

GDN Collaborative Vulnerability & Carbon Monoxide Allowance (VCMA)

Project Eligibility Assessment (PEA)

Research Study - Identifying and Protecting Pregnant Women from CO Exposure

Suzanne Callington and Phil Burrows
Suzanne.callington@cadentgas.com
Phil.m.burrows@cadentgas.com

25th March 2021

Gas Network Vulnerability & Carbon Monoxide Allowance (VCMA) Governance Document - Project Eligibility Criteria

Section 1 - Eligibility criteria for company specific projects (other than condemned essential gas appliance repair and replacement)	
In order to qualify as a VCMA project, a project must:	
VCMA Eligibility Criteria	Criteria Satisfied (Yes/No)
a) Have a positive, or forecasted positive Social Return on Investment (SROI), including for the gas consumers funding the VCMA project;	Yes
b) Either: <ul style="list-style-type: none"> i. Provide support to consumers in vulnerable situations, and relate to energy safeguarding, or ii. Provide awareness on the dangers of CO, or iii. Reduce the risk of harm caused by CO; 	Yes
c) Have defined outcomes and the associated actions to achieve these;	Yes
d) Go beyond activities that are funded through other price control mechanism(s) or required through licence obligations; and	Yes
e) Not be delivered through other external funding sources directly accessed by a GDN, including through other government (national, devolved or local) funding.	Yes
Section 2 - Eligibility criteria for company specific essential gas appliance servicing, repair and replacement projects	
In order to qualify as a VCMA project, unsafe pipework and essential gas appliance servicing, repair or replacement must meet the following criteria:	
a) A GDN has to isolate and condemn unsafe pipework or an essential gas appliance following a supply interruption or as part of its emergency service role;	n/a
b) The household cannot afford to service, repair or replace the unsafe pipework or essential gas appliance; and;	n/a
c) Sufficient funding is not available from other sources (including national, devolved or local government funding) to fund the unsafe pipework or essential gas appliance servicing, repair or replacement.	n/a
Section 3 - Eligibility criteria for collaborative VCMA projects	
In order to qualify as a collaborative VCMA project, a project must:	
a) Meet the above company specific and boiler repair and replace (if applicable) project eligibility criteria;	Yes
b) Have the potential to benefit consumers on the participating networks; and	Yes
c) Involve two, or more, gas distribution companies.	Yes

Gas Network Vulnerability and Carbon Monoxide Allowance (VCMA) Governance Document - Project Registration Table 2

Information Required	Description
Project Title	Project title: Identifying and Protecting Pregnant Women from carbon monoxide (CO) Exposure
Funding GDN(s)	The GDN(s) which register(s) the VCMA project
Role of GDN(s) *For Collaborative VCMA Projects only	The specific role(s) of GDN(s) participating in a collaborative VCMA Project
Date of PEA Submission	Thursday 25 th March 2021
VCMA Project Contact Name, email and Number	Phil Burrows / Suzanne Callington Phil.m.burrows@cadentgas.com / Suzanne.callington@cadentgas.com
Total Cost (£k)	£311,470 excluding VAT
Total VCMA Funding Required (£k)	£249,974.00 excluding VAT
Problem(s)	<p>This should outline the problem(s) which is/are being addressed by the VCMA Project.</p> <p><i>We don't have data that tells us the scale of the issue of in utero risk related to CO exposure.</i></p> <p><i>We don't know how best to engage the pregnant women community to reduce risk and increase safe in-home practices.</i></p> <p>Resolving these problems are important for GDNs and Healthcare professionals if actions to support this vulnerable group and their unborn babies are to be effective at a regional and ultimately, national level.</p> <p>Currently there is nothing in the published scientific literature that shows that any such work specific to environmental CO in this country and specific to pregnant women exists. NICE (National Institute for Health and Care Excellence) guidance was developed to use exhaled CO as an indicator of smoking, not environmental exposure, (examples of environmental exposure are, CO within the home, outside environmental CO, vehicle, workplace, passive tobacco smoke, or any combination of these).</p> <p>However, in those women who don't smoke and who produce high CO levels, exposure to environmental CO has been suspected and, in some cases, confirmed. There have been no studies to consider and evaluate environmental exposure in pregnant women following confirmed raised CO breath test readings during screening appointments with midwives.</p> <p>The majority of CO testing during pregnancy is carried out by midwives in hospitals and maternity units. However, the detection of levels of CO is notoriously problematic because CO starts to leave the body when air not contaminated with CO is breathed in. Therefore, if the person has spent time away from the source of CO (such as an appliance in the home), by the time the breath test is conducted with the midwife, levels expired into the breath monitor will have dropped. As a result, it is anticipated that a number of women are being exposed to environmental CO but aren't diagnosed because they are tested away from their homes. Also, women who smoke may have their raised CO level attributed to smoking whereas some may be raised even higher due to additional CO from environmental exposure. This leaves a situation where midwives are concerned they are not always able to identify women and babies at risk of high levels of exposure from environmental sources.</p> <p>Despite there being well known guidance for addressing CO in pregnancy caused by smoking, there is no official protocol for investigating elevated CO amongst pregnant women that is not caused by smoking. This problem is compounded by midwives' own</p>

