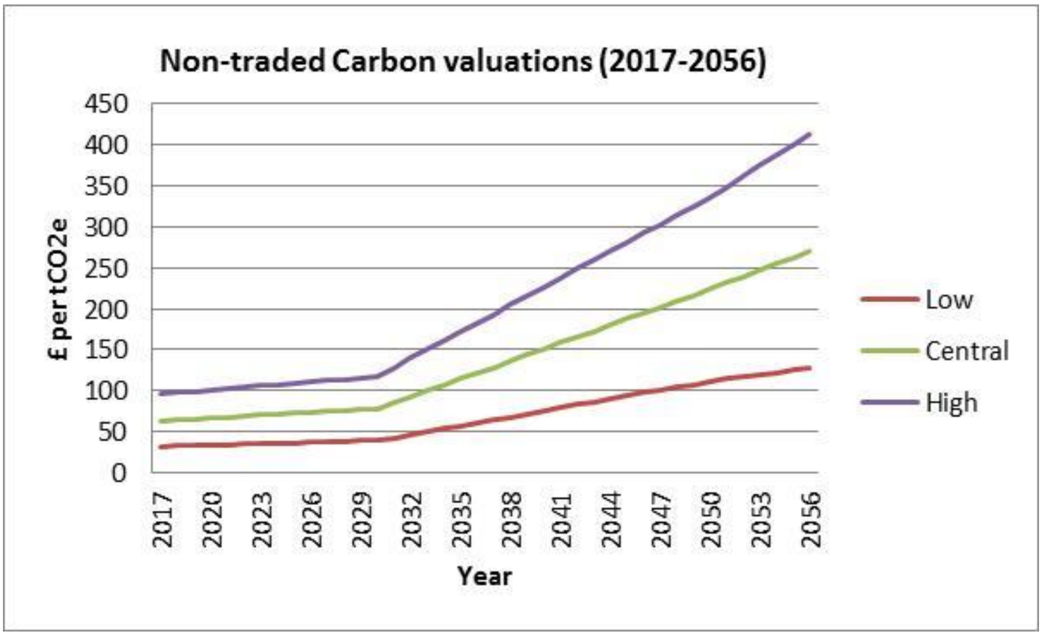

Figure 5 Carbon valuation by year (non-traded) (source: BEIS[18])

5.6.3. Noise pollution

The assessment of noise pollution was undertaken by our specialist regulatory consultants, using a DEFRA-sourced noise valuation modelling tool[20] 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

18 https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal

20 Defra (2014) https://www.gov.uk/guidance/noise-pollution-economic-analysis#noise-modelling-tool

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

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 and the economic impact of the breakdown of the gas trading market. Following discussions with Ofgem it was agreed not to include these high consequence-low probability service measures at this stage, pending further research and discussions with stakeholders.

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 supporting document). 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 as a result of taking pre-emptive operational and commercial interventions, and of relatively low direct cost, all loss of supply service valuations is 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).

6.3.1. Compensation Payments for Loss of Supply

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[22].

The compensation charge has been updated to £30 per property per day from £20 per property per day. This reflects the current amount payable for a loss of service, which has increased since the original risk

[22] Planning and Network Analysis Requirements for the Evaluation of Security of Supply (T/PM/NP/15)

valuation was undertaken[23]. This monetised risk is modelled as a societal cost, as these charges are payable by the gas supplier, not NGGT.

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 NTS Exit point.

The costs to society of a power station customer being unable to produce electricity as a result of a gas outage, are not considered at this stage but could be included in the future.

6.3.2. Variable Entry and Exit Constraint Costs

We have adopted a different approach to model the potential costs of Entry (terminal) and Exit (offtake) constraints than used in version 2.0 of the NOMs Methodology. Previously a fixed capacity buyback assumption was used, whereby the constraint cost was independent of the flow at the terminal at the time of the outage. The constraint cost is now modelled to be directly proportional to the assessed terminal flow, or customer demand, under the chosen supply and demand scenario. Terminal flows and customer demands under each scenario are now taken from our hydraulic modelling solution (SimOne).

