FEMP Feasibility Study

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Table of Contents

Introduction

As of January 1, 2020, oil and gas producers and midstream operators across Canada were required by Environment and Climate Change Canada (ECCC) to implement Fugitive Emissions Management Programs (FEMPs) to reduce fugitive methane emissions by 45% from 2012 levels by 2025[1]. Provinces in turn could match the emissions reduction targets via a different method than that prescribed by ECCC, and therefore use their own regulations instead of ECCC's so long as ECCC approved the equivalence. Alberta achieved equivalency with its Directive 060[2] which allowed oil and gas producers and mid-streamers (referred to as duty holders in Alberta) the potential to pivot from conventional FEMPs to alternative FEMPs (Alt-FEMPs). The purpose of the (Alt)FEMP Feasibility study is to develop an understanding of the supply for-and demand of-methane leak detection efforts in Alberta as a core component of FEMPs and Alt-FEMPs. The objective of the study from a supply perspective is to develop a dataset of methane leak detection technologies and their associated performance measures and, if possible, their cost parameters. From a demand perspective, the objective of the study is twofold. The first objective is to document upstream and mid-stream oil and gas industry duty holders' intentions and current efforts to undertake an Alt-FEMP. The second objective seeks to determine duty holder intentions to use third party leak detection services, self-perform or apply a hybrid third party/self-performance model for either Alt-FEMPs of conventional FEMPs. Ultimately, many of the study's data elements will be considered for inclusion in the Canadian Emissions Reduction Innovation Network (CANERIC)-funded Integrated Methane Measurement and Monitoring System (IM3S).

FEMPs are a significant regulatory tool that both federal and provincial governments have invoked to meet current and future methane reduction targets. With respect to greenhouse gas (GHG) management, methane management as a subset has experienced noteworthy activity with respect to new technology development and commercialization efforts over the past several years. Methane leak detection using optical gas imaging (OGI) features prominently in both provincial and federal regulation[1], [2]. Alternatives to OGI may result in more efficient and cost-effective delivery of detection services and are expected to be commonly cited in Alt-FEMPs. The FEMP Feasibility study addresses the supply and demand of conventional and alternative methane emissions leak detection services (e.g., OGI) and alternative methane leak detection efforts. The study scope from a supply perspective, includes OGI and alternative leak detection performed by third parties or self-performed by duty holders. The demand component of the feasibility study includes both upstream and midstream pipeline operators. Leak repair is not the focus of this study but is likely an important area for future research. The geographic focus of this study is Alberta; however, the study design recognizes the potential for competition for leak detection and repair (LDAR) resources presented by other jurisdictions in Canada including those defaulting to the ECCC 3x/year LDAR protocol.

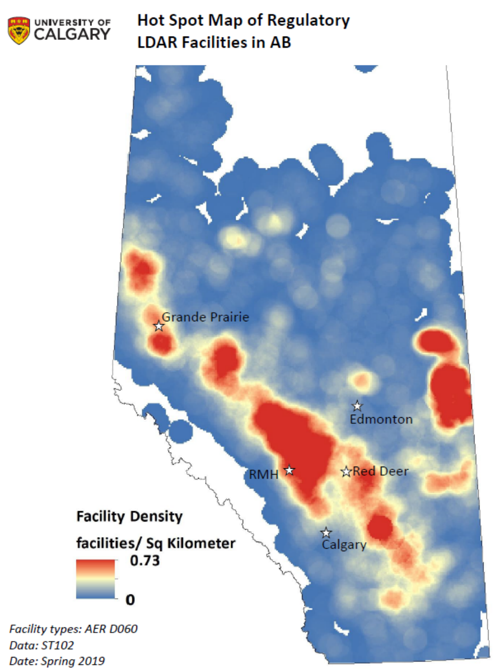
Background: FEMP and Alt-FEMP Demand in Alberta

As of 2019, under the Alberta Energy Regulator's Directive 060 (AER D60) there are a potential 26,000 sites that could require a minimum of once-a-year leak detection operations. Of those, a potential 7,400 sites could require tri-annual leak detection operations. This amounts to approximately 40,800 unique leak detection surveys. These counts were made using Petrinex[3] facility and production data from mid-2018 to mid-2019. A breakdown of the number of facilities per facility subtype that require LDAR operations are presented in Table 1. Using the same dataset there are approximately 17,000 sites that would require tri-annual leak detection operations based on current ECCC federal regulations (if Alberta were to lose its equivalency with the federal regulatory framework). Figure 1a was developed by the University of Calgary (UofC) and presents an LDAR heat map that reflects the number and density of D60 regulated facilities requiring one time (1x) or three times (3x) per year LDAR. This heat map, and the Petrinex derived LDAR demand was corroborated as recently as March 2020 by a Canadian Association of Petroleum Producers (CAPP)[4] estimate which indicated there are approximately 27,000-28,000 sites that require LDAR. Importantly, there are an additional ~13,000 sites cited by Petrinex (and the AER) as unknown status. Should these sites be active, they would require LDAR bringing the total sites in Alberta up to ~41,000. This finding is based on research conducted by the Sundre Petroleum Operators' Group (SPOG) - Methane Emissions Management Program (MEMP)[5] using Petrinex/AER licensing queries using the ArcGIS platform [6]. The "unknown status" sites finding is significant as demand for FEMP and Alt-FEMP activities in Alberta could be up to ~50% higher than previously estimated by this study and CAPP. Notably, a rising driver for LDAR demand is from the switch to exploiting sweet oil and gas formations in fields that have initially been produced and licensed as sour (i.e., containing hydrogen sulfide H_2S). The potential increase in demand for LDAR activities is owing to the D60 stipulated frequencies of 3x/year for sweet (non- H_2S) facilities vs. 1x/year for sour facilities.

Table 1: AER D60 Leak Detection Approximate Facility Counts – Petrinex 2018/19 data

	Facility Subtype Code, Alberta																			
	311	321	322	351	361	362	363	401	402	403	405	407	501	502	503	505	507	601	621	671
Facility Count	5976	441	1938	4979	2565	426	381	368	54	28	46	13	726	2	818	23	119	4316	2700	174

	Annually	Tri-annually
Totals	26093	7384



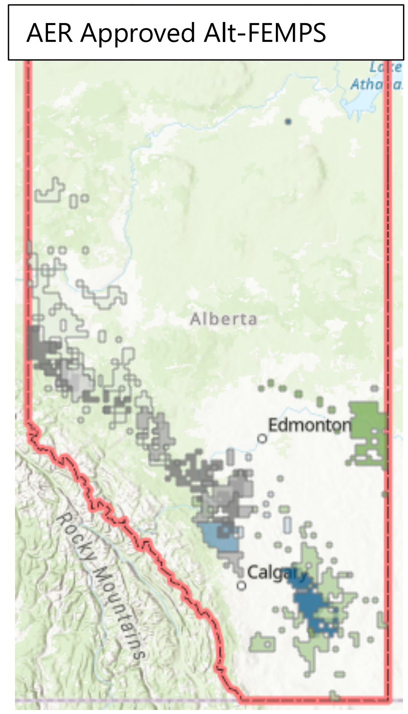


Figure 1a: Facility LDAR Heat Map of Alberta, UofC (2019)

Figure 1b: 2020 AER Approved Alt-FEMPs, AER (2021)

Following the January 2020 update of D60, several Alt-FEMPs were approved by the AER as either 1-or 2-year Pilots or Full Scale. As of April 2021, there were a total of 9 approved pilot and full-scale Alt-FEMPs. These Alt-FEMPs were being conducted by four duty holders including Canadian Natural Resources Limited (CNRL), Seven Generations Energy (now ARC Resources), Torxen, Cenovus, Enhance Energy and Bonavista. Table 2 summarizes the approved Alt-FEMPs which include approximately 5.600 sites across Alberta. Figure 1b depicts the locations of these Alt-FEMPs which not surprisingly align with the heat map presented in Figure 1a. The majority () of Alt-FEMPs are aerial based and truck-based methane sensors with OGI follow up (~5600 sites), with one being continuous monitoring of 16 sites. Additional information on these approved Alt-FEMPs is available on the AER website[7].

Table 2: Approved Alt FEMP programs in Alberta (Source: AER[7]*)*

Submitted By	Proposal Type	Detection Technologies	Approx. # of Sites	Approval Issued & Program Start Date	Program End Date
Torxen1	1 yr Pilot	OGI and truck mounted methane sensors	600	01-May-20	31-Dec-21
Cenovus	2 yr Pilot	Aerial methane sensor with OGI follow-up	400	19-May-20	19-May-22
Seven Generations (now ARC)	3 yr Full Scale	Baseline OGI survey and aerial methane sensor with OGI follow-up	200	08-Jul-20	08-Jul-23
CNRL	2 yr Pilot	Aerial and truck methane sensor with OGI follow-up	1000	01-Jan-21	31-Dec-22
CNRL	2 yr pilot	Aerial and truck methane sensor with OGI follow-up	600	01-Jan-21	31-Dec-22
CNRL	2 yr pilot	Aerial and truck methane sensor with OGI follow-up	900	01-Jan-21	31-Dec-22
SPOG	2 yr Pilot	Aerial and truck methane sensor with OGI follow-up	1200	01-Apr-21	01-Apr-23
Enhance Energy Inc.	2 yr Pilot	Continuous monitoring	16	30-Apr-21	31-Dec-22
Bonavista	2 yr Pilot	Aerial and truck methane sensor with OGI follow-up	700	30-Apr-21	30-Dec-22

Survey Design and Testing

To understand the nature of FEMP-and Alt-FEMP-based service offerings and duty holder demand for them, two questionnaires were developed by DXD in collaboration with the University of Calgary's Thomas Fox. Dr. Fox's familiarity with LDARSim[8] and IM3S contributed significantly to the creation and refinement of the questionnaires. His expertise was essential to ensuring questionnaire elements related to leak detection technologies and methods would service the data/information requirements of IM3S as well as furthering the understanding of the supply and demand relationship related to FEMPs and Alt-FEMPs.

Survey Testing

Once designed both the Service Provider/Vendor and Producer/Duty Holder surveys were shared with the study's industry and regulatory champions (i.e., Richelle Foster – CNRL and Lindsay Campbell – AER). The study champions provided review and advice regarding the accessibility of the surveys re. question intent and structure, the length of the surveys (to maximize likelihood of responses particularly from duty holders) and data and information solicited by the surveys (and its utility to the ARPC, the AER, duty holders and service providers).

Upon finalizing the questionnaires, an online survey platform was selected. Using Survey Monkey[9], the two questionnaires were uploaded and tested internally. A final review of the Producer/Duty Holder Survey was conducted by Don McCrimmon – Manager, Air CAPP.

Appendix A provides the Service Provider/Vendor Questionnaire and Appendix B provides the Producer/Duty Holder Questionnaire.

Respondent Anonymization

The Service Provider/Vendor Questionnaire were provided with the opportunity to have their participation in the study disclosed to PTAC and its members. The vast majority of respondents to this questionnaire elected to have their participation shared. This opportunity was not offered to producers/duty holders. Regardless of the disclosure of a respondent's participation, in all instances questionnaire respondents were anonymized. PTAC and the UofC/IM3C will receive anonymized data sets and completed questionnaires have been redacted to ensure the anonymity of the respondents.

Service Provider/Vendor and Producer/Duty Holder Identification and Participation

Service providers and leak detection vendors were identified using a variety of methods. These methods included online searches, use of contact lists from previous PTAC methane research projects managed by DXD (e.g., Alberta Methane Field Challenge 1.0 and 2.0 and the Fugitive Emissions Management), conferences attendee lists held by various organizations, word of mouth, and producer and regulator-held contact lists. A total of 85 service providers / vendors were identified, contacted, and invited to participate in the Alt-FEMP feasibility study survey starting in February of 2021 and continuing through to April of 2021. Appendix C provides a listing of the service providers and vendors invited to participate in this study. To ensure, maximum response rates, each vendor was approached by email and/or a phone call to introduce the survey and solicit their participations. Subsequently, multiple email reminders and additional invitations were sent out during this period. At the conclusion of outreach efforts, a total of 24 organizations responded to the survey by the end of May 2021.

Duty holders / producers and midstream organizations were identified via their membership in various organizations which include PTAC, CAPP, EPAC, CEPA, and SPOG among others. A total of 49 producer and midstream organizations were identified and invited to participate in the study. Appendix D provides a listing of the companies invited to participate in the study. Notably, these companies were selected owing to their participation in methane related committees, methane-related conference attendance and status as a duty holder, producer or midstream operator. Using PTAC, EPAC and CAPP as initial distribution channels, invitations to participate in the Producer/Duty Holder/Midstream Operator survey were issued beginning in late January 2021. As of June 2021, 10 producers and one mid-stream organizations had responded to the producer survey. Numerous attempts were made to seek additional participation in the survey. Additional reminders were sent directly to invitees, invitations through partner organizations (CEPA, EPAC, CAPP, and PTAC), and personalized e-mails. These efforts raised participation from approximately 5 respondents in March 2021, to the 11 in June 2021. The total production of the 10 producer-respondents was approximately 60% of Alberta's total BOE production in 2020 (~3.3 MMboe/d of ~5.2 MMboe/d[4]). These respondents represent a significant portion of Alberta's overall production and allow insights into the current market for FEMP and Alt-FEMP technologies, programs, and availability.

There are 9 service providers of the 24 respondents who indicated that they offer 2 to 4 types of detection technologies (e.g., OGI and Truck based). For these service providers, only one technology will be considered to represent the service provider in the results. These will be done based on the screening technology offered in the order of satellite, aircraft, truck, continuous, UAV, and lastly handheld. UAV is considered second to last due to restrictions on drones (particularly the need for line of sight), but still being used as a screening technology before handheld. This order is estimated to be the approximate order of productivity in number of sites visited per day for screening / Alt-FEMP technologies. Service providers are assigned a number from 1 to 24 for anonymization. The service providers with multiple technology offerings are #2, 8, 14, 17, 18, 20, 22 and 23 (Appendix E). Of these service providers, only provider #20 offers their multiple technologies as separate packages, all other service providers offer their multiple technologies together. Please refer to Appendix E and F for their responses and the data analysis for these service providers. Ideally, a survey response for each type of technology offered would be gathered, unfortunately that is not the case as these service providers would be required to spend a significant amount of time filling out multiple surveys. Therefore, the described method is used, with the raw response data and analysis methods disclosed in the appropriate appendices.