	<p>concerns that they and their colleagues are not adequately trained to address non-smoking causes of elevated CO in pregnancy. Also, the common symptoms of CO poisoning can be attributed to pregnancy itself e.g. nausea, vomiting, fatigue and headache, which can lead to CO poisoning not being identified in pregnant women by either healthcare professionals or by the pregnant woman.</p> <p>Midwives are identifying pregnant women with unexplained raised levels of CO when conducting routine CO breath tests. Faulty appliances are sometimes being identified as the cause. In other cases, women who have been referred to stop smoking services, have, when quit, continued to provide higher than expected CO breath readings and have been similarly identified as having faulty fuel burning appliances.</p> <p>There are approximately 650,000 live births in England each year with about 4,700 perinatal deaths (3,200 stillbirths and 1,400 neonatal deaths). Of this figure, over 1,500 will be classified as unexplained deaths. It is possible some of these deaths are the result of CO poisoning of the pregnant woman.</p> <p>Data from three NHS Trusts have shown around 7% of non-smoking pregnant women have blown CO readings above the threshold that triggers healthcare action from the midwife (unpublished). Understanding the range of expired CO levels being recorded in pregnant women at their booking appointment, confirming the source of exposure, and understanding the implications of the readings, is important for developing interventions and action to turn a pregnancy with a potentially adverse outcome into a healthy pregnancy outcome for the baby and its mother, with a safe home environment to live in.</p> <p>Foetal and neonatal death, congenital malformations and neurological problems occur with moderate to severe maternal exposure to CO. Toxicological studies provide evidence that there is an association between low level chronic CO exposure and reduced foetal growth and low birth weight of babies. There is also evidence that suggests exposure to CO can cause congenital defects, infant mortality and effects on the developing auditory system. Results from post-mortem studies show foetal brain injury due to hypoxia from CO poisoning.</p> <p>The reason that the foetus is so susceptible to CO is that foetal blood has a greater affinity for CO than that of an adult. This is due to the lower partial pressure of oxygen in foetal blood and the relative hypoxia that increases the effects of foetal exposure to CO. Therefore, foetal blood takes up CO more readily than the mother but will also release the CO more slowly when the mother resumes the breathing of non-polluted air. This is important as it means that the foetus will be poisoned for a longer duration than the mother because the foetus will also release CO more slowly than the mother. The concentration of CO and the duration of exposure will both have a greater impact on the developing foetus than on the mother.</p>
<p>Scope and Objectives</p>	<p>The scope and objectives of the VCMA Project should be clearly defined including the benefits which would directly impact customers on the participating GDNs' network(s), and where the benefits of the VCMA Projects lie.</p> <p>Overview</p> <p>This study aims to bring together information on expired CO levels in women recruited into the study, with information collected on exposure in their home. Recruitment into the study will trigger a Home Safety Visit with an additional aspect on CO, conducted by the local Fire and Rescue Service, and a two-week period of CO monitoring using a CO alarm, Data Loggers and CO breathalysers in the woman's home. Recruitment and testing to take place during autumn and winter when potential exposure is greatest. By monitoring indoor CO levels, the scale of the problem that is due to elements within the home will be identified.</p> <p>The study will also provide an understanding and measurement of pregnant women's knowledge, attitudes, beliefs and concerns regarding CO and exposure. The study will go on to develop potential approaches and interventions to help better protect pregnant women, their family and their unborn child.</p>

The women and families targeted for this work will be from lower socio-economic and disadvantaged groups across all GDN footprints. They are more likely to be living in lower quality, private rented accommodation, less aware of the dangers of CO poisoning, less likely to consider CO poisoning a priority, less empowered to improve their living conditions and less able to act if a problem is identified.

The study will be undertaken across each GDN footprint within England. Previous experience of carrying out research with vulnerable pregnant women reassures us that the findings of both the qualitative and quantitative studies should be applicable across the UK.

There may be differences in the way agencies based across the four nations are able to respond to the findings. At an early stage of the project, the project team will identify key agencies and individuals within the devolved nations to enable sharing of the research process and findings, recognising any differences in the way services are organised and delivered. Factors that may impact their ability to utilise the findings will be identified and addressed in the final report when considering how the findings can be utilised to protect pregnant women and their unborn child.

The aim

To understand the **prevalence of environmental exposure to CO in pregnant women and how they and their unborn babies can be better protected.**

The objectives of this initiative are to:

1. Understand the **relationship between CO and pregnancy** by gathering data.
2. Understand the **effective engagement** mechanisms to support information sharing and increased awareness of the risks of CO to pregnant families across community demographics.
3. Build effective relationships with key stakeholders linked to pregnancy and early years development to **support a national programme** the design based on data and community need.
4. Understand what women and health professionals know about CO, the symptoms and the warning signs and **general attitudes to staying CO safe.**
5. Understand the **conditions that would be required to better protect** women and their unborn child.
6. Make a step change to **improving practices, knowledge and attitudes** towards CO safety across all stakeholder groups.

The scope

1. 18 months – 2 year programme (this includes 6 months of data analysis)
2. A minimum of 400 pregnant women/families (for quantitative research purposes) and 60/70 pregnant women/families (for qualitative research purposes) engaged across England in all GDN footprint areas.
3. Communities engaged across a range of community demographics but targeting those from the lower socioeconomic and disadvantaged groups.
4. Engagement of 25-30 local stakeholders and 7-10 national stakeholders.
5. Programme of engagement and testing to take place during autumn and winter when the potential for exposure is greatest.
6. The study will be undertaken in four localities across England, covering each of the GDN footprint areas.

Methodology

Recruitment

In this study, all women (irrespective of smoking status) attending their booking visit will be invited to take part in the research and offered a Fire and Rescue Service (FRS) home safety check as part of the discussion and explanation regarding the breath test results. This will utilise participant information developed for the study and the Test Your Breath information card for pregnant women which was developed by the Smoking in Pregnancy Challenge Group. This discusses the dangers of CO in pregnancy, including from sources other than smoking and is a free resource for maternity units nationally. There is an associated professional briefing that has been made available to all midwives

in England which will also be utilised. Midwife training in recruitment specifically for this study and information for midwives and their women, will be provided.

Pregnant women will receive:

- Information relating to the causes and dangers of CO, and CO poisoning signs and symptoms.
- A CO alarm (to keep).
- A free Home Fire Safety Check (completed by the Fire and Rescue Service).
- Data logger equipment to capture CO data (installed in the home for 2 weeks)
- A £15 retail voucher offered as a thank you in recognition of the time she has given to the study. (does not allow the purchase of alcohol or tobacco).

We do not expect COVID-19 to impact the recruitment of women into this study, as recruitment will begin during the Autumn and Winter of 2021, when COVID-19 is likely to have diminished as the vaccine will have been rolled out. If, next winter, there are restrictions to entering homes the research team will adapt the methodology.

Ethical approval

NHS ethical approval will be sought. The team have experience of applying for and gaining ethical approval projects involving vulnerable pregnant women.

Quantitative Study Methodology

The methodology will follow the same lines as the validated protocol used in the Liverpool John Moore University (LJMU) study. Details of the LJMU study:

FRS, as part of their home safety visits in districts of Liverpool, measured indoor CO levels in homes using ToxiRae-3 detectors to see if a) there was CO present in the homes, b) whether the homes had a CO alarm. All homes tested had a CO alarm installed. In some homes two-week CO monitoring was undertaken by leaving an OM-EL-USB-CO datalogger in the home. A questionnaire was also answered. FRS found very few homes with any level of CO detected by their ToxiRae-3 detectors, but quickly established that there was CO being detected in homes over the two-week period where they placed the dataloggers (despite having recorded zero readings on their ToxiRae-3 detectors in those properties). The FRS realised that opening the front door to allow FRS entry into the property vented homes sufficiently to prevent a reading on the ToxiRae-3 detectors for the duration of their visit. The study continued with all homes being tested over a two-week monitoring period using an OM-EL-USB-CO datalogger. The data recorded by the datalogger captured activities (e.g. cooking - stove or oven, boiler / hot water switching on and off) and time at which CO started to be detected: showing peak levels, reductions in levels, durations of exposure and baseline levels for each property. The data also captured actions that caused levels to drop (appliance switched off or following discussion, window opened etc.). The study results also confirmed that the time of day of the FRS visit made a difference to the likelihood of CO being present in the indoor ambient air, but that homes having a continuous baseline level of CO was possible. The methodology as well as being used in this local Liverpool-based study has also been conducted more widely across the country, although on a smaller scale.