6.3.3. Entry and Exit Constraint Values

The Auction Book Prices for Entry points has been updated to the Quarterly System Entry Capacity (QSEC) Reserve and Step Prices.

The Auction Book Prices for Exit points have been updated to the Indicative prices for 2020/21. these can be found in: Notice of Final NTS Exit (Flat) Capacity Charges effective from 1 October 2019, and Indicative NTS Exit (Flat) Capacity Charges for the 2019 Annual Application Window for Enduring Annual NTS Exit (Flat) Capacity dated the 30th April.

6.3.4. Valuation of Alternative Supply and Demand Scenarios

Our approach for evaluating alternative supply and demand scenarios is discussed in the Consequence of Failure supporting document[24] and Validation Report[25]. Several scenarios and the potential impact of each of these on the Availability and Reliability (AR) monetised risk analysis were discussed with Ofgem. These included:

1. A 1 in 20-year scenario using current demands as the base year
2. A Bacton Terminal Stressed scenario, where demands are stressed locally to reflect Bacton operating at full capacity and demands for the remainder of the network rebalanced to a level corresponding to the highest winter day demand experienced over the last 7 years
3. A St Fergus Terminal Stressed scenario, where demands are stressed locally to reflect St Fergus operating at full capacity and demands for the remainder of the network rebalanced to a level corresponding to the highest winter day demand experienced over the last 7 years
4. An Easington Terminal Stressed scenario, where demands are stressed locally to reflect Easington operating at full capacity and demands for the remainder of the network rebalanced to a level corresponding to the highest winter day demand experienced over the last 7 years
5. A Milford Haven Terminal Stressed scenario, where demands are stressed locally to reflect Milford Haven operating at full capacity and demands for the remainder of the network rebalanced to a level corresponding to the highest winter day demand experienced over the last 7 years

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23 This has been changed again to £60 per day, but after RIIO-1 and RIIO-2 target setting was completed. This will be updated in future Methodology changes and will require updates to NRO targets

24 NGGT Consequence of Failure Supporting Document, Section 6

25 NGGT NARMs Methodology Validation Report, Section 9

6. A low-summer's day demand scenario, with high gas flows into storage

A comparison of these scenarios was undertaken using original fixed constraint charge assumption which indicated minimal sensitivity to the applied stressed terminal scenario. It was determined following consultation with Ofgem that we would use 1 in 20 demand scenarios, based on 2021 base Future Energy Scenario (FES) demands. To project forward in time we used the FES Steady Progression scenario. Steady Progression is consistently used within NGGT as it is the most conservative scenario with regards to the rate of decarbonisation and decentralisation and provides a conservative, but realistic indication of what levels of NTS demand may be experienced in the future.

A comparison of Availability & Reliability **consequence of failure** (the monetised risk if an outage event occurred) resulting from each of these scenarios, using the new variable Entry constraint cost assumption, is shown in . A comparison of Availability & Reliability **monetised risk** (the consequence of failure x probability of an outage) resulting from each of these scenarios, using the original fixed Entry constraint cost assumption, is shown in Table 8. Both tables use the stressed output Bacton Terminal scenario as a point of comparison with alternative 1 in 20 scenarios (2021 and 2025 base years).

Table 7 Impact of alternative supply/demand scenarios on NTS AR consequence of failure

Scenario	AR Monetised Risk Delta
Bacton Stressed	0%
1 in 20 2021 FES	+19%
1 in 20 2025 FES	+20%

Table 8 Impact of alternative supply/demand scenarios on NTS AR monetised risk

Scenario	AR Monetised Risk Delta
Bacton Stressed	0%
1 in 20 2021 FES	+21%
1 in 20 2025 FES	+22%

The selected 1 in 20 (2021 demands) scenario carries approximately 20% more risk than the stressed Bacton Terminal scenario. There is little sensitivity to the chosen FES base demand year,

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. Figure 7 summarises the financial service risk measures considered.