Findings

The following section summarizes the survey results. These are divided into Service Provider/Vendor Responses and Producer/ Duty Holder/ Midstream Operator Responses. The former focuses on leak detection services, technologies, and methods while the latter addresses duty holder plans re. use of third party and/or self-performed LDAR. Appendix G provides a detailed summary of the Service Provider/Vendor Responses while Appendix H provides a similar summary of the Duty Holder/Midstreamer Responses. Appendix E provides the redacted questionnaire responses for the Service Provider/Vendor Surveys and Appendix F provides the redacted questionnaire responses for the Producers/Duty Holders/Midstream Operator Responses.

Service Provider/Vendor Survey Results

There was a total of 24 unique responses to the service provider questionnaire, these 24 service providers are assigned a number from 1 to 24 for anonymization purposes, each number corresponding to a service provider. All respondents indicated that they were active in the Alberta market, with 11 service providers also participating in British Columbia, 11 in Saskatchewan, 9 in the United States, and 12 in other regions of Canada and/or around the globe. 20 of the respondents mentioned whether they were AER D60 compliant or part of potential Alt-FEMPs, 10 being AER compliant and 10 for Alt-FEMP programs (e.g., drone or truck monitoring technology). Only 4 service providers indicated that they had successfully applied for Alt-FEMP programs within Alberta, with more service providers are planning to apply in 2021 and/or in the future.

Service Provider Results

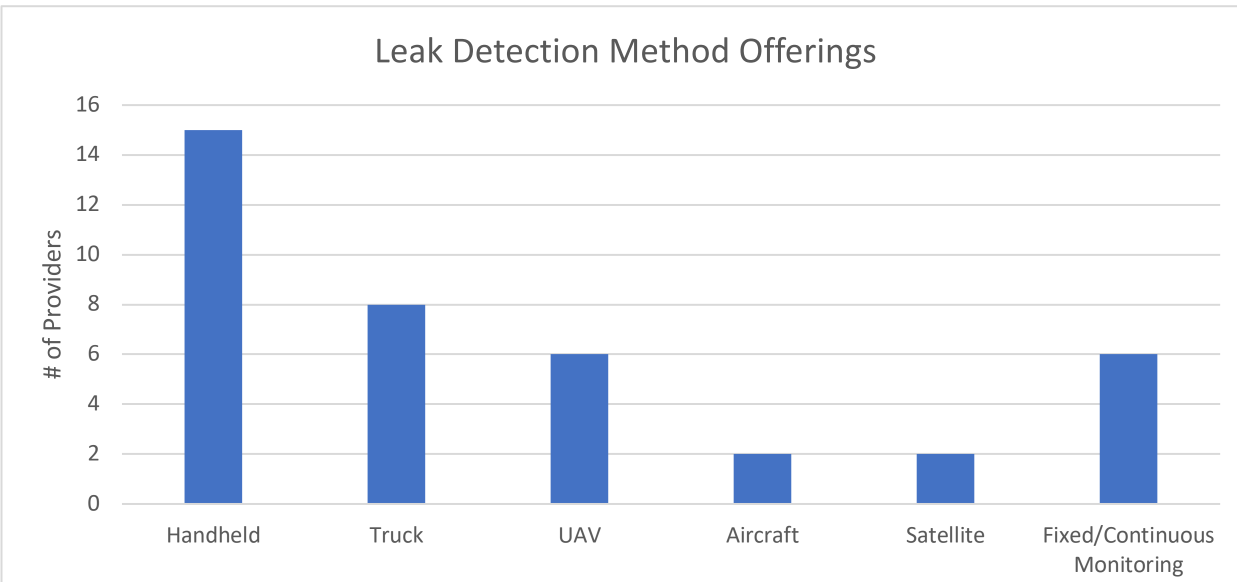


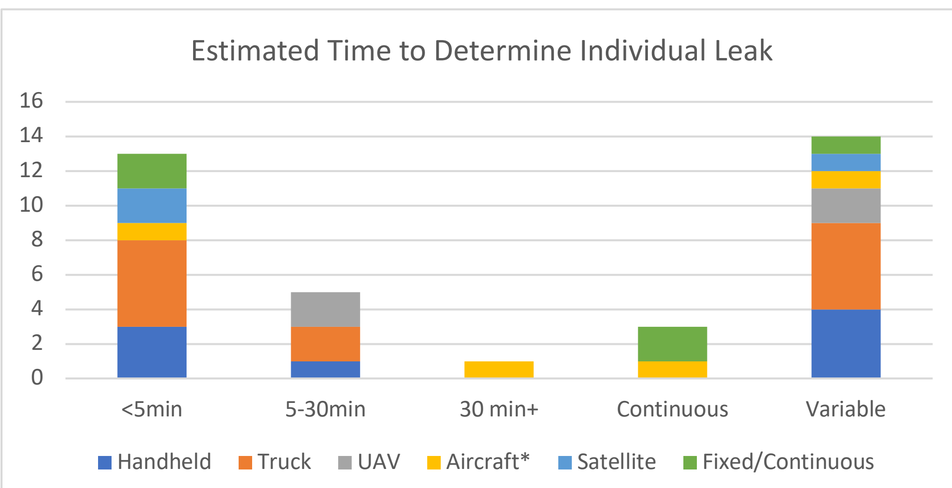
Figure 2: Leak Detection Method Offerings, n=22 offering 39 monitoring methods (8 service providers offer more than just 1 type of monitoring, e.g., handheld and UAV)

Table 3: Technology Offerings by Service Provider

Service Provider	Handheld	Truck	UAV	Aircraft	Sattelite	Fixed/Continuous	If Multiple, Together or Separate
1	1	1					Together
2	1						
3		1					
4		1					
5					1		
6							
7	1	1	1				Together
8							

9						1	
10	1						
11	1						
12	1	1					Together
13				1	1		
14	1						
15	1		1				Together
16	1	1	1	1		1	Together
17						1	
18	1	1	1			1	Separate
19	1						
20	1		1				Together
21	1	1	1			1	Together
22	1						
23	1						
24						1	

Figure 2 shows the different technology offerings available from the 24 service providers. Nine service providers indicated they offered more than 1 method (e.g., UAV and handheld). There are 5, 1, 2 and 1 service providers offering 2,3,4 and 5 technologies respectively. Of the vendors that offer multiple methods, 7 distinctly indicated that their methods could potentially work in unison to provide an Alt-FEMP method, typically starting with Truck/UAV/Satellite for an initial screening survey then moving to handheld OGI if a site's estimated emissions are above a threshold based on the initial survey.



*Aircraft monitoring of 30+ min is likely due to the service provider including OGI follow-up time.

Figure 3: Estimated time to Determine Individual Leaks, multiple answers per service provider were allowed, n=21.

The time it takes to determine an individual leak from the respondents' technologies are shown in Figure 3. 13 of 21 respondents stated their technologies can determine an individual leak under 5 minutes, with some technologies taking potentially longer. 14 of 21 respondents indicated that their leak determination times were variable in addition to an approximate time selection. Variables that affect this timing were stated to include items such as weather conditions, location of component, and type of leak detection technology being used. The one aircraft service provider with 30 minutes or longer potentially includes overall site leak determination and not just a single leak (i.e., OGI follow-up time).

Table 4: Tagged Leaks Specificity of Method, n=21

Technology	Component	Equipment	Facility
Total	17	15	16
Handheld	7	3	3
Truck	4	5	6
UAV	2	1	1
Aircraft	1	1	1
Satellite	1	2	2
Fixed/Continuous	2	3	3

The specificity of leak tagging (facility, equipment, and component) is presented in Table 4. Many service providers offer multiple technologies which can tag leaks at different levels which is why the total is more than 24. Table 5 shows how many vendors disclosed if they could classify a methane source as a fugitive (leak) or vent, ability to tag leaks individually (component/equipment level), and if a flow rate can be calculated. 12 of 21 service providers indicated they can perform all three detection specificities, 5 of 21 only at component level, and 4 of 21 at equipment and/or facility level. 5 of 19 service providers report being unable to determine a leak from a vent while 3 of 20 are unable to calculate a flow rate but can determine whether a site or piece of equipment is leaking.

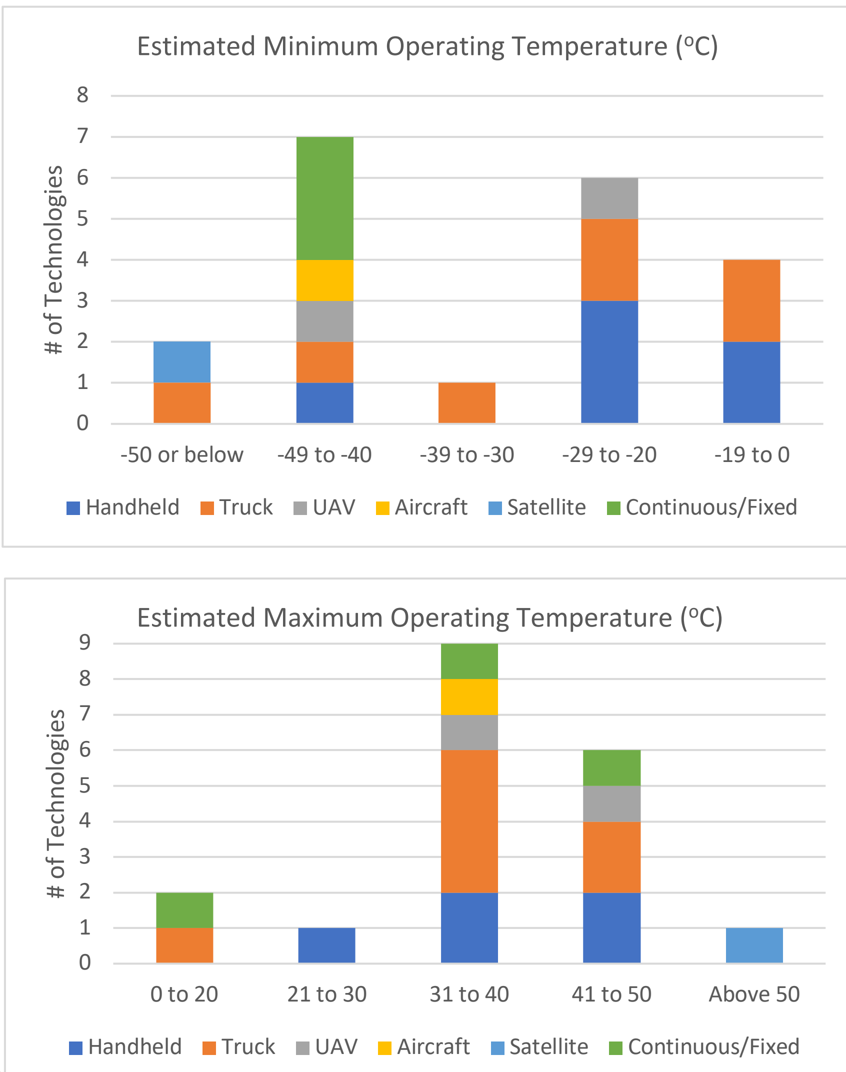
Table 5: Methane Emission Source Tagging Attributes, n=22

Technology	Y/N	Classification of emissions as Fugitive or Vent	Able to tag individual leaks	Flow Rate Calculated
Total	Yes	15	21	17
	No	5	1	4
Handheld	Yes	6	7	5
	No	1	0	2
Truck	Yes	3	7	6
	No	3	0	1
UAV	Yes	2	2	2
	No	0	0	0
Aircraft	Yes	1	0	1
	No	0	0	0
Satellite	Yes	1	1	1
	No	1	1	0

Fixed/Continuous	Yes	2	3	3
	No	0	0	0

Climate Conditions

The climate conditions that were included in the questionnaire include operating ambient temperatures, humidity, and levels of rain, snow, snow on ground, and wind. Climate conditions can potentially affect the operation of vendor technologies and, consequently, their ability to be reliably deployed in the field and seasonal limitations to their application.



(a)

(b)

Figure 4 a/b: Minimum and Maximum Operating Temperature of Technologies, (a) n=20 (b) n=19

The operating temperature threshold for technologies varies from -50°C (14 of 20 being from -20°C to -49°C) to above 50°C as shown in Figure 4 a/b. The maximum threshold for most technologies (15 of 19 responses) is between 31°C and 50°C, with only one technology that can operate above 50°C. Minimum operating temperature varies significantly among the technologies. As for humidity, only two service providers indicated a maximum humidity of 80-95%, with 12 responses indicating that humidity would not affect the operation of their leak detection technology or method. With respect to wind speed, all 13 of 13 respondents indicated that they were effective at wind speeds of 20 km/h or less. 6 of 13 respondents indicated their technologies have challenges operating in the range of 20-40 km/h winds. As shown in Figure 5, three respondents indicated that they can operate effectively in winds above 80 km/h.

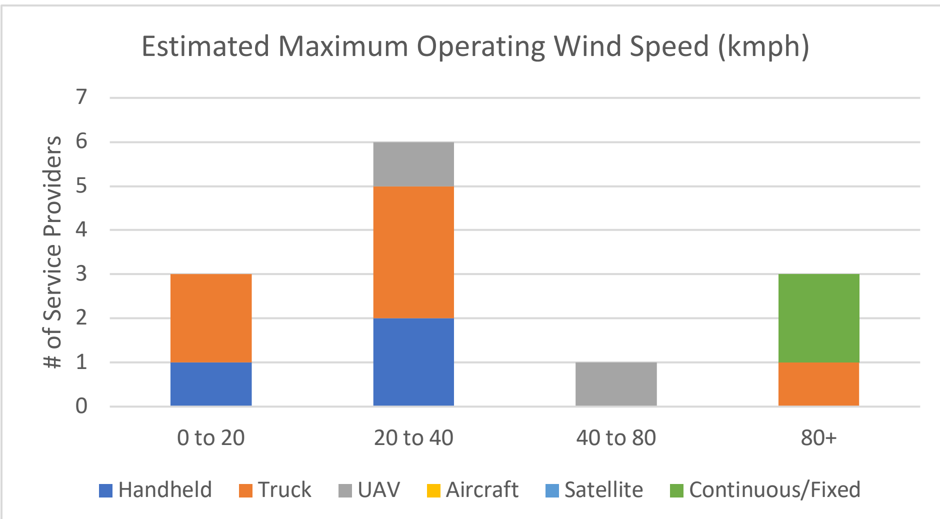


Figure 5: Maximum Operable Wind Speed, n=13

Table 6 to Table 8 indicate the level of rain, snow, and settled snow that service provider technologies were able to operate at. The responses to these questions were quite varied; however, most offered methods that can tolerate light rain and snow levels.