This methodology will be followed but also include questions that would be of greater relevance to pregnant women and escalation procedures to ensure pregnant women and their unborn babies are protected.

Below is the methodology which will be used specifically for this CO in pregnancy research study.

On being alerted, FRS will carry out a Home Fire Safety Check, which is part of their routine service to the community, of the property occupied by each pregnant woman recruited into the study. FRS will initially take CO readings in the property using the ToxiRae-3 monitor or similar, as used by crews to alert them to the presence of CO prior to the instalment of detection equipment and a CO alarm.

A subset of women will also be given an individual CO breath analyser linked to an app which stores and allows sharing of the readings. Women will provide twice daily readings throughout the two week monitoring period.

A questionnaire will be completed by FRS which will collect data from the occupant as an extension to the Home Fire Safety Check, moderately modified for pregnant women and encompassing data that was collected as part of the LJMU study. An OM-EL-USB-CO datalogger that measures and stores up to 32,510 CO readings over a 0 to 1000 ppm range, will be placed in each property for two weeks by FRS along with a fitted CO alarm.

Answers to the questionnaire will be collected on a Toughbook and data downloaded, anonymised as required by ethics and uploaded onto the project SharePoint site. Dataloggers will be left in the properties for a period of two weeks. These will be collected by FRS and the data from the datalogger downloaded and then uploaded to the project SharePoint site for analysis. The dataloggers can then be cleared of data and re-used.

During this appointment, a further breath test will be taken, and the £15 retail voucher will be provided.

Anonymised data, relevant to the study will be provided to LJMU in an ethically approved format for analysis.

Any concerns regarding CO levels found in properties will prompt actions that will be agreed with the Gas Emergency Service, GDNs and other fuel providers prior to commencement of the project and agreed by the ethics committee. The CO alarms used in the study will allow direct download of data and include monitoring of low levels of CO.

The questions to be asked by FRS specifically for information relating to this study include:

1. Property type (categorised as purpose built flat, house split into flats, bungalow, terraced, semi or detached).
2. Length of occupancy.
3. Number of occupants.
4. Number of children under the age of 5.
5. Age of occupants.
6. Reported disability/pre-existing health conditions.
7. Number of smokers.
8. Existing smoke alarm.
9. Occupancy status (private rented, social rented or owner-occupied, BnB).
10. Heating method (primary and ideally any secondary source) including fuel type; metered.
11. Cooking method including fuel.
12. Possession of a gas safety record if appropriate, i.e. rented properties.
13. Is flue pipe located by a window?
14. Date of last chimney sweep.
15. Date boiler last serviced/date of last landlord check.
16. Existing CO alarm.
17. CO reading.
18. Age of appliances.
19. Condition of appliances.
20. When were appliances last serviced?
21. CO awareness level prior to conversation (score between 1 and 5).
22. How likely would you be to buy a CO alarm if you didn't have one?
23. Are you aware of the signs and symptoms of CO?
24. What will you do differently/what action will you take as a result of being provided this information?
25. CO awareness level post conversation (score between 1 and 5).

Data analysis

Statistical analysis will provide descriptive statistics, qualitative analysis and the compilation of basic data related to aspects across the project. This will provide the information required for a study that would provide a more accurate indication of prevalence. Data analysis will be undertaken as for the LJMU study using the information collected in the FRS questionnaire (as listed above), the data logger (which will provide timing and a reading of CO levels detected) and in addition, information provided by the

midwife (notably on CO levels blown) and the alarm (that will provide readings similar to those of the datalogger). This mix of statistical data would allow for a number of variables to be analysed, but specifically, the proportion of pregnant women with raised CO levels in their breath and raised CO levels in their home environment will be calculated. Exploratory statistical exercises examining the LMJU study data and data obtained from this study will be considered.

Limitations

When undertaking the data analysis, limitations as to what could be inferred from this size of study will be acknowledged. It is hoped that by engaging different NHS sites, as representative a sample as possible of pregnant women to the wider population will be achieved and that differences in demographics might be captured.

There is no prevalence figure available for pregnant women exposed to CO as studies in this area have not been undertaken. However, this gives greater importance to the study findings and will provide the necessary data for scaling.

Number of properties

A minimum of 400 women (for Quantitative Research) and 60/70 women (for Qualitative Research) across all GDN footprints in England will be recruited for this study (based on the number of alarms available for mandatory use as part of this project). Alarms will be retained by the pregnant women if the property did not have an adequate CO alarm already installed.

Results from the LJMU study highlighted that alarm ownership was significantly reduced in areas of higher deprivation. This study will recruit pregnant women primarily from areas of higher deprivation as future intervention studies that inform maternity practice and regulation, are likely to focus on reducing the risk of the most vulnerable pregnant women.

Each year, there are approximately 650,000 first antenatal assessments in England. If the study is undertaken within four areas during a four - five-month period, an estimate of booking appointments for the duration of the study stands at around 5,500.

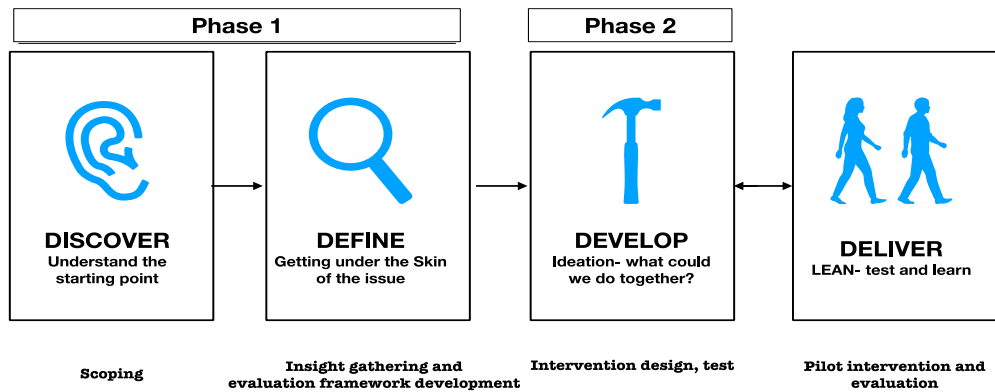
Qualitative Study Methodology

The approach will be based on following iPiP's and Activmob's proven track record of undertaking behavioral insight, person centered co design and product creation across a range of topics and sectors. This is more than just a methodology or approach, the values and principles that underpin this way of working are at our core and evident in every piece of work we do.