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 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 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 to value emissions-driven investments and may be included in future revisions to the Methodology or treated separately.

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 (refer to Consequence of Failure[26] report). Other smaller losses are 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

7.3.1. 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[27] 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 values will be and continuously reviewed.

7.3.2. Impact on operating costs

Costs are categorised differently for the Sites and Pipelines risk models. These are reactive costs only; proactive intervention costs are discussed in the Main Methodology document[28]

The source of defects data is our asset register. Field operatives identify faults during routine inspection and maintenance and any works requiring rectification are recorded as defects, which are then planned and scheduled for rectification. Defect data is taken from Ellipse over several years, grouped into assets which have similar purposes and failure modes, and then averaged to give an annual defect frequency. We assume that this defect frequency is error-free through routine Ellipse QA and data management processes.

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[26] Consequence of Failure Supporting Document, Section 4.2

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

[28] Section 7.2.2

For Sites, the defect frequency subsequently drives all modelled consequence frequencies and monetised risk valuations. For each defect we collect the number of person hours booked to resolve a specific defect, which is then multiplied by an hourly rate for the inspection/repair team.

For Pipelines, assets are categorised as primary (pipeline) or secondary assets (e.g. cathodic protection) based on their function (refers to Probability of Failure[30] report). Costs are then allocated based on the activity carried out on the asset.

Appendix B lists the cost categories used in the Sites and Pipelines model.

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

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 directly valued. Figure 8 shows the elements of the Social and Company service risk measures. All the severity bands within this measure are assessed based on the expected number of incidents.

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

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.

[30] Probability of Failure Supporting Document, Section 2

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 regulatory 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[31] 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
- 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. As discussed previously, an element of company and wider industry reputation is factored into the gross disproportionality factor included within Safety risk valuations.

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

8.5.1. Property Damage

The average UK house price in November 2016 was £217,928 based on the latest information available from the ONS[32] . 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[33]. 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.

8.5.2. 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.

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

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

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

Table 9 Transport disruption social values (per event)

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

9. Material Changes to Service Valuations

The Validation Report has undertaken a sensitivity analysis of all key inputs to the monetised risk models[34]. Based on this a more detailed study and justification was provided. The sensitive variable (extracted from the Validation Report) are listed in Appendix E.

[34] NGGT Validation Report, Sections 3 & 4

Document Control

Version	Date of Issue	Notes
1.0	3rd April 2018	Version for public consultation (redacted)
1.1	11th April 2018	Unredacted version for Ofgem
2.0	22nd May 2018	Final version for Ofgem acceptance (unredacted)
3.0	17th May 2021	Draft NARMs Methodology version ready for public consultation updated following RIIO-2 business plan submission

Appendix A

Generic Value Transfer Process for Evaluating 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

Assets used for unit costing (Sites)

These are the asset types used for the application of unit costing. For each asset type one or more of the following intervention types may apply.

- Replacement
- Major Refurbishment
- Minor Refurbishment
- Removal
- Survey

We are in the process of moving to a new asset definition based upon ISO14224. This will be discussed in future revisions to the Methodology.

EQUIPMENT GROUPS
ACTUATOR
ACCUMULATOR
AFTER COOLER EQUIPMENT
AIR CONDITIONING UNIT
AIR INTAKE EQUIPMENT
ALTERNATORS
VALVE - ANCILLARY
ALARM
BATTERY
BATTERY SYSTEM
BLOW-IN DOOR
BOILERS
BYPASS

CAB VENTILATION
CAMERA
BUILDING
CIRCUIT BREAKER
CLADDING
CMS-ANTI SURGE CONTROL EQUIP
CMS-HMI/SCADA EQUIP
CMS-PLC/DCS EQUIP
CMS-STATION PROCESS CONTROL EQUIP
COMPRESSOR SEAL
CARD READER
CATHODIC PROTECTION
CONTACTOR
CONTROL DEVICE
CONTROL PANEL
CONTROL SYSTEM
CONTROLLER
COMPUTER
CONDENSATE TANK
VALVE - LOCALLY OPERATED
SWITCHBOARD - LV
GAS COMPRESSOR
GAS CYLINDER
GAS EQUIPMENT