Table 6: Approximate Maximum Rain Level, n=18

Technology	None (no cloud)	Light	Medium	Heavy
Handheld	0	1	3	1
Truck	0	5	2	0
UAV	0	1	0	1
Aircraft	0	1	0	1
Satellite	1	0	0	0
Continuous/Fixed	0	0	1	2

Table 7: Approximate Maximum Snowfall Amount, n=18

Technology	None	Light	Medium	Heavy	N/A
Handheld	1	0	2	1	2
Truck	0	4	2	0	0
UAV	0	1	1	0	0
Aircraft	1	0	0	1	0
Satellite	0	0	0	1	0
Continuous/Fixed	0	0	1	2	0

Table 8: Approximate Maximum Amount of Settled Snow, n=18

Technology	None	Thin	Moderate	Deep	N/A
Handheld	0	1	1	3	1
Truck	0	3	0	4	0
UAV	0	0	0	2	0
Aircraft	0	0	0	0	1
Satellite	0	0	0	1	0
Continuous/Fixed	0	0	0	3	0

Capacity

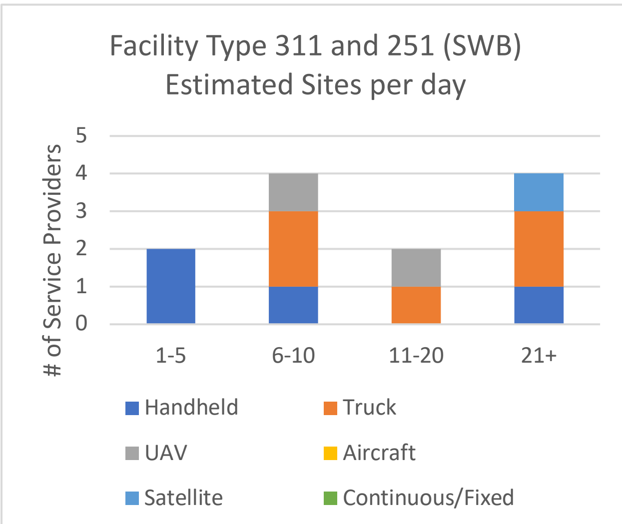
This section of the survey sought to determine pricing for LDAR services as well as their daily productivity.

There were 6 responses which provided some insight into pricing which ranged from $750/day up to $3,500/day for leak detection services. Table 9 summarizes the available cost data from these 6 responses in relation to the reported estimated facilities per day (SWBs) and technology type offered by the service provider.

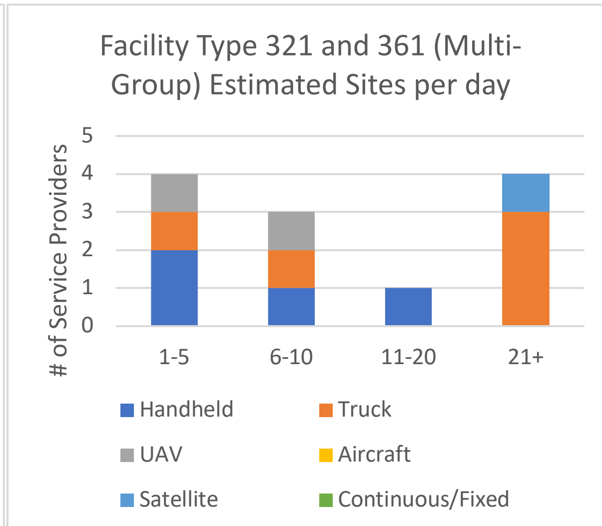
Table 9: Available Cost Data from Service Provider Surveys

Technology	Cost per day ($/d)	Estimated SWB Facilities per day
Handheld	3,000	20
UAV	3,500	6
UAV	3,200	10
Truck	750	N/A
Handheld	3,500	3
Handheld	2,250	8

Figure 6 a/b/c/d shows the amount of service providers (12 of 24 total) that indicated daily productivity (per site type) of a single leak detection survey crew. 1-10 sites per day range was most frequently cited for larger site types (multi-group, sweet gas plant, and Compressor stations), and more distributed towards more sites per day for single well facilities. The majority of D60 compliant methods are under 20 sites per day, with Alt-FEMP methods reaching 21+ sites per day. There were no D60 compliant methods that were shown to be able to do 21+ facilities per day for a single crew.



(a)



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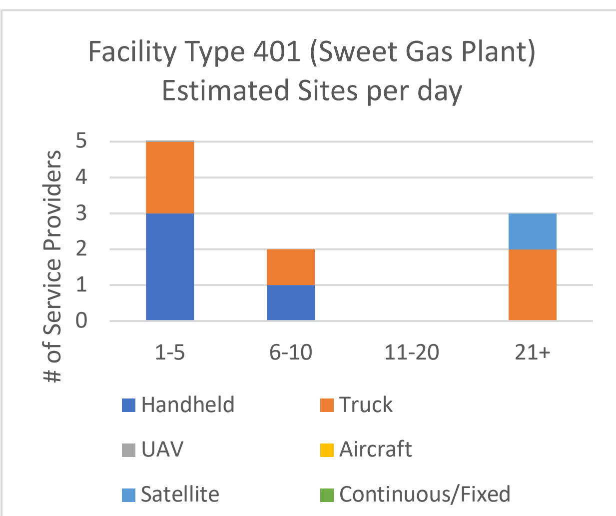

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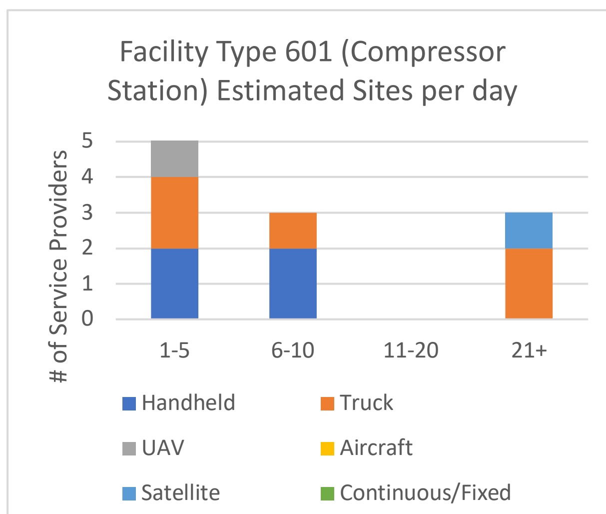


(d)

Figure 6 a/b/c/d: Estimated Site visits per day by site and technology type, n=12

With respect to crew capacity, 13 service providers that disclosed their current crew capacity, ranging from 1 field crew to 10 and shown below in Figure 7. Unfortunately, these same providers did not all disclose how many SWB facilities per day they would likely be able to average per crew. The service providers that disclosed this information can be seen in *Figure 8*. The service provider numbers (x-axis) match between Figure 7 and Figure *8*. Figure *8* however does not include the satellite technology sites per day, as they number into 1000's.

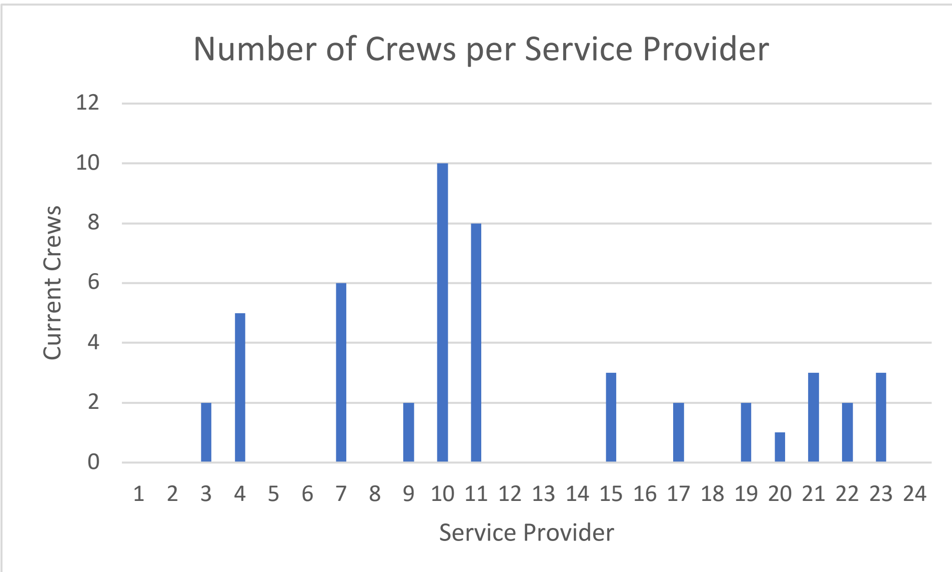


Figure 7: Number of Crews per Service Provider n = 13

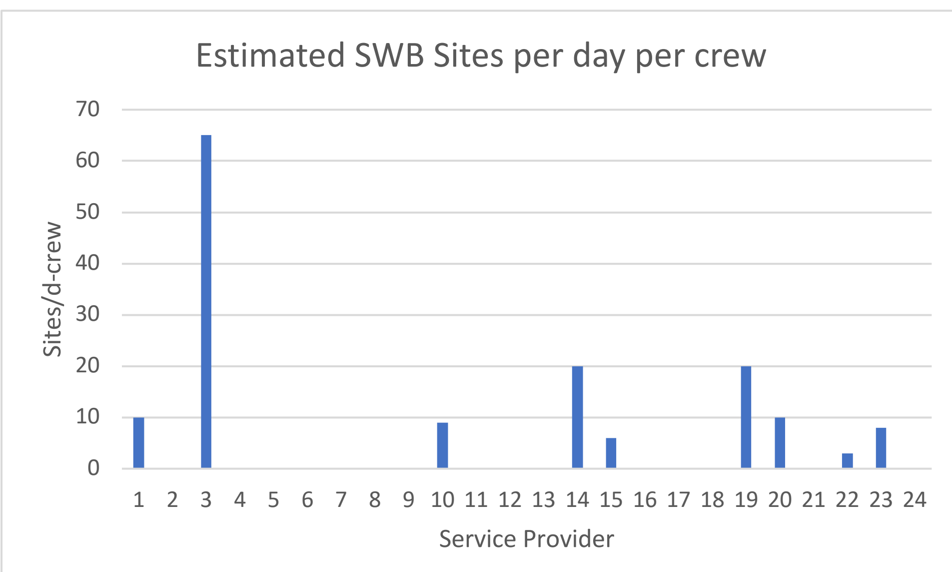


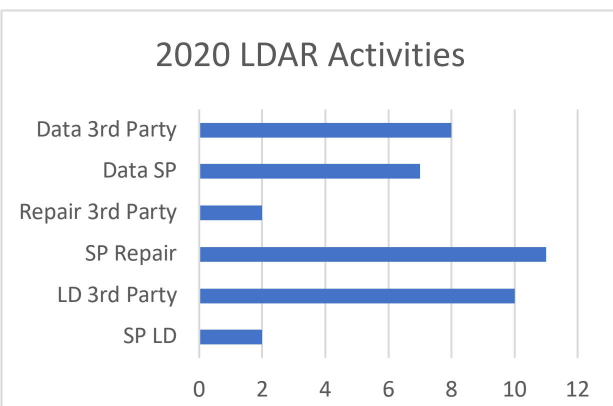
Figure 8: Estimated Sites per day per crew by Service Provider, n=10, satellite provider not shown (1000+ sites/day)

From these responses, we can generate a non-statistically valid estimate of the potential capacity of D60 compliant service providers to meet the LDAR requirements of duty holders. For purposes of this study, we will draw upon the responses of service providers 3, 10, 14, 19, 20, and 22. Multiplying their crews by their estimated sites/day-crew provides a total of 318 sites/d for all 6 service providers that provided responses. Notably, all 6 providers offer AER Directive 60 compliant methods (typically handheld OGI). Recalling from the Background Section that under D60 approximately 40,800 unique LDAR surveys are required every year in Alberta, we see that the combined daily productivity of just 6 D60 compliant service providers can conduct the required surveys in approximately 128 days (i.e., 40,800 sites/318 sites/day = 128 days).

Of the Alt-FEMP methods, there are 3 providers which indicated that they had the capacity to survey 9, 65, and 1000+ (satellite) sites per day per crew. Unfortunately, a similar "capacity" calculation cannot be conducted Alt-FEMP service providers as they cannot be taken on face value as offering equivalent reductions to D60 standard – handheld OGI.

Producer/Duty Holder/Midstream Operator Results

There was a total of 11 unique responses for the producer/duty holder/midstream operator questionnaire, available in Appendix G. All participants indicated that they had a FEMP program budget for 2021 planned with a variation of self-performance and 3rd party combinations. Figure 9 depicts a brief summary of respondents 2020 vs planned 2021 activities. Most activities stayed the same except one respondent who moved from self-performance of leak detection activities to 3rd party. The trend shows that respondents tend to participate in their data analysis and management (mostly in conjunction with a 3rd party) as well as perform most of the repairs, but the majority contract the leak detection portion to a 3rd party.



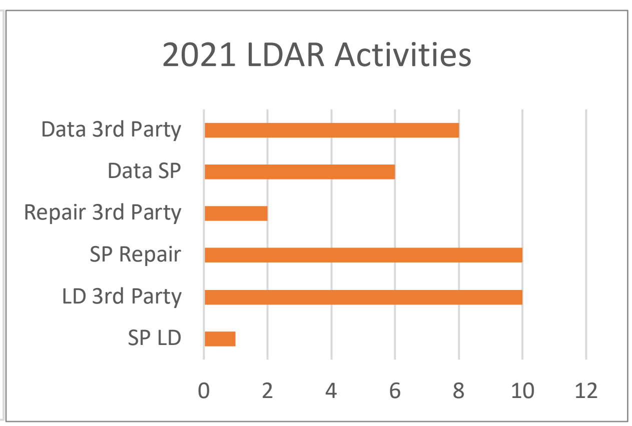


Figure 9: 2020 vs. 2021 LDAR Activity, Self-perform (SP) and/or third party for data analysis (DA), repair, and leak detection (LD). n = 13

For leak detection activities, all participants stated they used optical gas imaging (OGI) as a base, with some using Method 21 approved (other than OGI, 4 participants), and alt FEMP methods (5 participants) for their operations across Alberta. Only one participant disclosed that they owned 12 cameras and had their own personnel to perform leak detection. The majority indicated that they were in the process of applying for an Alt-FEMP pilot with the AER.

For 2021, 4 producers indicated that they are moving or have already moved to aerial and/or truck-based survey and ground-based OGI for follow up Alt-FEMP programs instead of the conventional OGI based survey. As far as supply, none of the producers indicated any difficulty in finding 3rd party leak detection and/or data analysis services; however, one producer indicated that they did not have resources to go from 3rd party to in-house leak detection. In addition, only one producer indicated further development for in-house leak detection operations.