The person-centred methodology, called INSIGHT2ACTION facilitates a full participatory process rooted in a whole systems outlook. Put simply, the approach is not a one-off exercise, it is a series of processes that are iterative and evolves over time. It fosters a mindset and attitude about people, at the heart of which is the belief that people are the experts of their own lives, families, health and communities.

The methodology facilitates those experts; communities and individuals, frontline professionals and other key stakeholders within a safe and supportive environment to play an active part in the creation, test and refine process resulting in solutions that meet real needs. The graphic outlines this approach

INSIGHT2ACTION: CO-DESIGN



Phase One – Discovery shallow dive

Insights to be gathered will include:

Pregnant women, their families and the general community:

1. General information: attitudes and barriers to identifying and rectifying the risks, existing attitudes and knowledge, number of homes which already have a CO alarm. Understanding the signs and symptoms of CO exposure.
2. Beliefs and attitudes amongst pregnant women (plus other household members and fathers) including: their knowledge about CO exposure, what is considered to be a risk worth acting on, role of family in prompting action, understanding the reality of pregnant women's lives, who women trust to deliver messages and interventions, their expectations about the provision of health messages, services and how to attribute value to the CO monitors if provided for free. How important do you consider CO to be and would you do anything different now you have an awareness.

Health professionals, engineers and landlords:

3. General information: knowledge about CO exposure, barriers to identifying and rectifying the risks, existing practice and attitudes, landlords' attitudes about their responsibilities.
4. The message/offer, how it is to be delivered, who should deliver the message and in what way, if not midwives, then who?

Technical:

5. Technical information about CO exposure including identifying levels of risk associated with exposure, symptoms of exposure, impact on the mother to be, impact on foetus.
6. To obtain the insights we will use semi-structured interview and inclusive tools designed to build the picture.
7. Over the project we will engage with a minimum of:
 - 60 - 70 pregnant women/families** across locations
 - 25 - 30 local stakeholders** (including front line workers) across locations.
 - 7 - 10 national stakeholders**
8. This engagement will be via a variety of methods including one-to-one or small group interview, both face to face and virtual.

The topic guide for discussions with women will include:

- Understanding the reality of pregnant women's lives
- Motivating factors
- Knowledge and understanding of risk around CO exposure.
- What is considered a risk which is significant enough to act on.
- The barriers and facilitators to action.
- The role of friends and family – importance and ability to stimulate action.
- What is already happening locally.

- Who they trust.
- Role of health care and industry professionals.
- Role of landlords.
- How and where they access information about home safety and health issues.

Key stakeholders and front line staff who do or could potentially provide information/support to women will also be interviewed, including:

- Midwifery services
- General Practice
- Pharmacy
- Housing officers
- Private and social housing landlords
- Children's Centres
- Stop smoking services
- Health visitors
- Family Nurse Partnership
- Gas / Fuel providers
- Private organisations where pregnant women shop
- GDNs

Potential areas to explore include:

- Current understanding of the risk of CO exposure, especially during pregnancy.
- Current knowledge of CO including signs, symptoms.
- Current advice and information and how they access that information
- Importance compared to other topics
- Attitudes
- Barriers and facilitators faced by organisations and front line workers.

A short presentation will be prepared highlighting the key themes emerging from the analysis. These will be shared with the stakeholder group to discuss and agree where we should focus more in depth discussions in the deep dive.

Phase Two - Deep dive

The deep dive enables the team to return, meet with people, including some from the shallow dive and with trust built, be in a position to explore in more depth some of the emerging themes from the shallow dive.

These more in-depth discussions will include approximately 10 - 15 women and 5 - 7 front line workers and stakeholders at each site.

The insights and ideas from the shallow dive will be utilised to build a deeper understanding of the motivations and barriers that influence pregnant women's behaviour in relation to CO exposure, risk, and engagement with potential support.

This may include how important women view CO alarms, actions they would take if it were activated, what actions they would take if concerned, who might they contact, what factors might determine their course of action i.e. cost implications, and how this would impact on their actions, for example, open a window or turn the boiler off to avoid costs. Through these conversations we will begin to develop an understanding of which organisations and people they trust. How women want to be supported including being clear on the importance of language and the methods of communication. Other areas for deeper exploration may include conversations around incentives such as free CO alarms: to understand whether they would work.

An important aspect will also be to understand from providers the conditions that would be required to implement the recommendations or suggestions found. Topics to explore more deeply could include:

- How do front-line workers perceive value that can be attributed to the CO alarms, if they are being provided for free?
- Ideas of a future offer to be made and how it would be received by the women and front-line workers.
- Exploring further who is at risk.