GAS GENERATOR
INDICATOR
ISOLATOR
LIGHTING
GAS VENTING
SECURITY
INSTRUMENTATION
JUNCTION BOX
METER
MACHINERY OIPTIMISATION EQUIPMENT
OVERSPEED PROTECTION
HEATER
SWITCHBOARD - HV
GENERATOR
OIL EQUIPMENT
HARMONIC FILTER
LIFTING EQUIPMENT
INVERTER
PIPEWORK - DISCHARGE PROCESS
DUCTING
DUMMY
EXHAUST
ELEMENT
FILTER

DISTRIBUTION BOARD
EARTH BAR
EARTHING
DOMESTIC SERVICES EQUIPMENT
FAN
DESICCANT DRIER
EMERGENCY LIGHTING
FIRE SYSTEM
FUEL GAS EQUIP
TRANSMITTER - DP PRESSURE
DRAINAGE
FENCE
HEAT EXCHANGER
ENGINE
ENGINE GOVERNOR
DETECTOR
DIESEL ENGINE
ELECTRICAL COMPRESSOR DRIVE
FLOW CONTROL
SENSOR
SEPERATOR
CONTROL LOOP - SIL
SOCKET
PIPEWORK - SUCTION PROCESS

TRANSFORMER
VESSEL
TANK
SOLENOID
STANDBY GENERATOR
STARTER
SCRUBBER
THERMOSTAT
TRANSMITTER
TRAP
VALVE
SWITCH
TEMPERATURE MONITORING
TRACE HEATING
UPS
MOTOR
PRA STREAMS + SUPPLY EQUIP
RADIO HANDSET
NITROGEN GENERATOR UNIT
PIPEWORK
PIR
RECTIFIER
VALVE CONTROL CABINET
VALVES - CRITICAL - NON REMOTE OPERATION

VALVES - CRITICAL - REMOTE OPERATION
VIBRATION ELEMENT
VISUAL ALARM
TRANSMITTER - PRESSURE
PRESSURE VESSEL
PROCESS PREHEATING EQUIPMENT
PROCESS COMPRESSED AIR
SPEED ELEMENT
PIPE SUPPORT
STRAINER
PIPEWORK - RECYCLE PROCESS
MONITOR
ROAD
OIL STORAGE
POWER GAS EQUIPMENT
PANEL
PANIC GATE
REGULATOR
VALVE - RELIEF
PUMP
PUSHBUTTION
POWER SUPPLY
POWER TURBINE
PERIMETER CONTROL CABINET

WATER BATH HEATER
WATER SYSTEM
WEATHER STATION
IS BARRIER BOX
IS JUNCTION BOX
MAGNTETIC PERTICLE EQUIPMENT
GEARBOX
KIOSK
LAN SWITCH
DIFFERENTIAL TEMPERATURE SWITCH
ELECTRICAL
GAS SYSTEM
EQUIPMENT RACK
ETHERNET SWITCH
FUSE BOARD
GAS QUALITY SYSTEM
DRY GAS SEAL
EXCHANGER
EXPANSION TANK
PIPEWORK - ABOVE GROUND
ACCESS & SITE SERVICES SYSTEM
ACCESS GATE
ACOUSTIC SENSOR
ADACS UNIT

PIPEWORK - IMPULSE
PIPEWORK - SMALL BORE
PIPEWORK - STATION
AIR BLOWER
AIR COOLER
ANALYSER
BARRIER
PIPEWORK - BELOW GROUND
BREAK GLASS UNIT
VALVE - BURIED INOPERABLE
BURSTING DISC
BUSBAR
CALORIMETER
CP POST
VALVE - CRITICAL
CONCRETE VENTED (DUCTING SYSTEM)
LAND AND BUILDINGS
LIMIT SWITCH
LINK BOX
LOCAL DISPLAY
GAS ODOURISATION EQUIPMENT
IGNITOR
PIPEWORK - GENERAL
INTERCOM