Study Limitations

There are a few major potential limitations to this study as it was a voluntary participation questionnaire to industry. Some of the potential limitations are the following:

- Number of questionnaire participants,
- Ability and/or 'want' to disclose potentially sensitive business information,
- Representation of participants to overall market,
- And subjectivity of responses.

The number of questionnaire respondents for the producer / duty holder / midstream operator and service provider surveys were 11 and 24 unique responses, respectively. Although the service provider responses represented 24 out of 85 identified vendors (or 28%), questionnaire responses were incomplete for several questions which further reduces the sample size for individual survey questions and their capacity to represent their peers in a statistically robust fashion. The 10 producers (and one midstream operator) that responded to the questionnaire account for approximately 60% of Alberta's oil and gas production based on 2020 production numbers from year end reports. This represents the majority of the upstream industry by production and can allow for the approximation of the overall industry's demand for FEMP and Alt-FEMP programs either in-house or from service providers. That said, it is important to recognize that the capacity of small and mid-size producers and duty holders to either self-perform their LDAR activities or plan and execute an Alt-FEMP may be limited relative to the 11 survey respondents.

Discussion

The 24 participants in the service provider survey were approximately evenly split in offering FEMP (AER D60 compliant) and Alt-FEMP methods. This potentially shows that although conventional FEMP methods are readily available and likely thriving in the current market, there is large growth potential for Alt-FEMP methods pending successful applications with the AER.

Seeing as some Alt-FEMPs have already been approved or are in a trial phase, the likelihood of more Alt-FEMPs being approved in the future is high as technologies mature and offer savings in time and/or capital for producers.

Alt-FEMP methods typically have the advantage of being able to perform more surveys (sites/day) compared to conventional FEMP methods. This allows producers to potentially save a significant amount of time and capital should their Alt-FEMP method be approved. This may also be a driver for service providers to develop their own Alt-FEMP methods whether they be truck, drone, UAV, or satellite based. The challenge of most Alt-FEMP methods comes to determination of the properties of individual leaks whether that be the component source, flow rate, or fugitive vs. vent. OGI follow-up, consequently, becomes a necessity for the identification and repair fugitive and leaked emissions.

Many Alt-FEMP methods have challenges in more severe/heavy weather conditions which could be any individual or combination of rain, snow (falling and settled), and wind. These conditions can affect either the visibility of the gas, or the patterns of the emissions themselves which current technology has a difficult time circumventing. Additionally, road bans and winter-only access can be limiting factors for technologies requiring site access. Therefore, a significant portion of the year in Alberta is affected, winter months (~November to March), rainy season (portions of April - July), along with windy days throughout the year could make meeting regulatory requirements challenging as supply of FEMP and Alt-FEMP programs to all producers may be constrained at certain times of the year.

This study examined the supply of 6 providers for conventional FEMP methods, which roughly can equate to ~300 single well battery sites a day. If 6 providers can perform up to 300 sites per day and represent an approximate industry average, then it potentially stands to reason that the up to 30+ providers of FEMP services identified in the initial outreach phase could potentially survey 1500+ sites per day. This would cover all of Alberta's conventional LDAR needs (barring transportation to remote area time) in 1-2 months (accounting for m   ore time-consuming site/facility types) to fully survey the province. This simplified analysis, however, does not address factors such as difficulty of access, distance between sites, size of sites (e.g., SWB vs Gas processing facility) among other logistical challenges. It is this study's finding that the current supply of FEMP and Alt-FEMP providers is likely to satisfy current demand (based on ~26,000 potential sites requiring at least 1 time leak detection per year). Four of the service providers who indicated their projected growth over the next few years all responded that they were planning for significant expansion to 400, 3,000, 1,000, and 1,000 sites per day, totaling 5,400 sites/yr for 4 providers.

With respect to producers/duty holders, most producers plan to utilize 3rd party service providers to perform the leak detection portion of their FEMP/Alt FEMP programs. With a combined approach (for most) for data management and analysis, and mostly self-performing repairs. Only one producer of those surveyed plans to perform their leak detection activities in-house. These findings infer that the industry overall is likely to rely on service providers, and therefore it is likely that most Alberta sites which will require LDAR will contract a service provider for leak detection services. This causes a potential challenge with supply, as the service sector capacity to supply experienced, reliably performing FEMP and Alt-FEMP services will be limited in the first few years following the release of D60.

Currently, all approved, or Trial Alt-FEMP programs use the approach of a screening survey, followed by a handheld OGI follow-up on sites that trigger a certain emissions threshold. The screening survey is completed via a truck/drone/UAV technology, which can survey sites at a faster rate compared to conventional FEMP methods. These technologies and methods, following successful applications and trials with the AER, can expand the capacity of the market to perform FEMP and Alt FEMP programs. As more Alt-FEMP methods become approved, the potential strain on supply of service providers diminishes. Another potential benefit to Alt-FEMP programs is the ability to target high emission sites at a faster rate, thus reducing emissions at a faster rate compared to conventional FEMP programs.

Conclusions

The current capacity of service sector to meet needs of duty holders' FEMP programs is likely sufficient to satisfy the oil and gas industry's requirements in Alberta. We identified potentially 80+ service providers and have based this conclusion on the responses of only 24 service providers. Based on our service provider outreach and the survey results, it is evident that there is a wealth of competition in the FEMP/Alt-FEMP market. This is likely to bode well for duty holders regarding future access to and costs of LDAR services resulting in an greater ability to identify and mitigate methane emissions.

The producer/duty holder survey indicated that just less than half are in the process of-or are planning to move towards Alt-FEMP programs as they offer the promise of cost and time savings compared to conventional FEMP programs. This sends a strong signal to the AER, that compliance and cost-effectiveness are both desired ends for its duty holders.

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Appendix A: Service Provider Questionnaire

Questions will have a bracketed 3 number system highlighted in yellow for response rate of (X,Y,Z) where:
X = Response recorded
Y = No response due to NDA or other reason
Z = No response
Total respondents: 24

LDAR Feasibility Study: Invitation to Participate

Background: The Petroleum Technology Alliance of Canada (PTAC) through DXD Consulting Inc. and its academic research partner at the University of Calgary, is conducting a feasibility study to address the knowledge gap between methane leak detection technology testing and commercial implementation in upstream and midstream oil and gas operations in Alberta. It is widely anticipated by industry and regulators that "alternative" methane leak detection and repair (LDAR) service providers will be prepared and available for work in the first quarter of 2020. However, it remains unknown whether these companies can (1) mitigate fugitive emissions as well as Method 21 or OGI cameras, (2) do so at a lower cost, (3) work legally and safely in Canada, and (4) scale operations to conduct up to tens of thousands of surveys per year that may be required across Alberta, beginning in January 2020.

The LDAR Feasibility Study is designed to compile and assess comprehensive data on methane leak detection technology performance, costing, and scaling from all market-ready and prospective service providers and technology developers. On behalf of PTAC and its members, we invite your organization to complete the following questionnaire. This questionnaire solicits key commercial and technical details from solution providers intending (now or at a future date) to enter the Canadian LDAR market. All participant information and related responses will be anonymized and aggregated for reporting.

Participant Value Proposition: The results from the Feasibility Study will be used to develop LDAR field programs for deployment as early as 2020. This information-gathering stage of the pilot program will create a comprehensive database of available solutions, helping us to develop effective LDAR programs for upstream oil and gas producers and midstream operators. After conclusion of the study, the most promising companies may be approached for additional modeling, analysis, and deployment.

In addition, at the written request of a participant, PTAC (via its website and related information services) will publish a respondent's company name, contact information and link to the participant's corporate/product/service website – no other details will be provided. Notably, this will provide methane leak detection technology developers and vendors with exposure to upstream and midstream operators across Canada – a market of in excess of 40,000 facilities requiring LDAR services.

Commercial readiness: We strongly encourage a wide range of companies to participate, ranging from those with low commercial readiness or limited scalability to those who have many years of experience providing LDAR services. We are looking to the future, and it will be important to be on this list as we continue to grow and explore new and innovative LDAR programs.

Instructions: We encourage participants to be as detailed and honest as possible. Embellishing the performance or playing down the cost of services may heighten initial interest, but will lead to problems during testing and deployment and may ultimately damage your organization's reputation. Before starting, we encourage participants to review the following open-source article in the journal Elementa [link]. This brief article covers important definitions and concepts for those seeking participation in an Alt-LDAR economy. In particular, pay close attention to the definitions of leak detection *technologies*, *methods*, and *programs*.

Anonymity: The findings from this study will be synthesized and shared with oil and gas producers and may form the basis of a peer-reviewed publication in which all identifying information, trademarks, and any specified proprietary information will be anonymized.

Please complete the questionnaire by **SET DEADLINE**. Feel free to include any available evidence to support your application (e.g. independent controlled releases, sample data products, etc.) Note that if your organization has multiple stand-alone deployment methods, an individual questionnaire should be filled out for each of them. However, if multiple pieces of equipment or sensors make up a single method, a single questionnaire should be submitted for the method.

Questions regarding the program are welcome and can be directed to fempfeasibilitystudy@ptac.org

THE FOLLOWING WILL GO INTO AN ONLINE FORM (E.G. SURVEY MONKEY)

Application Information

Applicant Organization:

Applicant:

Contact Information:

Role:

Date:

Definitions

For the purpose of this study, we use the following definitions:

- fugitive emissions (i.e., leaks): unintentional releases of hydrocarbons from sources that should not be emitting (e.g. broken valves, flanges, etc.)
- vented emissions: intentional releases of hydrocarbons, typically in a controlled manner, resulting from normal process conditions
- technology: a gas sensing instrument, optionally configured with a deployment platform and/or ancillary instruments (e.g. anemometers, positioning), that can be used to gather data on emissions.
- method: combines a technology, a work practice, and analytics for use in an LDAR program. A method must clearly state any mandatory actions to be performed as part of the work practice, along with suitable operating conditions for the technology. These can include environmental conditions, limitations on facility-types, technology configurations, and survey procedure.
- LDAR program: the systematic implementation of one or more methods across a collection of assets. The program describes the method, or combination of methods, to be used for each facility, along with survey frequency, repair response, and reporting standards. Ultimately, it is the LDAR program that results in emissions mitigation, not the technologies or methods in isolation.

Survey and Data Management

Please confirm that your understanding that all data collected as a part of this study is anonymous (tick Y)

Please select "yes" if you wish for your organization to be publicly listed as a participant in this study. In this scenario, your organization would be identified as a participant that contributed data, but your organization's name is not associated with data you have submitted (anonymity is preserved) (tick Y/N)

General Information and Logistics

1. Does your organization have commercial LDAR surveying experience (*tick Y/N/NA/unknown/decline to answer*)? If yes, please describe (*text box*). (23/1/0)
2. Is your organization able (legally/logistically/etc.) to work in Canada (*tick Y/N/NA/unknown/decline to answer*)? (24/0/0)
3. Is your organization able (legally/logistically/etc.) to work in the US (*tick Y/N/NA/unknown/decline to answer*)? (24/0/0)

4. Please describe any safety concerns, risks, interruptions or annoyances possibly introduced by your product/service when completing LDAR surveys (*text box*). (22/0/2)
5. Has the recent COVID-19 outbreak and/or market conditions affected/will affect your operations? (*Y/N/NA/unknown/decline to answer*) (24/0/0)
6. Has the establishment of equivalency with federal methane regulations in Alberta and Saskatchewan affected your operations? e.g., scale, frequency, jurisdictions? Please comment if yes. (24/0/0)
7. Have methane-related Canadian provincial and federal programs affected your operations or planned operations? Please comment if yes. (23/0/1)
8. Is your method or technology compliant with AER Directive 60 leak detection methods (e.g., Method 21) or is it intended to be applied in an AltFEMP? (21/0/3)

Involvement in an LDAR program

9. Define your method in detail, including what equipment is used and how it is deployed. Points to address include (but are not limited to) (*text box*):
    a. Does your organization offer a technology or a method (see definitions)? (21/1/2)
    b. Does your organization offer a product, a service, or a combination? (21/1/2)
    c. Is the method mobile or stationary? (21/1/2)
    d. Does your method require site access, or does it measure remotely? (21/1/2)
    e. What deployment platform(s) is/are used? (for example: hand-held, aerial, truck-mounted, UAV, fixed sensor, portable and temporary on-site mount). If multiple deployment platforms are used, explain them all and how they work together. (22/0/2)
    f. What is the specific work practice? Be as detailed as possible. Examples may include, but are not limited to: (20/2/2)
        i. At what distances from source are measurements taken?
        ii. What sensors are employed and how?
        iii. How many people comprise one field crew? What are their roles?
        iv. How much time do is spent surveying each potential source?
        v. How much training are field staff required to have??
        vi. What output data are generated and reported?

10. LDAR programs are required to mitigate fugitive emissions (i.e. unintentional emissions). However, most sites in Alberta and elsewhere have legal venting (i.e. intentional

emissions), which often accounts for 50-90% of total site emissions. In order to reduce fugitive emissions, individual leaks (at the component scale) must be tagged for repair.

a. What scale(s) does your method target? Note that 'component' means inspectors can confirm, diagnose and tag individual leaks (*tick component, equipment, facility*)? (22/0/2)
b. Is your method able to distinguish vented from fugitive emissions (*tick Y/N/unknown/decline to answer*)? If yes, how (*text box*)? If not, how does it account for potential false positives (*text box*)? (21/1/2)
c. Does the work practice lead to diagnosis and tagging of individual leaks (*tick Y/N/NA/unknown/decline to answer*)?)? (22/0/2)
    i. If yes, how? Please describe in detail the process of going from measurement to tagging of leaks (*text box, or tick NA/unknown/decline to answer*).
    ii. If no, how does the information generated lead to the mitigation of fugitive emissions/leaks (*text box, or tick NA/unknown/decline to answer*)?
d. For methods that are unable to confirm and tag individual leaks (i.e. "screening" methods), please define any relevant follow-up work practices used. For example, are follow-up OGI crews sent to high-emitting sites to tag leaks? If so (*text box, or tick NA/unknown/decline to answer*): (19/3/2)
    i. What criteria are used to determine which sites receive follow-up visits? Examples could include (*text box, or tick NA/unknown/decline to answer*):
        1. Site-level emissions thresholds to trigger follow-ups (in which case, what thresholds are used?)
        2. Follow-up ratios, such that the top 50% of emitting sites surveyed in a day receive follow-up surveys (if so, what ratios are used?)
    ii. What do follow-up crews do onsite? For example, do they conduct classic facility-wide OGI surveys, looking for all leaks, or do they target large emitters? (*text box, or tick NA/unknown/decline to answer*):
        1. If following a non-standard work practice, what are the details?
        2. If not immediate, what is the time interval between screening measurement and follow-up tagging of leaks (in days). Please explain how this delay is estimated.