	<ul style="list-style-type: none"> • Opportunities to engage with mothers. • How can key professionals be empowered/enabled to act? <p>Phase Two – Developing solutions</p> <p>Based on the insights work from Phase One, the team will begin to develop, with the women and key stakeholders, ideas and potential interventions/products. Key to this development will be having a clear problem statement and hypothesis to which the group can ideate solutions for.</p> <p>Key activities will include:</p> <ul style="list-style-type: none"> • Workshops to facilitate ideas and opportunities further with women and stakeholders. • Production of an outline brief to test with women and stakeholders. <p>A specification/outline that has been tested back with audiences/stakeholders will be presented in the final report. This report will look at the overall findings from both phases but also consider any differences across the four sites.</p> <p>Project outputs</p> <ol style="list-style-type: none"> 1. Household data (housing type and status; appliance and fuel-type) and personal CO exposure data amongst pregnant women. 2. Understanding of the “typical” environments that this vulnerable group of people live in and factors or combinations of factors that might increase risk. 3. Understanding of whether current routine breath testing, undertaken at the booking appointment with a midwife, can be used as an indicator of exposure to CO in the home. Also, whether a breath test undertaken by the Fire and Rescue Services (FRS) at a safe and well check could be used as an indicator. 4. Knowledge about the levels of CO present in the home of pregnant women in vulnerable situations by monitoring indoor ambient CO readings over a two-week period using CO monitoring data loggers and alarms. 5. Assessment of personal CO exposure levels and CO levels in the home following the Home Fire Safety visit from the data recorded by monitors installed at the initial visit. 6. Understanding of the levels of CO that pregnant women are exposed to in their homes and evaluation of the potential for such levels to cause harm. 7. Understanding of what women and health professionals know about CO, the symptoms, and the warning signs. 8. An understanding of general attitudes to staying CO safe. 7. Understanding of the barriers and facilitators to taking action to remediate problems – both for the women and professionals involved in their care. 8. With women, health care providers and industry professionals, co-designed approaches and interventions that can help protect pregnant women and their unborn children. 9. Information that will underpin the protocol used in future studies. Such work will be cited by future studies in this field. 10. Because of the qualitative methodology used, the in-depth conversations with professionals and women will provide an opportunity to provide funders with information able to benefit their wider work programmes.
<p>Why the Project is Being Funded Through the VCMA</p>	<p>This should include an explanation of why the VCMA Project meets the VMCA eligibility criteria.</p> <p>Funding is coming from two funding sources, 80% between GDN companies and 20% Gas Safety Trust.</p> <p>This study will be used across all of the GDN networks to ensure that regionalities and different demographics are used to understand whether attitudes to CO awareness and CO safety differ across the country. This will allow individual GDNs to tailor make their approach depending on the findings and determine the viability of a national approach to engagement for pregnant women and their families.</p> <p>There may be differences in the way agencies based across the four nations are able to respond to the findings. At an early stage of the project, key agencies and individuals</p>

	<p>within the devolved nations will be approached to enable sharing of the research process and findings, recognising any differences in the way services are organised and delivered. Factored in the final report when considering how the findings can be utilised to protect pregnant women and their unborn child.</p> <p>The outputs of the trial will help GDNs have a fact-based approach to steer future CO strategies supporting our customers in vulnerable situations, in particular pregnant women as a distinct group with specific vulnerabilities and specialist agency involvement.</p> <p>The outputs will support identification of which agencies the GDNs need to engage with in terms of service providers and front-line visitors and establish how the GDNs can work with expert partners to reach an additional group.</p> <p>The outputs will enable GDNs to reach additional vulnerable group and advise on FPNES, debt advice, home improvements (energy efficiency interventions) and switching.</p> <p>The research will allow GDNs to further support their workforce in their knowledge of this vulnerable group; enabling them to identify actions that they can take to make a positive difference, be more informed on CO and vulnerable groups, and develop capacity and ability in their actions and in their professional positions.</p>
<p>Evidence of Stakeholder/Customer Support</p>	<p>This should provide information of the customer engagement that has taken place in the development of VCMA Projects where appropriate. If there is no evidence of stakeholder engagement or customer support, this should justify why it was not appropriate to engage with stakeholders and customers.</p> <p>GDN Stakeholder engagement feedback</p> <ol style="list-style-type: none"> 1. GDNs should be doing more to support customers living in vulnerable situations. 2. This vulnerable group is often overlooked, and it is unclear where this group is recorded on the PSR. <p>APPCOG</p> <ol style="list-style-type: none"> 1. Professor the Baroness Finlay of Llandaff, from The All-Party Parliamentary Carbon Monoxide Group. <p>Policy Connect wrote to the Gas Safety Trust advising that pregnancy was one of the topics explored in their 2017 report ‘Carbon monoxide poisoning: Saving lives, advancing treatment’. In 2019 they developed this work further and their network of medical professionals, COMed, published a working paper on this topic.</p> <p>Quote from Baroness Finlay: <i>“From this research we have become increasingly concerned that pregnant women exposed to CO are slipping through the cracks and aren’t receiving timely or accurate diagnoses. This is particularly worrying for unborn children, as there is emerging evidence that in-utero exposure to CO can have long-term consequences for a child’s mental development. With this in mind, I hope the Gas Safety Trust is already funding research into CO poisoning during pregnancy or is at least open to the prospect of commissioning such research.”</i></p> <ol style="list-style-type: none"> 2. In its most recent report ‘Carbon Monoxide Poisoning: Saving Lives, Advancing Treatment – a call for action across the healthcare sector’, case study 6.6, Carbon Monoxide poisoning: in pregnancy; <p><i>‘In 2013, a 23 year old woman in her first pregnancy attended her first appointment with a midwife. As part of the routine checks a carbon monoxide (CO) monitoring was undertaken and her expired breath level was found to be 64 ppm. This woman reported being a non-smoker and could not understand this high reading. Her partner volunteered to be tested as part of this check as he was concerned she was smoking. His reading was 82 ppm. The woman had reported symptoms of headache and nausea during the last couple of weeks. These symptoms may have been dismissed as being symptoms experienced</i></p>

during a normal pregnancy. We discussed their household appliances and asked that they make an emergency call to have their home checked. The emergency department (ED) was also contacted for advice. The couple attended the ED, where oxygen therapy was administered. A gas engineer attended the home and found the CO levels readings to be above 200 ppm. The boiler was condemned. The couple did not have a CO alarm and were not aware of the dangers. This lady went on to have a normal delivery of a healthy baby, however she suffered severe anxiety throughout her pregnancy due to concerns regarding the possible impact this exposure may have had.'

Based on this case study the All Party Parliamentary CO Group recommended (Recommendation 16) that:

'Appropriate funding bodies should fund research in order to: provide a better understanding of the scale of environmental CO poisoning in pregnancy; ... gain a better understanding of the barriers and facilitators to the identification of CO poisoning in pregnant women; ... understand how better to protect women from CO poisoning by the actions of health professionals and other agencies; and provide better information to individuals to help them protect themselves.'

Reference to COMed, Working paper on CO in Pregnancy letter from APPCOG:

'Each year CO poisoning causes approximately 4,000 visits to A&E in England and Wales, as well as over 30 deaths and 200 hospitalisations. CO poisoning is estimated to cost the taxpayer £178 million every year. These figures are likely underestimated due to data gaps caused by insufficient reporting of CO incidents, and the difficulty healthcare professionals face diagnosing CO poisoning. The effects of CO poisoning increase for certain vulnerable or at-risk groups, including pregnant women and their unborn child, and young children. In-utero CO exposure is particularly harmful and has been linked with low birth weight, neurodevelopmental problems, congenital malformations and sudden infant death.'