INTERPOSING RELAY
IR LIGHT
BOUNDARY PRESSURE CONTROL
RELAY
CP SYSTEM
VALVE - REMOTE OPERATION
RCD
ODORANT VESSEL
ODORISER
ORIFACE PLATE
ORIFICE CARRIER
PHASE REVERSAL UNIT
PIG TRAP
ROUTER
TELEMETRY
PITS AND CHAMBERS
WASHER
SUPPLY REGULATOR SYSTEM
SAFETY RELATED PLC/DCS EQUIP
SATELLITE EQUIPMENT
LEVEL SWITCH
SIGNAL CONVERTOR
SILENCER
TRANSMITTER - TEMPERATURE

SURGE PROTECTOR
PIPEWORK - TERMINAL PROCESS
TIMER
SEWAGE PLANT
TRANSDUCER
TRANSIENT BARRIER
VALVE POSITIONER
VALVES - NON CRITICAL - NON REMOTE OPERATION
VALVE - SLAMSHUT
VAPOUR SEPARATOR
TRIP AMPLIFIER
VOLUMETRIC REGULATOR STREAM EQUIPMENT
PRE-HEATEING SYSTEM
PRESSURE REDUCTION
VALVE - PROCESS
PROTECTION RELAY
PROTOCOL CONVERTOR
POWER TRANSFORMER
PURYFYING UNIT
VALVE - NON-CRITICAL
VALVE - NON-RETURN VALVE
CONTROL LOOP - NON SIL
POWER FACTOR CORRECTION EQUIPMENT

Assets used for unit costing (Pipelines)

Units		Survey	Routine Maintenance	Repair (Proactive)	Repair (Reactive)	Refurbish / Overhaul	New (Proactive)	Replace (Reactive)
		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 C

Estimation of Domestic Property Occupancy

Parameter	Value	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

Parameter	Value	Source
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

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

Appendix D

Charges for Capacity Failures

For purposes of testing the Methodology we have considered national demand for a peak 1 in 20 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 are 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

In a recent review of network charges, the capacity charges were aligned so that all sites of the same type i.e. Storage, Terminal, GDN had the same values.

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 meters (Domestic and Industrial) x £30 compensation charge per day this is the RIIO-1 value) x number of incident days (assumed to be 28 days) x 0.5 (customers being reconnected steadily over incident period) = Compensation Charges
- Number of meters 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 gas demand from adjacent offtakes and transport this gas to consumers via the LTS network. Historically each of the four GDN operators published flow swap capability and total volume flow swap capacity to NGGT. 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. The table supplied by the GDN's is dated circa 2013, but little has changed since so is considered relevant for planning purposes.

Previously this was considered in the methodology to prioritise offtakes that could not be flow swapped , but this is currently turned off in the model due to the issue around Blackrod and flow swapping in Greater Manchester highlighting that historic ability to flow swap does not consider the current state of networks and assets, or the capacity and flow available in the LTS pipelines. **For the chosen a 1 in 20 scenario the ability to flow swap is not considered feasible**.

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.

The GDNs currently use a tactical model from DNV which considers the best strategy to reconnect many disconnected customers. This currently the risk of fatalities from cold weather as well as the risk that is poised by people attempting to reignite their own boilers.