11. Is your organization currently a part of an Alternative FEMP Proposal to the AER, as described in the AER's *Submission Checklist for Directive 060: Alternative FEMP Proposals*? *(text box, or tick NA/unknown/decline to answer)* (20/2/2)

   a. If no, is your organization planning/intending to be involved in an Alternative FEMP Proposal in 2020? *(text box, or tick NA/unknown/decline to answer)*

Technical specifications

12. What is the methane sensor used? Where applicable, specify brand or type(*text box, or tick NA/unknown/decline to answer*): (18/4/2)
13. Does your surveying result in a quantified flow rate (*tick Y/N*)? If so:
    a. What are the minimum and maximum measurable flow rates of your method (SCFH)? (*text box, or tick NA/unknown/decline to answer*): (16/4/4)
    b. What is the median detection limit (i.e. the flow rate corresponding to a 50% detection probability)? (*text box, or tick NA/unknown/decline to answer.*): (12/3/9)
    c. What is uncertainty/quantification accuracy of flow rate estimates? (*text box*) (14/3/7)
    d. Are emissions quantified at the component, equipment or facility level? (*text box, or tick NA/unknown/decline to answer*): (18/0/6)
    e. Has your organization developed detection probability curves for your method? (*text box, or tick NA/unknown/decline to answer*) (15/4/5)
14. Does your method require environmental data? If so, what is it and how is it collected? (*text box, or tick NA/unknown/decline to answer*) (18/1/5)
15. Can your organization provide results from controlled release testing and/or field performance? If this information will be or has been published in academic papers, please indicate the paper/project. Please provide information on methods, e.g. Who conducted the testing? Was it performed indoors or outdoors? Under what range of environmental conditions? (*text box, or tick NA/unknown/decline to answer*) (13/3/8)
16. Has controlled release testing data or performance data on your organization's method been used in modelling or computer simulations? (*text box, or tick NA/unknown/decline to answer*) (13/3/8)

Environmental and operational constraints

17. Under what environmental and operational conditions does your organization not operate in the field (be specific)? (*text box*) (20/1/3)
18. What conditions affect your method's performance? For each condition, how is performance impacted? (*text box*) (20/0/4)
19. Please declare the following (qualifying responses if necessary): (20/2/2)

a. What is the range of temperatures where the technology is operational (max and min)? (enter range and units, or tick NA/Unknown/Decline to answer, comments box)
b. What is the range of wind speed where the technology is operational (max and min)? (enter range and units, or tick NA/Unknown/Decline to answer, comments box)
c. How much active rain is tolerated? (*tick none/light/medium/heavy*)
d. What is the maximum deployment humidity? (*enter number and units, or tick NA/unknown/decline to answer; comments box*)
e. How much falling snow is tolerated? (*tick category: none/light/medium/heavy; comments box*)
f. How much snow can be tolerated on the ground? (*tick category: none/patchy/thin cover/deep; comments box)*

20. How long does it take to deploy at the start of the day (exclude time spent driving to individual sites, if that is a part of the method)? *(enter number, in minutes)* (22/0/2)
21. How long is take-down at the end of the day (exclude time spent driving to individual sites, if that is a part of the method)? (*enter number, in minutes)* (22/0/2)
22. Is deployment required at each site? If so, how long does set-up/take-down take? (*enter number, in minutes)* (22/0/2)
23. From the day of measurement, what is the *guaranteed* reporting timeline (in days)? If multiple reports are generated/provided, please explain what information they contain, and the number of days required for delivery of each report. (*text box, or tick NA/unknown/decline to answer*) (20/1/3)
24. What is the factor most limiting to safe and efficient field performance leading to high-quality results? (*text box, or tick NA/unknown/decline to answer*) (20/1/3)

Scalability

25. What is your organization's approximate overall work capacity (number of facilities that can be surveyed per year)? (*text box, or tick NA/unknown/decline to answer*) (18/2/4)
26. How many independent crews fully equipped with deployment platform, sensor, and trained personnel are currently available for simultaneous deployment? (*text box, or tick NA/unknown/decline to answer*) (18/1/5)
27. How will the answers from questions 21-24 change over the next five years? (*text box, or tick NA/unknown/decline to answer*) (19/2/3)
28. What is your organization's capacity to scale operations to meet anticipated demands in Alberta (40 000+ facilities)? How long would it take and what are your biggest barriers to

scaling (e.g. investment, manufacturing of sensors, training of personnel) (*text box, or tick NA/unknown/decline to answer*) (17/4/3)

Cost – THIS SECTION IS OPTIONAL

29. What is your method's approximate all-inclusive cost per day (single value or range) in 2020 Canadian dollars (please state assumed currency exchange if Canada is not your host country) under typical operating conditions in areas with facility densities up to 0.5/km^2? (*text box, or tick NA/unknown/decline to answer*) (7/13/4)

30. How would this cost per day change if your organization is contracted for multiple days, weeks, months, or years? (*text box, or tick NA/unknown/decline to answer*) (12/8/4)

31. Please complete the table below, to show costing (*optional*) and productivity for each type of site. Costs (*if supplied*) should be all-inclusive (i.e., include management, preparation, mobilization, field expenses, materials and reporting.) Please note the units requested in the headings of the columns. Use the following assumptions: (15/2/7)
    a. LDAR surveying of 2,000 sites, made up of these facility subtype codes. The percentage of each facility subtype code should not dramatically impact your estimates, given the request is for costs on a per facility subtype code basis. Number of sites is communicated largely for an understanding of the size of the program and the economies of scale that can be achieved.
    b. The sites are all located in central Alberta, in an area spanning approximately 1,000 KM N-S by approximately 600 KM E-W

(fillable table with comments box)

Alberta Energy Regulator Facility subtype code	Description (Full descriptions of AER facility subtype codes can be found the AER Manual 11)	*Cost (CAD)/site (single value or range)* ***Optional***	Time to survey in minutes (not including time spent between sites) (single value or range)	Productivity (sites per day per crew, including time spent offsite) (single value or range)
311/351	Single-well battery			

321/361	Multi-well group battery			
401	Gas plant – sweet			
601	Compressor station			

Final Comments

32. Are you interested in being contacted for future research, including potential field campaigns (*tick Y/N*)?

As a reminder, the objectives of the application are to understand:

1. Capacity to mitigate emissions
2. Cost of services
3. Ability to work legally and safely in Canada
4. Work capacity and ability/intent to scale operations (in 2020, 2021 and beyond 2021)

If you have any further information that you would like to provide in fulfilment of one of these objectives, we welcome any further information you can provide, alongside the reminder that questionnaire data released publicly will be aggregated and anonymized.

(*text box*)

Files and supplementary information that exceed the space available here may be sent to: fempfeasibilitystudy@ptac.org

Files and supplementary information that exceed the space available here may be sent to: fempfeasibilitystudy@ptac.org

Appendix B: Duty Holder Questionnaire

Questions will have a bracketed 3 number system highlighted in yellow for response rate of (X,Y,Z) where:

X = Response recorded

Y = No response due to NDA or other reason

Z = No response

Total respondents: 11

LDAR Feasibility Study: Invitation to Participate

The School of Public Policy, University of Calgary, working in collaboration with DXD Consulting Inc. is studying the feasibility of regulatory-compliant and alternative Fugitive Emissions Management Programs (FEMPs and Alt-FEMPs) in Alberta. This project addresses the knowledge gap between technology testing and implementation. The LDAR Feasibility Study is designed to compile and assess comprehensive data on technology performance, costing, and scaling from all market-ready and prospective service providers.

The study will survey (1) alternative leak-detection suppliers; (2) optical gas imaging suppliers; (3) upstream producers; and (4) midstream facilities/pipelines.

As part of this study, we are soliciting information from oil and gas producers to evaluate the extent to which they intend to internalize regulatory and alternative Fugitive Emission Management Programs (FEMPs) (i.e., self-performed leak detection), rather than rely on hired third-party services. For the purposes of this study, self-performing LDAR means that your organization is planning to purchase all the necessary equipment and have employees conduct LDAR surveys.

The Petroleum Technology Alliance of Canada (PTAC) is funding this study, under grant XXXXX.

Results will be presented in a report and summary PowerPoint presentation and report to PTAC.

Questions should be directed to Mr. Wes Funk, Principal Investigator, at wes.funk@dxdconsulting.com or (403) 830-4715.

Thank-you for your time and contribution to this study. We look forward to disseminating the results.

Participant Information

Organization:
Name:
Contact Information:
Role:
Date:

Survey Questions

1. Does your organization intend to self-perform leak detection and repair (LDAR) in 2020?
   RESPONSES: [tick: *yes/no/unknown/haven't decided/decline to answer*]
   (11/0/0)

   BRANCH

   a. If answer to Q1 is *yes/decline to answer*, "Please provide clarification on your organization's decision criteria to self-perform LDAR." Then proceed to....Q2
      RESPONSES: [text box; tick: *not applicable/decline to answer/unknown*]
   b. If Q1 was Yes, "What percentage of LDAR surveys does your organization intend to self-perform?" (11/0/0)

   RESPONSES: [tick category: *1 – 25%, 25% - 50%, 50% - 75%, 75 – 99%, All, unknown, decline to answer*]

   c. If answer to Q1 is *no/haven't decided/unknown*, Proceed to Q2
2. Did your organization successfully apply for the Baseline and Reduction Opportunity Assessment Program (BROA) for 2020/21? (11/0/0)
3. What is the approximate number of assets licensed to your organization that will be subject to the Government of Canada's methane regulations for the upstream oil and gas sector (SOR/2018-16)? (5/2/4)
   RESPONSES: [text box to enter number; tick: *decline to answer/unknown*]

4. What is the approximate number of assets licensed to your organization that are subject to the Alberta Energy Regulator's methane regulations? (5/0/6)
   a. *Directive 060: Upstream Petroleum Industry Flaring, Incinerating, and Venting*?
      RESPONSES: [text box to enter number; tick: *decline to answer/unknown*]
   b. *Directive 017: Measurement Requirements for Oil and Gas Operations*)?
      RESPONSES: [text box to enter number; tick: *decline to answer/unknown*]

5. Does your organization intend to use Method 21 (https://www.epa.gov/sites/production/files/2016-06/documents/m-21.pdf), Optical Gas Imaging (OGI) cameras, an alternative method/program, or some combination in 2020? Select all that apply. (11/0/0, also for responses for OGI, Method 21, and Alt-FEMP sections below)
   RESPONSES: [tick all that apply: *Method 21, OGI, Alternative Methods*)?
   a. If a combination, please describe. Include which alternative methods.
      RESPONSES: [text box or tick: *not applicable/unknown/decline to answer*].

BRANCH

a. If answer to Q5 includes selection of OGI, respondent completes OGI sub-section
b. If answer to Q5 includes selection of Method 21, respondent completes Method 21 sub-section
c. If answer to Q5 includes selection of Alternative methods, respondent completes alternative sub-section
d. If answer to Q5 is *not applicable/decline to answer/unknown*, proceed to …

OGI sub-section

1. Responses to previous questions suggest your organization will use OGI cameras in some capacity to comply with Canadian and Albertan methane regulations.
    a. How many cameras does your organization currently own? (6/1/4)
    RESPONSE: [text box to enter number or tick: *unknown/decline to answer*]
    b. Does your organization intend to purchase more OGI cameras? (5/0/6)
    RESPONSE: [tick: *Yes/No/Not applicable/unknown/decline to answer*]
    c. *If Q1b is Yes*: If so, how many and by when?
    RESPONSE: [text box or tick: *Not applicable/unknown/decline to answer*]

2. How many trained OGI inspectors does your organization employ?
RESPONSE: [text box or tick: *Not applicable/unknown/decline to answer*]

3. Does your organization intend to employ more or train more employees in OGI inspection?
RESPONSE: [tick: *Yes/No/Not applicable/unknown/decline to answer*]
    a. *If Q3 is Yes*: If so, how many and by when?
    RESPONSE: [text box or tick: *Not applicable/unknown/decline to answer*]

Method 21 sub-section

1. Responses to previous questions suggest your organization will use Method 21 (https://www.epa.gov/sites/production/files/2016-06/documents/m-21.pdf) in some capacity to comply with Canadian and Albertan methane regulations. How many trained Method 21 inspectors does your organization employ? (3/1/0)
RESPONSE: [text box or tick: *Not applicable/unknown/decline to answer*]

2. Does your organization intend to employ more or train more employees in Method 21 inspection?
RESPONSE: [tick: *Yes/No/Not applicable/unknown/decline to answer*]
    a. *If Q2 is Yes*: If so, how many and by when?

RESPONSE: [text box or tick: *Not applicable/unknown/decline to answer*]

Alternative method sub-section

1. Responses to previous questions suggest your organization will use alternative methods or technologies (e.g., other handheld technologies, alternative practices) in some capacity to comply with Canadian and Albertan methane regulations. If your organization intends to self-perform alternative LDAR, please provide a high-level overview of the program it intends to implement.
   RESPONSE: [text box or tick: *Not applicable/unknown/decline to answer*]
   a. What deployment platform(s) will your organization use? (5/0/2)
      RESPONSE: [text box or tick: *Not applicable /unknown/decline to answer*]
   b. What labour or equipment limitations is your organization facing, and do you anticipate that they will be resolved?
      RESPONSE: [text box or tick: *Not applicable /unknown/decline to answer*]

2. How many trained alternative-method inspectors does your organization employ?
   RESPONSE: [text box or tick: *Not applicable/unknown/decline to answer*]

3. Does your organization intend to employ more or train more employees in alternative inspection methods?
   RESPONSE: [tick: *Yes/No/Not applicable/unknown/decline to answer*]
   a. *If Q3 is Yes*: If so, how many and by when?
      RESPONSE: [text box or tick: *Not applicable/unknown/decline to answer*]

4. Has your organization prepared an alternative fugitive emission management program (FEMP) proposal, as described in the AER's *Submission Checklist for Directive 060: Alternative FEMP Proposals*, or does your organization intend to prepare a proposal in the future (please state expected timeframe e.g., 6 months, 12 months etc.)? (10/0/1)
   RESPONSE: [text box or tick: *Not applicable/unknown/decline to answer*]

End of survey

1. Is your organization interested in being contacted to share the research outputs?
   RESPONSE: [tick *Y/N*]

As a reminder, the objectives of the research project are to understand:

- Demand for emissions-reducing technologies and methods
- Capacity to mitigate emissions
- Cost of services
- Ability to work legally and safely in Canada/Alberta
- Work capacity and ability/intent to scale operations (in 2020, 2021 and beyond 2021)

- Uncover lesser known service providers via a larger network of respondents

If you or your organization have any further information that you would like to provide in fulfilment of one of these objectives, we welcome any further information you can provide, alongside the reminder that questionnaire data released publicly will be aggregated and anonymized.