To address this, COMed met to discuss how to better prevent pregnant women from being exposed to CO and improve the support they receive. They made the following recommendation: Recommendation 10:

'Qualitative research into perceived CO risks amongst pregnant women should be conducted, particularly amongst pregnant women in vulnerable circumstances. Such research should have a quantitative element included to confirm exposure.'

The full 'COMed working paper on CO in pregnancy' is attached below as supporting information.



COMed - Working
paper on CO in pregn

3. CO Workshop

Reference to the recommendations made at the GST Medical Management of CO Workshop, November 2018:

- a) **Midwives need protocols to work to and simple pathways for referral ...**
- b) **A study to understand the scale of CO poisoning in pregnant women should be conducted.**

<p>Outcomes, Associated Actions and Success Criteria</p>	<p>Details of the VCMA Project, outcomes and the associated actions to achieve these, interim milestones and how the Funding Licensee will evaluate whether the project has been successful. Each action should have a proportion of the funding allocated.</p> <p>The outcomes</p> <ul style="list-style-type: none"> • Understanding the knowledge base on CO, the scale and levels of CO exposure (where, what and how) in this vulnerable group and how pregnant women and their unborn children might be better protected from harm. Various ranges of low-level exposure and the potential impact to people within this e.g., length of time exposed and impact. In utero exposure in the third trimester, followed by neonatal (and onwards) exposure is key to health outcome of a child by five years of age in terms of developmental outcomes. • Most immediately, the protection of the women recruited into the study and improve the safety of their home for both themselves, their unborn child and family members. It will also educate and improve awareness of the dangers of CO and other risks related to combustion. Issuing CO alarms during the recruitment phase of the study to those women identified as vulnerable, and making appropriate referrals as required. • New interventions/approaches and escalation processes to ensure that the appropriate level of support is given to understand how well the process works. Able to understand how the agencies and the women on the trial reacted to the intervention. • Information to allow the GDNs to be able to further improve their escalation routes for this group of people. • Bespoke escalation process which can be incorporated into training and practice. • The identification of the key organisations/agencies which need to collaboratively act to protect women and their unborn child. These may include local authorities, GDNs, NHS Trusts, NHS England, Public Health England, Landlords, APPGs, Housing (Govt – charities), Fire and Rescue Services, baby and CO charities. • Findings which the All Party Parliamentary CO Group can use to support a future inquiry into maternal and foetal exposure to CO. • Findings that will inform the effective deployment of CO alarms in the homes of pregnant women. • Information to inform basic scientific research on CO to improve outcomes where prevention practices failed. The data will further inform NHS professionals, maternity services, and baby charities. • Data collected during this project, combined with results from basic scientific research will provide information for the alarm and domestic gas industry sector on levels of CO that pregnant women need protection from. This will feed into sensor, appliance testing, and training material development, along with informing CO awareness strategies for all GDNs. • Data that can be used to inform the healthcare community on levels of CO that professionals administering care for pregnant women in a community setting might be exposed to. • Data that will inform future work undertaken to further the understanding of exposure to CO in pregnant women. • The development of long-lasting relationships between local midwifery teams and the local FRS on fire and CO safety. Ensuring there is a focus on CO when entering people's homes, whereas currently this is lacking. <p>Key outputs and measures</p> <ul style="list-style-type: none"> • A data set that will be specific to pregnant women within deprived communities and their exposure to CO, including an understanding of the typical environments of this vulnerable group and factors which increase the risk of environmental CO exposure. • Assessment of the scale of personal exposure of the pregnant women in the study to CO in the home environment. • Analysis of whether breath tests are a reliable indicator of exposure to CO. • Assessment of the potential harm to the woman and her unborn child of the identified exposure. • A qualitative report of the current knowledge regarding CO exposure, of pregnant women and health/social care professionals.
---	--

- A qualitative report identifying the barriers and facilitators to remedying the problem (from the women's perspective, industry, policy makers, health professionals)
- A report describing the co designed approaches and interventions that would help protect pregnant women and their unborn children.
- Identification of key organisations which need to work collaboratively to protect this vulnerable group (may include policy makers, industry, NHS, LAs, FRS).
- A written report outlining the rationale for the study, methodology, outcomes, implications for policy and practice, and the health of pregnant women and their unborn children. This will include potential implications within devolved nations.
- A published paper describing the need, methodology, findings and outcomes

Project milestones



Total project costs

	Days	At rate	Costs	Sub total
Steering Group Meetings (3)				
Project Director	4	850	3,400.00	
Project Coordinators	4	700	2,800.00	
Academic Lead	4	350	1,400.00	
Additional members	16	200	3,200.00	
Project Administrator	6	175	1,050.00	
Travel, subsistence & venue hire			2,500.00	
sub total	34			14,350
Set up plus Project Management/Coordination				
Project Director	12	850	10,200.00	
Project Coordinators	56	700	39,200.00	
Academic Team	20	135	2,700.00	
Project Administrator	15	175	2,625.00	
Travel and subsistence			1,800.00	
sub total	103			56,525
Ethics Approval				
Project Director	4	850	3,400.00	
Project Coordinators	8	700	5,600.00	
Academic Team	6	350	2,100.00	
Project Administrator	6	175	1,050.00	
sub total	24			12,150
Recruitment Period				
Project Coordinators	16	700	11,200.00	
Trainers	8	700	5,600.00	
Project Administrator	4	175	700.00	
Travel & subsistence			1,600.00	
sub total	28			19,100
Data Gathering (quant)				
Project Coordinators	28	700	19,600.00	
Project Administrator	6	175	1,050.00	
FRS/research teams x 4	120	200	24,000.00	
Travel, subsistence			1,800.00	
sub total	154			46,450
Data Collation and Analysis (quant)				
Academic Lead	5	350	1,750	
Academic Team	50	150	7,500	
Travel and subsistence			800	
Sub total	55			10,050

Data Gathering and analysis (qual)			
Insights team	45	350	15,750
Insights team	55	650	35,750
Travel			3,200
Sub total	100		54,700
Report Writing (interim and final)			
Project Director	3	850	2,550
Project Coordinators	12	700	8,400
Insight team	12	650	7,800
Academic Lead	10	350	3,500
Academic Team	10	150	1,500
Project Administrator	4	175	700
Travel			800
sub total	51		25,250
Presentation of results			
Project Director	4	850	3,400
Project Coordinators	4	700	2,800
Insights team	4	650	2,600
Lead Academic	4	350	1,400
Travel			1,200
sub total	16		11,400
Other cost			
Overheads and contingency (20%)			49,995
Technical Consumables			500
Incentives for women (550)		20	11,000
Sub total	0		61,495
Total excluding VAT	565		311,470

* Project set up, management and coordination costs include:

- Ensuring the project is delivered on time and within budget.
- Recruiting the midwifery sites and completing the portfolio process.
- Recruiting the Fire and Rescue services.
- Developing the study pathways and protocols.
- Developing a risk register and managing risks.
- Developing and implementing escalation procedures for when potential harm to pregnant women is identified during the recruitment and data gathering period.
- Developing the data collection items and system.
- Engaging with partner organisations to benefit the study design, implementation and dissemination.