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)**]**

Where a site or pipelines (**A**) has solely fed offtakes or pipelines downstream (**B**), then it is assumed that the loss of the (**A**) will also cause the loss of (**B**) and this is factored into the value of section (**A**)

Appendix E

Sites Sensitive Model Inputs

Variable	Description	Driver	Sensitive Years	Reason for sensitivity
<Vent Quantity>	Volume of a compressor vent (ESD)	Carbon	2021 2051	Compressor vents are relatively frequent and the volume of gas vented is significant
<Minor Hole Size>	Assumed hole size for a minor leak (mm)	Carbon	2021	There are more minor than major leaks and fixed orifice size assumptions controls the volume of gas lost over a fixed time and gas pressure
<People per Prop>	Average property occupancy	Safety	2021 2051	More people assumed to be in the property the greater the fatality/injury rate and higher the social fatality risk
<HS_FATAL_MID_PROPN>	Number of properties in the MIDDLE hazard zone (4 x BPD)	Safety	2021 2051	More people assumed to be killed/injured the higher the social fatality risk.
<PIE Rural Locations>	Factor applied to reduce probability of death/injury in urban area	Safety	2021 2051	This is a correction factor agreed through the expert review to consider that not all properties within hazard zones are equally at risk
<P_Delayed_Ignition>	Probability of a delayed ignition following leak	Safety	2021 2051	Directly factors the number of predicted fires or explosions. Only applies to significant leaks
<P_Explosion_Ignition>	Probability of an explosion following an ignition	Safety	2021 2051	Directly factors the number of predicted explosions

Variable	Description	Driver	Sensitive Years	Reason for sensitivity
<P_Immediate_Ignition>	Probability of an immediate ignition following a leak (due to likely failure of fire protection system)	Safety	2021 2051	Directly factors the number of predicted fires or explosions (on sites with a fire protection system in place)
<HS_FATAL_INNER_PROPN>	Probability of fatality in inner hazard zone	Safety	2021 2051	More people assumed to be killed/injured the higher the social fatality risk.
<Gross disproportion factor>	Factor applied to account for wider societal impacts of fatality / major injury	Safety	2021 2051	Multiplies the HSE value of a fatality directly, so more fatalities/injuries the higher the social fatality risk
<Working Hours>	Working hours (exposed to asset) for employees	Safety	2021	The more working hours, the higher the risk that an employee is on site at the time of a fire/explosion and a higher chance of death or injury

Pipelines Sensitive Model Inputs

Variable	Description	Driver	Sensitive Years	Reasons for sensitivity
<Det Corrosion High>	Rate of corrosion growth with bad CP protection (mm/year)	Carbon Safety Availability	2021 2051	Rate of corrosion hole growth increases resulting in more corrosion leaks
<Det Corrosion Med>	Rate of corrosion growth with average CP protection (mm/year)	Carbon Safe Availability	2021 2051	Rate of corrosion hole growth increases resulting in more corrosion leaks.
<Block Valve Distance>	Assumed distance between block valves & assumed losses before depressurisation	Carbon	2051	Volume of gas required to be vented to carry out leak and rupture repairs. Increases with numbers of

Variable	Description	Driver	Sensitive Years	Reasons for sensitivity
				predicted leaks and ruptures. Impact is predominantly due to leaks. Distance between block valves can be 10's of kilometres, therefore volumes of gas vented are significant
<Elec_Transmission_Factor>	Increased corrosion growth & deterioration due to AC interference (presence of HV cable within 50m)	Carbon	2051	Rate of corrosion hole growth increases resulting in more corrosion leaks. Only applies to c. 1.7% of pipeline network but becomes important by 2051 without intervention
<Det CIPS>	CP protection deterioration rate (mV/year). Rate of movement between High, Medium & Low protection bands below	Carbon Safety Availability	2051	Rate of corrosion hole growth increases resulting in more corrosion leaks
<People per Property>	Assumed property occupancy (average over a 24-hour day assuming a failure can occur at any time)	Safety	2021 2051	More people assumed to be in the property the greater the fatality/injury rate and higher the social fatality risk
<HS_FATAL_MID_PROPN>	Probability of fatality in middle hazard zone	Safety	2021 2051	More people assumed to be killed/injured the higher the social fatality risk.
<Gross Disproportion Factor>	Factor applied to account for wider societal impacts of fatality / major injury	Safety	2021	Multiplies the HSE value of a fatality directly, so more fatalities/injuries the higher the social fatality risk

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