RESPONSE: [text box]

Appendix C: Service Provider Contact List

Organization	Name	Phone	E-mail
Advisian			ERIC.JOHNSON@advisian.com
Aerodyne Research		(978) 663-9500	info@aerodyne.com
AGAT			
Altomaxx Technologies	Sent to contact us form on website	1 833 258-6629	jared@altomaxx.com
Bravo Target Safety		(403) 264-1160	info@bravotarget.ca
Bridger Photonics	Ben Losby	(406) 585-2744	Ben.Losby@bridgerphotonics.com
Bureau Veritas	Shawn Miner		shawn.miner@bvlabs.com
Calvin Consulting Group Limited		(403) 547-7557	info@calvinconsulting.ca
Canadian Infrared Ltd.	Gord Gonie	(587) 988-1498	gord@canadian-infrared.ca
Clearstone Engineering	Yori Jamin		yori.jamin@clearstone.ca
Dapenco Inc.		(403) 869-7368	info@dapenco.ca
Davis Safety Consulting	Josh Clarke		jclarke@davissafety.ca
Digital IR Technologies	Rodger Legault	(250) 257-0092	rodger.legault@digitalir.ca
Edmonton Valve & Fitting	Andrew Beliveau		Andrew.beliveau@edmontonvalve.com
Emission Monitoring Service Inc.		(281) 628-7800	
Enviro Trace Ltd		(780) 418-0882	info@envirotrace.ca
Eosense	Colleen Gosse		colleen@eosense.com
Flux Lab	Dave Risk (St. Francis Xavier University) Chelsea Hall, PMP	(902) 867-4854 (902) 867-5282	drisk@stfx.ca chall@stfx.ca
Frostbyte Consulting		(403) 370-9675	info@frotbyteconsulting.com
GAS Recon Inc	Vic Kelly	1 (403) 693-2691	vic.kelly@gasrecon.ca
Gas Track Engineering	Jason Paziuk	(780) 228-1080	jp@gastrack.ca
GHG Sat	David Wares		david.wares@ghgsat.com
Greenpath	Mike D'Antoni		mdantoni@greenpath.ca janhalt@greenpathenergy.com
Grey Owl Engineering		(403) 266-5810	hello@greyowleng.com
Grid Environment Ltd.		(587) 226-0268	info@gridenvironmental.com

		(306) 910-3378	
Heat Seeking Thermal Imaging Ltd.		(403) 329-1539	info@heatseeking.ca
Heath Consultants	Kevin Bendele		k.bendele@heathus.com
Hetek Solutions	Ashwin Mohan		ashwin.mohan@hetek.com
Highwood Emissions Management	Thomas Fox		thomas@highwoodemissions.com
Infratech Corporation		(780) 778-4226	sales@infratech.cc
Integra Technologies	Shalayne Martens	(780) 670-3994	smartens@integratechnologies.com
Intelliview Technologies		(403) 338-0001	
Ion Engineering		(587) 689-2039	info@ionengineering.ca
IRT Consult Inc.	Darren Whyte	353 (0) 89-457-7198	info@irt.ie
Kuva Systems		(617) 925-0480	info@kuvasystems.com
LiDAR Services International Inc.		403-517-3130	info@lidarservices.ca
LineRiders Inc.	Phil McNeil	(780) 518-5356	phil@lineriders.ca
Matrix Solutions Inc.		(403) 237-0606	info@matrixsolutions.com
Montrose Environmental Group	Montrose acquired Target in 2019		
Noralta	Nathan Bender, Technical Operations Corey Hegseth, COO Field Operations	(403) 462-5093 (306) 461-6637	
North Shore Environmental Consultants	Cody Halleran	(403) 228-3095	
Optimum Results		1-403-633-0589	doug@optimumresults.ca
Pace Technologies		(403) 580-0770	https://www.pacetechnologies.com/contact
Qube	Carol Elliot Eric Wen		Carol.elliott@qubeiot.com Eric.wen@qubeiot.com
Resolve Energy Solutions	James Garten	(250) 263-9434	jgarten@resolvesolutions.ca
RJA Contracting Ltd		403 391-3493	Only facebook page, no emails found
SeekOps	Paul Khuri		pkhuri@seekops.com
SensorUp Inc.			info@sensorup.com
SolutionCorp Inc.		(403) 742-0123	

Step Engineering		(403) 476-9560	info@step-eng.com
Target	Imran Nurani		nurani@targetemission.com
The Sniffers (Keneco Environmental in Canada?)	Kevin Kropf Troy Wawrinchuk		kevin.kropf@the-sniffers.com twawrinchuk@kenecoenviro.com
Thermal Scan Ventures	Ryan Wetherill Murray Handfield	(250) 782-0976 (250) 784-5447	thermal@pris.ca
Vertex Resource Group Ltd.	Dani Urton (female)		
WSP			
AROlytics			liz.oconnell@arolytics.com
UofC POMELO			tbarchyn@ucalgary.ca
GeoVerra	Jennifer Baillie		adrienne.maskalyk@geoverra.com jennifer.baillie@geoverra.com
ESRI			leads@esri.ca
Deloitte			
Tetratech		4037236879	kim.baker@tetratech.com
Clarifi?	Sent to contact us form on website		
Envirosoft?	Sent to contact us form on website		
ABB Los Gatos	Sent to contact us form on website		doug.s.baer@us.abb.com
Avitas	Sent to contact us form on website		
Bruker Scientific	Sent to contact us form on website		
FLIR/Providence Photonics	Sent to contact us form on website		
Fluke	Sent to contact us form on website		canadaservice@fluke.com
IC-More	Can't find website, (Defence/Security company??)		
Kairos	Sent to contact us form on website		info@kairosaerospace.com
Nexus Space			INFO@NEXUSSPACE.NET
Project Canary	Found no contact info other than phone # on site		
Prosaris	Contact Form & Info e-mail		csewell@prosaris.ca
QLM technology Ltd.	Only e-mail on website (		doug@qlmtec.com
Rebellion Photonics	Links to Honeywell, link is dead?		info@rebellionphotonics.com
Scentroid	E-mail provided (Craig Louks)		craig.l@scentroid.com

Scientific Aviatino	All Contacts - Michael Conleyt is General Counsel, Stephen Conley is President & CEO	mconley@scientificaviation.com sconley@scientificaviation.com
Sensit	jscottk is CEO	jscottk@gasleaksensors.com
SM Instruments	Can't find website or company	
Wyvern Space	Can't find website or company	
Picarro	info@picarro.com	info@picarro.com
Aeris Technologies	Sent to contact us form on website	
Bluefield	Sent to contact us form on website	i@bluefield.co
MethaneSAT	Sent to contact us form on website	

Appendix D: Duty Holder and Midstreamer Contact List

Company Name	Main Contact Name	Role	E-mail
Advantage Oil & Gas Ltd.	Reg Beck	Director HSE and Regulatory Compliance	rbeck@advantageog.com
Alliance Pipeline Ltd.	Daryl Bailey	Facility Project Engineer	daryl.bailey@alliancepipeline.com dbailey@alliancepipeline.com
ATCO	Kym Fawcett	HSE & Quality Director	kym.fawcett@atco.com kymfawcett@atco.com
Baytex Energy Corp.	Anthony Traverse	Sr. Environmental Coordinator	Anthony.Traverse@baytex.ab.ca
Black Crane Energy Corp.	Too small		
Canlin Energy Corporation	Julie Oxtoby	Senior Regulatory and Environmental Advisor	julie.oxtoby@canlinenergy.com
Cardinal Energy Ltd.	LinkedIn Request		
Chevron	Paul Dziuba	Environmental Specialist	pdziuba@chevron.com
CNOOC Petroleum North America ULC	Adam Judd referred Chris Kellerman		Chris.Kellerman@intl.cnoocltd.com
CNRL	Richelle Foster	Project Engineer	richelle.foster@cnrl.com
ConocoPhillips	Julie Dalzell	Senior GHG Coordinator	julie.a.dalzell@conocophillips.com
Crescent Point	Morgan Reid		
Ember Resources Inc.	Bryce Watson	Environmental/Regulatory Coordinator	bwatson@emberresources.com
Encana	Moruf Aminu		moruf.aminu@encana.com
Enerplus	Lisa Studzinski	Environmental Compliance Advisor	LStudzinski@enerplus.com
Harvest Operations Corp.	Pat Harrison	Senior Regulatory and Environmental Coordinator	pat.harrison@harvestenergy.ca
Inter Pipeline Ltd.	Audra Papp Salima Loh	EHS & Sustainability Manager	audra.papp@interpipeline.com salima.loh@interpipeline.com
Keyera	Kerri Gilders	Environment and Regulatory Director	kerri_gilders@keyera.com
NAL/Whitecap	Patrick Kitchen		
Obsidian Energy Ltd.	Steve Sterling	President and Chief Executive Officer	steve.sterling@obsidianenergy.com
Ovintiv (previously Encana)	Filiz Onder	Air Compliance Manager	filiz.onder@encana.com

Pacific Canbriam	Dave Webster?	Operations/HSE/Integrity Manager	
Paramount Resources Ltd.	Leili Chepelkevitch	Sr. environmental representative	leili.chepelkevitch@paramountres.com
Pembina Pipeline Corporation	Jeff Hamilton	Senior Environmental Advisor	JHamilton@pembina.com <JHamilton@pembina.com>
Perpetual Energy Inc.	Darren Gramlich	Surface Land Manager	Darren.Gramlich@perpetualenergyinc.com
Petrochina Canada	Devin Newman	Regulator, Land & Stakeholder Affairs Director	Devin.Newman@PetroChinaCanada.com
PETRUS RESOURCES CORP.	Neil Korchinski	President and Chief Executive Officer	nkorchinski@petrusresources.com
Plains Midstream Canada ULC	Chris Horne	HSE Director	chris.horne@plainsmidstream.com
Plains Midstream Canada ULC	Tom Knapik		tom.knapik@plainsmidstream.com
Repsol	Greg Unrau	Senior Environmental Coordinator	gunrau@repsol.com
Rife Resources Ltd.	Bob Lamond?		reception@rife.com
Seven Generations Energy Ltd.	Carolyn Pfau	Emissions Engineer	cpfau@7genergy.com
Shell	Bill Kovach rep Allison Fisher	Senior Air Specialist	Allison.Fisher@shell.com <Allison.Fisher@shell.com>
Strathcona Resources Ltd.	Megan Bowen	Environment and Sustainability Coordinator	
Suncor	James Beck		jbeck@suncor.com
Suncor	Rekha Nambiar		rnambiar@suncor.com
Syncrude	Michelle Velez	Bitumen Production Advisor	
TAQA North Ltd.	Tracy Yarrow Aileen Raphael Mark Stanley	President and Chief Executive Officer Engineer and Technical Sales	tracy.yarrow@taqa.ca aileen.raphael@taqaglobal.com mark.stanley@taqaglobal.com
TC Energy	Rob Cooney	Senior Environmental Advisor, Air Emissions at TC Energy	rob_cooney@tcenergy.com
TC Energy	Koray Onder		koray_onder@tcenergy.com
TC Energy	Neuczki Mathurin		neuczki_mathurin@tcenergy.com
TORC Oil and Gas Ltd.	Shelly Gerber	Operations Accounting Manager	sgerber@torcoil.com shelley.gerber@torcoil.com
Torxen Energy Ltd.	Holly MacDonald	Regulatory, Compliance and Environment Manager	holly.macdonald@tolko.com
Tourmaline	Dean Soucy?	HSER Manager	soucy@tourmalineoil.com

Trans Mountain Corporation	Margaret Mears Cyril Jenkins	Environment Manager Senior Director, EHS	cyril_jenkins@transmountain.com
TransGas Limited	Lori Parks	Manager, Environmental Protection at SaskEnergy	lori.parks@gs.gov.sk.ca
Trans-Northern Pipelines Inc.	Gail Sharko	Regulator & External Affairs Manager	gsharko@tnpi.ca
Vermilion	Robin Cole	Senior Environmental Coordinator	rcole@vermilionenergy.com
Vesta Energy Ltd	Mark Lansing	VP HSE & Sustainability	mark.lansing@vestaenergy.com mlansing@vestaenergy.com
Whitecap Resources Inc.	Patrick Kitchin	Director, Regulatory and Environmental Sustainability	pkitchin@wcap.ca
Wolf Midstream	Rebecca McAllister	HSE & Regulatory Coordinator	rmcallister@wolfmidstream.com
Yangarra Resources Ltd.	Jim Evaskevich Michael D'Entremont	President and Chief Executive Officer COO	trina@yangarra.ca michael.dentremont@yangarra.ca michael@yangarra.ca j.evaskevich@yangarra.ca

Vendor #1 Response

Collector: [redacted]

[redacted]

Page 2: Introduction

Q1

Contact Information (For Administrative Purposes Only - All Responses Are Anonymized)

Respondent Organization:	[redacted]
Respondent Name:	Vendor 1
Respondent Role:	[redacted]
E-mail:	[redacted]
Phone:	[redacted]
Website:	[redacted]
Response Date (yy/mm/dd):	[redacted]

Q2

Please confirm your understanding that all data collected as a part of this study are anonymous - check "Yes" to confirm.

Yes

Q3

Are you interested in being contacted for future PTAC methane emissions management research including, potential field campaigns?

Yes

Q4

Please indicate if you would like your organization to be publicly listed as a participant in this study. In this scenario, your organization would be identified as a participant that contributed data, but your organization's name is not associated with data you have submitted (data anonymity is preserved).

Yes

Page 3: General Information and Logistics

Q5

Does your organization have commercial LDAR surveying experience? If yes, please describe e.g., types of LDAR services provided, core markets (industry and/or locations), years of corporate experience with LDAR services.

Yes,

If yes, please describe::

We offer LDAR in the Oil and Gas industry across Western Canada. We currently use the FLIR IR camera technology with both a standard lens and telescopic lens for higher risk locations. Vendor 1 been in the leak detection industry since [redacted].

Q6

Does your organization participate in methane measurement markets outside of Alberta? If you intend to enter new methane measurement markets in 2021 or later please answer - Yes.

Yes

Q7

Is your organization able (legally/logistically/etc.) to work in Canada?

Yes

Q8

Is your organization able (legally/logistically/etc.) to work in the United States?