Payment schedule based on key milestone delivery					
GDN Payment Schedule		Cadent	WWU	NGW	SGN
	Overall	49.81%	11.57%	11.56%	27.07%
Apr-21	45,828	22,825.42	5300.74	5296.18	12,406.26
Jul-21	45,828	22,825.42	5300.74	5296.18	12,406.26
Oct-21	45,828	22,825.42	5300.74	5296.18	12,406.26
Jan-22	45,828	22,825.42	5300.74	5296.18	12,406.26
Apr-22	45,828	22,825.42	5300.74	5296.18	12,406.26
Jul-22	20,834	10,375.20	2409.2	2,407.35	5639.16
Total £	249,974	124,502.30	28,912.99	28,888.25	67,670.46

Key Milestones	
Apr-21	Set up period including 1st steering group
Jul-21	Recruitment of sites/Ethical approval/Escalation procedures/Data agreements
Oct-21	Preparation for recruitment and data collection including training of key staff
Jan-22	Recruitment and data collection
Apr-22	Recruitment/Data collection
Jul-22	Data collation/Analysis/Report writing

Project Partners and Third Parties Involved

Details of Project Partners or third-party involvement.

Joint VCMA Funders:
 Gas Distribution Companies: Cadent Gas, NGN, SGN and WWU
 Gas Safety Trust
 Liverpool John Moores University (LJMU) (provided In Kind contribution)

Research Partners:
 iPiP - Improving Performance in Practice
 LJMU

Equipment Partners:
 Bedford (20x CO breath analysers) AICO Ltd (400x EI 208 CO alarms and 5x Gateway alarms)
 LJMU (50x Dataloggers)

Working Partners:
NHS (maternity)

Fire and Rescue Services: providing free Home Safety Checks for families in the study

LMJU will provide data loggers that are to be placed in the homes that are being monitored.

Bedfont Scientific Ltd will provide CO breath analysers that will be used by FRS in women's homes.

AICO Ltd will provide CO alarms that have direct download and can low level monitoring plus Gateway alarms that provide remote notifications.

ENA will provide expert advice as require to the study team and steering group.

Gas Distribution Networks will provide 80% of the required funding identified.

Gas Safety Trust will provide 20% of the required funding. This is important for a project that utilises NHS staff and data, as Gas Safety Trust are NIHR portfolioed.

Total cost for Research Study: £311,470 excluding VAT

Total VCMA collaboration funding amount: £249,974 excluding VAT

Funding will be used for:

	<ul style="list-style-type: none"> • iPIP staff and associates as principal investigators, qualitative researchers and project coordinators. • University (LJMU) statistical support; analysis; and equipment calibration; steering group liaison • FRS and midwife team recruitment; development; training; management • FRS – data logger and monitor collection; questionnaire and data download; advisor to project working group. • NHS ethics applications: application, material development, contract implementation • Development of materials for women; midwives; FRS • Meetings; report writing • Administration • Gift vouchers for women who agree to take part in the study will be given at the end of the monitoring period
<p>Potential for New Learning</p>	<p>Details of what the GDN(s) expect to learn and how the learning will be disseminated.</p> <p>To date, no study to assess environmental exposure of pregnant women to CO has been undertaken in the UK.</p> <p>Undertaking a study which directly monitors the home of the pregnant woman is important to better understand the prevalence of exposure, how such exposure occurs and whether the breath test at time of booking, if not undertaken in the home, can be used as an indicator of exposure to CO in the home. This information will assist in the collection of more accurate data that allows for statistical analysis on CO exposure and provide information regarding possible requirements for the protection of pregnant women under schemes delivered by Central Government Departments, Agencies, NHS England and the Fuel industry.</p> <p>This study will build on previous studies by using similar protocols, methodologies, and utilising the Fire & Rescue Services Home Safety Check for the home monitoring of CO. This study will target pregnant women as a specific group, with the aim to establish the exposure of pregnant women within the study to CO in their homes, following a CO breath test at time of booking. Monitoring will be triggered by use of an alerting method between midwives and the local Fire and Rescue Service that instigates a Home Safety Check and home monitoring. Such collaboration has not been undertaken before and will assess whether this reporting pathway is feasible on a larger scale.</p> <p>It will also identify the barriers and enablers to protecting women and their unborn child from the harm of CO. It will seek to co-design an approach and develop interventions that could be implemented at scale and used to protect vulnerable families.</p> <p>Following the completion of both elements of the study it is our intention that an intervention for identifying and protecting pregnant women from exposure to CO in their home will have been scoped, designed and beta tested with the target audience. Understanding the scale of the problem along with having that potential solution will allow the costings and cost benefits to be outlined within the final report. The team will then work with key organisations to pilot the new approach. If successful, it is hoped the programme will then be rolled out nationally and become embedded as part of standard maternity care.</p> <p>Throughout the project, the team will work closely with all the agencies who may be involved in implementing any approach or intervention that the study identifies as being necessary to protect women and their unborn child.</p> <p>As detailed above, training and education will run throughout the study, in particular:</p> <ul style="list-style-type: none"> • Midwife training in recruitment specifically for this study • Bespoke escalation process training • Training material development on CO awareness strategies for all GDNs • FRS training in Home Safety Checks with pregnant women and indoor air monitoring.

	<p>Dissemination</p> <p>A study report will be produced along with research paper submissions to relevant scientific journals. Dissemination of results will be made at relevant events attended by authors of the report.</p> <p>The intention is to publish the results in academic, scientific and medical/midwifery journals, which will also result in media attention. The project team will actively seek out opportunities to present the findings at national and international events and through appropriate social media. Support from the funding bodies will be acknowledged in all cases.</p> <p>The research will also be made available to key organisations/agencies which need to collaboratively act to protect women and their unborn child. (These may include local authorities, GDNs, NHS Trusts, NHS England, Public Health England, Landlords, APPGs, Housing (Govt – charities), Fire and Rescue Services, baby and CO charities). The All Party Parliamentary CO Group Stakeholder and Medical and Healthcare sub-group will be approached to assist with dissemination to relevant stakeholders and policy professionals.</p> <p>The GDNs will engage their communications teams to further disseminate results of the research.</p> <p>Once the research analysis has been completed, key messaging and recommendations will be made.</p>
<p>Scale of VCMA Project and SROI Calculations</p>	<p>The Funding Licensee(s) should justify the scale of the VCMA Project – including the scale of the investment relative to its potential benefits. As part of this it should provide the SROI calculation.</p> <p>Undertaking projects that involve health data and in particular data from pregnant women, are not a straightforward undertaking. This project has therefore been developed by a core team who work for government agencies on pregnancy policy, with a particular focus on hazards that harm the unborn baby and co design solutions. By developing a research group using members of this team, experts in the fields of CO, public health, NHS, FRS, the built environment, academia and the GDNs, this collaboration brings together the key organisations and people with skills and knowledge to successfully execute this important and novel piece of research.</p> <p>The scale of the project in terms of the size of the population being analysed to provide meaningful results has been considered. A balance is required in terms of the number of women that can be expected to be successfully recruited to the study (allowing for drop out and completeness of datasets), the number recruited that will allow for useful statistical analysis, balanced with the cost of the project and the time that NHS professionals are given to undertake the work. As is always the case with projects where prevalence is unknown, it is difficult to calculate statistically the number of subjects that need to be recruited, especially when there is a paucity of data to refer to. This research group has aimed to recruit enough women to enable the aim and objectives of the work to be met with as much certainty as possible, but without overburdening the business as usual processes of the frontline workforce, whilst optimising the cost of the project, ensuring co-funding, and the provision of equipment in kind. The team believe that the figures will provide data of statistical significance with confidence behind the figures clearly explained in the conclusions of the report. Statistical techniques will be employed to eliminate manifestations of research with smaller numbers (as are routinely used in scientific research), to provide as much confidence and certainty in the outcome data as possible.</p> <p>The team has already succeeded in obtaining funding from the Gas Safety Trust. This is important given the portfolio status that enables NHS resources to be utilised. The team have also confirmed the provision of equipment in kind from the organisations involved.</p> <p>In terms of Social Return On Investment (SROI), for the project as detailed in this application, this is unknown as a costing cannot be ascribed to results that have yet to be</p>

	<p>revealed. This stage of the work is an investment in the science (both quantitative and qualitative) to gain an understanding of prevalence and co design interventions that will improve the quality of care and the safety of the home environment for pregnant women. A cost based on a series of different outcome scenarios that could be postulated has not been calculated. Such work would be difficult to calculate, given that the data required are not available.</p> <p>The actual cost of the project lies well within the average costs for such research.</p> <p>A full SROI on the outcomes of the project would be advised, but this activity cannot be included within the scope of this project and would need to be costed separately. This is because the work would have to be based on the results from the quantitative work and the cost and dissemination of the co-design intervention.</p> <p>Undertaking a full SROI would consider scenarios of outcomes for a child that was exposed <i>in utero</i> where a malfunctioning boiler was identified. Costs of the consequences in terms of detriments to health and development in terms of ongoing cost to government (e.g. NHS, DHSC, DfE) over a period of time would have to be considered. This would be assessed against the cost of implementing the qualitative outcomes and immediate remediation of the malfunctioning appliance, calculated from the data produced by this study. The SROI component would be likely to be a large, broad stakeholder item of work, undertaken following the completion of this important piece of research. This research will provide the data on which an SROI will be based.</p>
VCMA Project Start and End Date	<p>Detail start and end date of the VCMA project and, where relevant, the VCMA project that preceded this initiative.</p> <p>Preparatory work could commence in April 2021 and end 2023. Eighteen months to two years, which includes a six month's data collection during a winter period.</p>
Geographical Area	<p>Details of where the VCMA Project will take place. If the VCMA Project is collaborative, the Funding Licensee area(s) in which the project will take place should be identified.</p> <p>Projects will take place within one NHS locality in England for each GDN</p>
Remaining Amount in the Allowance at Time of Registration	<p>Remaining funding left in the Licensee's/ Licensees' funding pot.</p> <p>Amount before this project £15,000,000 Project costs £249,974.00 Remaining following this project <u>£14,750,026</u></p>

PEA Control Tables are provided overleaf

Gas Network Vulnerability and Carbon Monoxide Allowance (VCMA) Governance Document - PEA Control Table

In order to ensure that a VCMA project is registered in accordance with the Ofgem VCMA governance document (incl. project eligibility assessment), the below table should be completed as part of the project registration process.

Stage 1: GDN Collaboration Group PEA Review
Meeting date review completed: 11th Feb 2021
Review completed by:

GDN:	Name:	Job Title:
Cadent	Suzanne Callington Phil Burrows	- Customer Safeguarding Manager - Customer Vulnerability Social Programmes Delivery Manager
NGN	Steve Dacre Jill Walker	- Vulnerability Innovations Lead - Social Strategy Project Manager
SGN	Kerry Potter Dan Edwards	- Group Social Impact and Vulnerability Manager - Social Impact Programme Lead
WWU	Elizabeth Warwick Sally Thomas	- Stakeholder Engagement Manager - Stakeholder Engagement Officer

Stage 2: GD2CVG Panel Review
Meeting date sign off agreed: 19th Feb 2021
Review completed by:

GDN:	Name:	Job Title:
Cadent	Phil Burrows	Customer Vulnerability Social Programmes Delivery Manager
NGN	Eileen Brown	Customer Experience Director
SGN	Maureen McIntosh	Head of Customer Experience
WWU	Nigel Winnan	Head of Customer and Social Obligations

Stage 3: Participating GDN individual signatory sign-off

GDN	Name:	Job Title:	Signature:	Date:
Cadent:	Phil Burrows	Customer Vulnerability Social Programmes Delivery Manager	Philip Burrows	26 th April 2021
NGN:	Eileen Brown	Customer Experience Director	<i>Eileen Brown</i>	23 June 2021
SGN:	Rob Gray	Director of Stakeholder Relations and Communications	<i>Rob Gray</i>	17 June 2021
WWU:	Nigel Winnan	Head of Customer and Social Obligations	<i>Nigel Winnan</i>	11 th May 2021

Stage 4: Upload PEA Document to the Website & Notification Email Sent to Ofgem (vcma@ofgem.gov.uk)

Date that PEA Document Uploaded to the Website: Dates may vary as each GDN will individually upload on their websites

Date that Notification Email Sent to Ofgem: 12th July 2021