Yes

Q9

Please describe any safety concerns, risks, interruptions or annoyances (for duty holders/operators and/or local residents/communities) possibly introduced by your product/service when completing LDAR surveys (e.g., noise, airspace, road/site congestion).

There are no safety concerns with our current technology as it is a hand held device that is intrinsically safe. The only safety hazards are the one encountered while on the clients site eg: requirements for tight spaces, working at heights.

Q10

Has the COVID-19 outbreak and/or recent market conditions affected your operations re. LDAR services or is it expected to affect your operations? Please provide a comment if answering yes.

Yes, ongoing,

If Yes, please explain.:

The requirements for individual travel has increased our general cost to conduct our operations. Reduced budgets from clients has had the largest impact due to low oil prices and world wide demand.

Q11

Has the establishment of equivalency with federal methane regulations in Alberta and Saskatchewan affected your operations? e.g., scale, frequency, jurisdictions? Please comment if yes.

The larger demand has led to an increase in interest. We are still finding the larger corporations are purchasing their own equipment and incorporating it into their preventative maintenance plan.

Q12

Have methane-related Canadian provincial and federal programs affected your operations or planned operations? Please comment if yes.

We have increased our targeted business directed to LDAR as government programs have increased the requirement for testing.

Page 4: Leak Detection Service Description

Q13

Is your method or technology compliant with AER Directive 60 leak detection methods (e.g., Method 21) or is it intended to be applied in an AltFEMP?

AER Directive 60 Compliant / Method 21

Q14

Define your method in detail, including what equipment is used and how it is deployed. Points to address include (but are not limited to):

a. Does your organization offer a technology or a method?	**Technology and method**
b. Does your organization offer a product (for sale?), a service, or a combination?	**service**
c. Is the method mobile or stationary?	**mobile**
d. Does your method require site access or does it measure remotely?	**site access**

Q15

What deployment platform(s) is/are used? (for example: hand-held, aerial, truck-mounted, UAV, fixed sensor, portable and temporary on-site mount). If multiple deployment platforms are used, explain them all and how they work together.

We use a hand held platform that allows us to get as close as possible to the leak location. For harder to reach area we are able to use our high magnification lens to identify leak locations. We offer the ability to spot and record any leak locations in video form for our clients to ensure they are aware of the size and exact location of the leaks. We offer the ability to provide a post repair scan as well of the previously identified leaks.

Q16

What is the specific work practice associated with your methane leak detection method/technology? Several key elements of the work practice are listed below. Please add and comment on any others you feel are pertinent to your offering.

a. At what distances from source are measurements taken?	**N/A**
b. What sensors are employed and how?	**N/A**
c. How many people comprise one field crew? What are their roles?	**1 to 2**
d. How much time is spent surveying each potential source?	**2-5 mins**
e. How much training are field staff required to have?	**FLIR gasfind certification, 3-6 months hands on training (depending on number of scans)**
f. What output data are generated and reported?	**Location of leak, video and pictures of leak location, Leak identificatino tag**
Additional work practice details	**If requested a site walk through with operations indicating leak locations**

Q17

Has your method or technology been included in a successful AltFEMP proposal or application with a provincial regulator e.g., AER accepted Alternative FEMP Proposal, as described in the AER’s Submission Checklist for Directive 060: Alternative FEMP Proposals? If yes, please state the jurisdiction, regulator and scale of adoption by clients/duty-holder.

Decline to Answer

Page 5: Involvement in an LDAR Program

Q18

What scale(s) i.e., component, equipment, facility does your method/technology target? Note that ‘component’ means inspectors can confirm, diagnose and tag individual leaks.

Component,

Equipment,

Facility

Q19

Is your leak detection method/technology able to distinguish vented from fugitive emissions?

Yes,

If yes, how? If not, how does it account for potential false positives?:
Due to proximity of scanning, false positives are negligible.

Q20

Does the work practice lead to diagnosis and tagging of individual leaks?

Yes,

If yes, how? Please describe in detail the process of going from measurement to tagging of leaks. If no, how does the information generated lead to the mitigation of fugitive emissions/leaks?:

Each individual leak is tagged at the source with a bright yellow tag, with the Company Logo, technicians name, date, time and location of leak. We also provide the client with pictures and a video of the leak source to verify size of leak for the client.

Page 6: Leak Detection Service Description

Q21

For methods that are unable to confirm and tag individual leaks (i.e. “screening” methods), please define any relevant follow-up work practices used. For example, are follow-up OGI crews sent to high-emitting sites to tag leaks? (N/A, unknown, decline to answer)

N/A

Q22

What criteria are used to determine which sites receive follow-up visits? Examples could include:a. Site-level emissions thresholds to trigger follow-ups (in which case, what thresholds are used?)b. Follow-up ratios, such that the top 50% of emitting sites surveyed in a day receive follow-up surveys (if so, what ratios are used?)(N/A, unknown, decline to answer)

Follow up visits are at the request of the client based on on-site communications, reports and follow up calls with clients.

Q23

What are the roles/tasks of follow-up crews when onsite? For example, do they conduct classic facility-wide OGI surveys, looking for all leaks, or do they target large emitters?a. If following a non-standard work practice, what are the details?b. If not immediate, what is the time interval between screening measurement and follow-up tagging of leaks (in days). Please explain how this delay is estimated.(N/A, unknown, decline to answer)

Follow a standard work practice of scanning the reported leaks first, then will conduct a shorter general scan to ensure no new leaks were formed during the repair.

Page 7: Technical Specifications

Q24

What is the methane sensor that is used? Where applicable, specify brand or type.

N/A

Q25

Does your surveying result in a quantified flow rate? If no, please skip to next page.

No

Q26

What are the minimum and maximum measurable flow rates of your method (m3/day to align with AER regulations - please note if using another unit of measurement e.g., SCFH)? (N/A, unknown, decline to answer)

Respondent skipped this question

Q27

Please state its median detection limit (i.e. the flow rate corresponding to a 50% detection probability - please specify a corresponding distance and windspeed)? (N/A, unknown, decline to answer)

Respondent skipped this question

Q28

What is the uncertainty/quantification accuracy of flow rate estimates?

Respondent skipped this question

Q29

Are emissions quantified at the component, equipment or facility level? (N/A, unknown, decline to answer)

Respondent skipped this question

Q30

Has your organization developed detection probability curves for your method? (N/A, unknown, decline to answer)

N/A

Q31

Does your method require environmental data? If so, what types of data required and how are they collected?

Respondent skipped this question

Q32

Can your organization provide results from controlled release testing (CRT) and/or field performance? Please provide information on methods (e.g. Who conducted the testing? Was it performed indoors or outdoors? Under what range of environmental conditions?)If this information will be or has been published in academic papers, please indicate the paper/project. (N/A, unknown, decline to answer)

Respondent skipped this question

Q33

Has controlled release testing data or performance data on your organization's method been used in modelling or computer simulations? Were the model results used for AltFEMP proposals (N/A, unknown, decline to answer)

Respondent skipped this question

Page 8: Environmental and Operational Constraints

Q34

Under what environmental and operational conditions does your organization not operate in the field (please provide specifics)?

Under high wind conditions, extreme cold

Q35

What environmental conditions affect your method's performance (e.g., temperature, precipitation, wind)? For each condition, how is performance impacted?

Extreme cold - affects the quality of the scan
Wind- Due to open atmosphere of most locations it affects the ability for a proper scan as leaks can be missed due high wind sweeping across leak location, could indicate a smaller leak than the actual size.

Q36

Please declare the following (qualifying responses if necessary) (N/A, unknown, decline to answer where necessary):

What is the range of temperatures where the technology is operational (°C, max and min)?	**-15 - +40**
What is the range of wind speed where the technology is operational (kmph, max and min)?	**N/A**
How much active rain is tolerated (None, light, medium, heavy)?	**medium**
What is the maximum deployment humidity (%)?	**20-80%**
How much falling snow is tolerated (none, light, medium, heavy)?	**medium**
How much snow can be tolerated on the ground (none, patchy, thin cover, deep)?	**thin cover**

Q37

How long does it take to deploy at the start of the day (exclude time spent driving to individual sites, if that is a part of the method) in minutes?

15 mins

Q38

How long is take-down at the end of the day (exclude time spent driving to individual sites, if that is a part of the method) in minutes?

15 mins

Q39

Is deployment required at each individual site? If so, how long does set-up/take-down take (in minutes)?

yes, Set up 15 mins - take down 15 mins (excluding permitting)

Q40

From the day of measurement, what is the guaranteed reporting timeline (in days)? If multiple reports are generated/provided, please explain what information they contain, and the number of days required for delivery of each report. (if a null response please enter N/A, unknown, decline to answer)

Guaranteed report is delivered in 5 days upon completion of the entire project

---

Q41

What is the factor most limiting to safe and efficient field performance leading to high-quality results? (if a null response please enter N/A, unknown, decline to answer)

Field Location hazards eg: working at heights, H2S release, confined space, slips/trips/falls

---

Page 9: Supply and Scalability of Service Offering

Q42

Using single-well batteries as a baseline, approximately how many facilities can each crew inspect in a typical day, week, month, and/or year? (if a null response please enter N/A, unknown, decline to answer)

2-3 single well batteries per day depending on size of battery

---

Q43

How many independent crews fully equipped with deployment platform, sensor, and trained personnel are currently available for simultaneous deployment? (if a null response please enter N/A, unknown, decline to answer)

[redacted]

Q44

What is your organization's capacity to scale operations to meet your planned/desired market share of leak detection demand in Alberta? Using single well batteries to normalize site counts, how many do you project your operation to service in 2021, 2022, 2023 at 1 event per year (if this measurement of frequency doesn't apply to your method please explain)? (if a null response please enter N/A, unknown, decline to answer)

unknown

Q45

How many quarters in 2021 or years (if beyond) 2021 do you believe it will take to scale your operation to planned capacity based on projected market conditions?

currently capable of meeting current demands

Q46

Does your organization expect any changes in its overall work capacity (e.g., number of crews, equipment stock, etc.) in the next 5 years? (N/A, unknown, decline to answer)

unknown with the goal to increase work capacity [redacted]

Q47

What are your biggest barriers to scaling (e.g. investment, manufacturing of sensors, training of personnel)?

Entry into market share and competition.

Page 10: Productivity and Cost (Optional):

Q48

What is your method's approximate all-inclusive cost per day (single value or range) in 2021 Canadian dollars (please state assumed currency exchange if Canada is not your host country) under typical operating conditions in areas with facility densities up to 0.5 per square km? (if a null response please enter N/A, unknown, decline to answer)

[redacted]

Q49

How would this cost per day change if your organization is contracted for multiple days, weeks, months, or years? (N/A, unknown, decline to answer

unknown

Page 11: Productivity and Cost (Optional):

Q50

Approximately how many sites/day/crew can your technology/method survey for AER Facility Subtype 311/351 (Single well)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

1-5,
Survey time per site, cost per site (optional), and additional comments::
2-10 hours per site depending on variables in testing, number of leaks recorded, site locations, permitting requirements, difficult testing areas

Q51

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 321/361 (Multi-well group battery)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

1-5,
Survey time per site, cost per site (optional), and additional comments::
2-10 hours per site.

Q52

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 401 (Gas Plant - Sweet)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

1-5

Q53

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 601 (Compressor Station)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

1-5

Q54

If your technology or method is not readily quantified using the 4 questions above, please describe your approach to capturing and conveying leak detection efficiencies to your clients (duty holders) and the indicative performance.

Respondent skipped this question

Page 12: Data Management

Q55

Have LDAR-based data management services been a core requirement of your client/s?

No

Q56

Have your clients set specific requirements regarding data management, quality assessment/control, other requirements? Please explain if possible.

N/A

Q57

What LDAR-based data management services does your organization offer?

N/A

Vendor #2 Response

[redacted] [redacted]

Page 2: Introduction

Q1

Contact Information (For Administrative Purposes Only - All Responses Are Anonymized)

Respondent Organization:	[redacted]
Respondent Name:	Vendor 2
Respondent Role:	[redacted]
E-mail:	[redacted]
Phone:	[redacted]
Website:	[redacted]
Response Date (yy/mm/dd):	[redacted]

Q2

Please confirm your understanding that all data collected as a part of this study are anonymous - check "Yes" to confirm.

Yes

Q3

Are you interested in being contacted for future PTAC methane emissions management research including, potential field campaigns?

Yes

Q4

Please indicate if you would like your organization to be publicly listed as a participant in this study. In this scenario, your organization would be identified as a participant that contributed data, but your organization's name is not associated with data you have submitted (data anonymity is preserved).

Yes

Page 3: General Information and Logistics

Q5

Does your organization have commercial LDAR surveying experience? If yes, please describe e.g., types of LDAR services provided, core markets (industry and/or locations), years of corporate experience with LDAR services.

Yes,

If yes, please describe::

[redacted] developed and commercialized a vehicle-based solution for Advanced Leak Survey for natural gas pipelines which is currently used for compliance leak survey at a number of LDCs around the world as well as for leak detection and leak emissions rate quantification in downstream/midstream/upstream gas operations.

Q6

Does your organization participate in methane measurement markets outside of Alberta? If you intend to enter new methane measurement markets in 2021 or later please answer - Yes.

Yes,

If yes, which markets? (Optional):

[redacted]

Q7

Is your organization able (legally/logistically/etc.) to work in Canada?

Yes

Q8

Is your organization able (legally/logistically/etc.) to work in the United States?

Yes

Q9

Please describe any safety concerns, risks, interruptions or annoyances (for duty holders/operators and/or local residents/communities) possibly introduced by your product/service when completing LDAR surveys (e.g., noise, airspace, road/site congestion).

The system is vehicle-based and data is collected generally at night on roads or easements near gas assets. This generally does not cause significant safety issues or annoyances, however.

Q10

Has the COVID-19 outbreak and/or recent market conditions affected your operations re. LDAR services or is it expected to affect your operations? Please provide a comment if answering yes.

Yes, ongoing,

If Yes, please explain.:

On-site installation and training and support of our customers has been hindered by covid and remote or online solutions have had to be implemented.

Q11

Has the establishment of equivalency with federal methane regulations in Alberta and Saskatchewan affected your operations? e.g., scale, frequency, jurisdictions? Please comment if yes.

No.

Q12

Have methane-related Canadian provincial and federal programs affected your operations or planned operations? Please comment if yes.

No.

Page 4: Leak Detection Service Description

Q13

Is your method or technology compliant with AER Directive 60 leak detection methods (e.g., Method 21) or is it intended to be applied in an AltFEMP?

AltFEMP

Q14

Define your method in detail, including what equipment is used and how it is deployed. Points to address include (but are not limited to):

a. Does your organization offer a technology or a method?	**Both**
b. Does your organization offer a product (for sale?), a service, or a combination?	**All of the above**
c. Is the method mobile or stationary?	**Mobile**
d. Does your method require site access or does it measure remotely?	**Remote but must be within 150m minimum to measure.**

Q15

What deployment platform(s) is/are used? (for example: hand-held, aerial, truck-mounted, UAV, fixed sensor, portable and temporary on-site mount). If multiple deployment platforms are used, explain them all and how they work together.

Both vehicle-based and handheld systems can be used. The vehicle-based systems drive in areas where there are gas assets, collecting methane, ethane, wind and GPS data. In a typical distribution system, a total of six passes on each street, over at least two nights, are undertaken. After the drives are complete, Vendor 2 combine the data, removing non-natural gas indications, combining coincident leak indications, and calculating the resulting Field of View (FOV) coverage area. In an area where methane is detected, a leak indication is shown, and a search area is computed from the wind direction and variability – the software highlights the pipeline GIS assets requiring follow-up on foot to locate and grade the leak(s) using traditional ppm-level equipment or Picarro's handheld sensor. The measured ethane content of the gas is also used to determine the confidence level of the gas being from a natural gas leak or not. [redacted]

Q16

What is the specific work practice associated with your methane leak detection method/technology? Several key elements of the work practice are listed below. Please add and comment on any others you feel are pertinent to your offering.

a. At what distances from source are measurements taken?	**From <1m to >150m**
b. What sensors are employed and how?	**Vendor 2's patented [redacted] measure methane in the ambient air as the vehicle passes through plumes from leaks.**
c. How many people comprise one field crew? What are their roles?	**One driver per vehicle and later, one or more foot-based leak investigators.**
d. How much time is spent surveying each potential source?	**The car produces 2mi (plus associated services/assets up to 150m on either side of the vehicle path) of measured distribution mains per hour of driving. Each leak indication takes an average of 25 minutes to find and grade any leak(s).**
e. How much training are field staff required to have?	**Minimal training for driver, typical industry standard training duration for foot-based leak investigaiton personnel.**
f. What output data are generated and reported?	**GIS-based, digital outputs in various formats for FOV and leak indication search areas.**
Additional work practice details	**After the data is collected, personnel must run a report in the cloud-based software to generate the actionable output data for field crew follow-up.**

Q17

Has your method or technology been included in a successful AltFEMP proposal or application with a provincial regulator e.g., AER accepted Alternative FEMP Proposal, as described in the AER's Submission Checklist for Directive 060: Alternative FEMP Proposals? If yes, please state the jurisdiction, regulator and scale of adoption by clients/duty-holder.

No,

If no, is your organization planning to be involved in an Alternative FEMP Proposal in 2021 or later? Please provide specifics of your participation but do not reference duty holder(s).:

We currently have one gas distribution customer in Canada. It is unknown what regulatory approval, i[redacted] Vendor 2 [redacted]

Page 5: Involvement in an LDAR Program

Q18

What scale(s) i.e., component, equipment, facility does your method/technology target? Note that 'component' means inspectors can confirm, diagnose and tag individual leaks.

Component,

Equipment,

Facility

Q19

Is your leak detection method/technology able to distinguish vented from fugitive emissions?

Yes,

If yes, how? If not, how does it account for potential false positives?:

Potentially yes, assuming that fugitive emissions are constant in time and vented emissions are discontinuous. It would be possible to differentiate between these two temporal signatures provided data were taken during the time of the vented emission and compared to a time when no venting is occurring. False positives are virtually ruled out using the system's ethane measurement capability to distinguish natural gas from biogenic sources of methane.

Q20

Does the work practice lead to diagnosis and tagging of individual leaks?

Yes,

If yes, how? Please describe in detail the process of going from measurement to tagging of leaks. If no, how does the information generated lead to the mitigation of fugitive emissions/leaks?:

Leak indication search areas are produced by the software. These are investigated by foot-based crews with handheld equipment. They identify grade/tag leaks found at that time and repairs are conducted on the schedule determined by the severity of the leak.

Page 6: Leak Detection Service Description

Q21

For methods that are unable to confirm and tag individual leaks (i.e. “screening” methods), please define any relevant follow-up work practices used. For example, are follow-up OGI crews sent to high-emitting sites to tag leaks? (N/A, unknown, decline to answer)

N/A. The process confirms and tags leaks.

Q22

What criteria are used to determine which sites receive follow-up visits? Examples could include:a. Site-level emissions thresholds to trigger follow-ups (in which case, what thresholds are used?)b. Follow-up ratios, such that the top 50% of emitting sites surveyed in a day receive follow-up surveys (if so, what ratios are used?)(N/A, unknown, decline to answer)

This is determined by the operator. Vendor 2 provides three key metrics for each leak indication: potential risk of the leak, emissions rate of the leak, and probability of the leak being below-ground vs. above ground. These metrics are used differently by different operators to determine followup and/or mitigation actions.

Q23

What are the roles/tasks of follow-up crews when onsite? For example, do they conduct classic facility-wide OGI surveys, looking for all leaks, or do they target large emitters?a. If following a non-standard work practice, what are the details?b. If not immediate, what is the time interval between screening measurement and follow-up tagging of leaks (in days). Please explain how this delay is estimated.(N/A, unknown, decline to answer)

Crews fully investigate leak indication search areas with handheld tools following typical industry standards. Each operator has a different time period for followup which can range from days to weeks.

Page 7: Technical Specifications

Q24

What is the methane sensor that is used? Where applicable, specify brand or type.

Vendor 2 proprietary Technology Name sensor.

Q25

Does your surveying result in a quantified flow rate? If no, please skip to next page.

Yes

Q26

What are the minimum and maximum measurable flow rates of your method (m3/day to align with AER regulations - please note if using another unit of measurement e.g., SCFH)? (N/A, unknown, decline to answer)

0.1 to >10,000 SCFH depending on distance to the source

Q27

Please state its median detection limit (i.e. the flow rate corresponding to a 50% detection probability - please specify a corresponding distance and windspeed)? (N/A, unknown, decline to answer)

0.5 SCFH at <150m with 90% detection probability in winds <2m/s

Q28

What is the uncertainty/quantification accuracy of flow rate estimates?

3x factor uncertainty within a 90% confidence that improves with multiple plume measurements

Q29

Are emissions quantified at the component, equipment or facility level? (N/A, unknown, decline to answer)

at all levels as desired

Q30

Has your organization developed detection probability curves for your method? (N/A, unknown, decline to answer)

If yes, which variables contribute to your detection probabilities?:
Leak rate, distance to leak, number of plume detections, wind speed and atmospheric stability class.

Q31

Does your method require environmental data? If so, what types of data required and how are they collected?

The system collects its own environmental data on wind speed and variability via the system's sonic anemometer. The technician manually determines the atmospheric stability class by logging general weather condition information at the time of data collection.

Q32

Can your organization provide results from controlled release testing (CRT) and/or field performance? Please provide information on methods (e.g. Who conducted the testing? Was it performed indoors or outdoors? Under what range of environmental conditions?)If this information will be or has been published in academic papers, please indicate the paper/project. (N/A, unknown, decline to answer)

Yes, upon request, Vendor 2 can provide aggregate data [redacted]

Q33

Has controlled release testing data or performance data on your organization's method been used in modelling or computer simulations? Were the model results used for AltFEMP proposals (N/A, unknown, decline to answer)

Unknown

Page 8: Environmental and Operational Constraints

Q34

Under what environmental and operational conditions does your organization not operate in the field (please provide specifics)?

In winds >20mph and during heavy precipitation.

Q35

What environmental conditions affect your method's performance (e.g., temperature, precipitation, wind)? For each condition, how is performance impacted?

Wind and heavy precipitation.

Q36

Please declare the following (qualifying responses if necessary) (N/A, unknown, decline to answer where necessary):

What is the range of temperatures where the technology is operational (°C, max and min)?	**-10 to 45 °C**
What is the range of wind speed where the technology is operational (kmph, max and min)?	**0-32 kmph**
How much active rain is tolerated (None, light, medium, heavy)?	**medium**
What is the maximum deployment humidity (%)?	**99% RH non-condensing**
How much falling snow is tolerated (none, light, medium, heavy)?	**medium**
How much snow can be tolerated on the ground (none, patchy, thin cover, deep)?	**deep**

Q37

How long does it take to deploy at the start of the day (exclude time spent driving to individual sites, if that is a part of the method) in minutes?

5min

Q38

How long is take-down at the end of the day (exclude time spent driving to individual sites, if that is a part of the method) in minutes?

1min

Q39

Is deployment required at each individual site? If so, how long does set-up/take-down take (in minutes)?

no, system is installed in a vehicle and ready to use

Q40

From the day of measurement, what is the guaranteed reporting timeline (in days)? If multiple reports are generated/provided, please explain what information they contain, and the number of days required for delivery of each report. (if a null response please enter N/A, unknown, decline to answer)

Data is available <30min from final data collection run.

Q41

What is the factor most limiting to safe and efficient field performance leading to high-quality results? (if a null response please enter N/A, unknown, decline to answer)

Site access to within 150m.

Page 9: Supply and Scalability of Service Offering

Q42

Using single-well batteries as a baseline, approximately how many facilities can each crew inspect in a typical day, week, month, and/or year? (if a null response please enter N/A, unknown, decline to answer)

10 facilities/day

Q43

How many independent crews fully equipped with deployment platform, sensor, and trained personnel are currently available for simultaneous deployment? (if a null response please enter N/A, unknown, decline to answer)

Depends on type and location of deployment.

Q44

What is your organization’s capacity to scale operations to meet your planned/desired market share of leak detection demand in Alberta? Using single well batteries to normalize site counts, how many do you project your operation to service in 2021, 2022, 2023 at 1 event per year (if this measurement of frequency doesn't apply to your method please explain)? (if a null response please enter N/A, unknown, decline to answer)

Unknown

Q45

How many quarters in 2021 or years (if beyond) 2021 do you believe it will take to scale your operation to planned capacity based on projected market conditions?

Unknown

Q46

Does your organization expect any changes in its overall work capacity (e.g., number of crews, equipment stock, etc.) in the next 5 years? (N/A, unknown, decline to answer)

Yes, we project significant growth [redacted]

Q47

What are your biggest barriers to scaling (e.g. investment, manufacturing of sensors, training of personnel)?

Personnel

Page 10: Productivity and Cost (Optional):

Q48

What is your method’s approximate all-inclusive cost per day (single value or range) in 2021 Canadian dollars (please state assumed currency exchange if Canada is not your host country) under typical operating conditions in areas with facility densities up to 0.5 per square km? (if a null response please enter N/A, unknown, decline to answer)

Unknown -- would need more information about the infrastructure, etc. to formulate an answer.

Q49

How would this cost per day change if your organization is contracted for multiple days, weeks, months, or years? (N/A, unknown, decline to answer

Generally longer engagements would have higher efficiency and lower costs.

Page 11: Productivity and Cost (Optional):

Q50

Approximately how many sites/day/crew can your technology/method survey for AER Facility Subtype 311/351 (Single well)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

6-10,
Survey time per site, cost per site (optional), and additional comments::
Highly dependent upon site density and road accessibility.

Q51

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 321/361 (Multi-well group battery)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

6-10,
Survey time per site, cost per site (optional), and additional comments::
Highly dependent upon site density and road accessibility.

Q52

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 401 (Gas Plant - Sweet)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

6-10,
Survey time per site, cost per site (optional), and additional comments::
Highly dependent upon site density and road accessibility.

Q53

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 601 (Compressor Station)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

6-10,
Survey time per site, cost per site (optional), and additional comments::
Highly dependent upon site density and road accessibility.

Q54

If your technology or method is not readily quantified using the 4 questions above, please describe your approach to capturing and conveying leak detection efficiencies to your clients (duty holders) and the indicative performance.

Respondent skipped this question

Page 12: Data Management

Q55

Have LDAR-based data management services been a core requirement of your client/s?

No,

If yes/no/varied, are there any key reasons?:
Most of our clients are on the distribution side and so are more concerned with compliance leak survey rather than LDAR as it is commonly referenced for upstream infrastructure.

Q56

Have your clients set specific requirements regarding data management, quality assessment/control, other requirements? Please explain if possible.

Yes, each customer generally has unique requirements on each of these elements to which we adapt our solution/data delivery.

Q57

What LDAR-based data management services does your organization offer?

We provide geo-spatial (often customized) analysis and management of data collected by/for customers.

Vendor #3 Response

Collector: [redacted]
Started: [redacted]
Last Modified: [redacted]
Time Spent: [redacted]

Page 2: Introduction

Q1

Contact Information (For Administrative Purposes Only - All Responses Are Anonymized)

Respondent Organization:	[redacted]
Respondent Name:	Vendor 3
Respondent Role:	[redacted]
E-mail:	[redacted]
Phone:	[redacted]
Website:	[redacted]
Response Date (yy/mm/dd):	[redacted]

Q2

Please confirm your understanding that all data collected as a part of this study are anonymous - check "Yes" to confirm.

Yes

Q3

Are you interested in being contacted for future PTAC methane emissions management research including, potential field campaigns?

Yes

Q4

Please indicate if you would like your organization to be publicly listed as a participant in this study. In this scenario, your organization would be identified as a participant that contributed data, but your organization's name is not associated with data you have submitted (data anonymity is preserved).

Yes

Page 3: General Information and Logistics

Q5

Does your organization have commercial LDAR surveying experience? If yes, please describe e.g., types of LDAR services provided, core markets (industry and/or locations), years of corporate experience with LDAR services.

No

Q6

Does your organization participate in methane measurement markets outside of Alberta? If you intend to enter new methane measurement markets in 2021 or later please answer - Yes.

Yes

Q7

Is your organization able (legally/logistically/etc.) to work in Canada?

Yes

Q8

Is your organization able (legally/logistically/etc.) to work in the United States?

Yes

Q9

Please describe any safety concerns, risks, interruptions or annoyances (for duty holders/operators and/or local residents/communities) possibly introduced by your product/service when completing LDAR surveys (e.g., noise, airspace, road/site congestion).

None.

Q10

Has the COVID-19 outbreak and/or recent market conditions affected your operations re. LDAR services or is it expected to affect your operations? Please provide a comment if answering yes.

Yes, ongoing

Q11

Has the establishment of equivalency with federal methane regulations in Alberta and Saskatchewan affected your operations? e.g., scale, frequency, jurisdictions? Please comment if yes.

No.

Q12

Have methane-related Canadian provincial and federal programs affected your operations or planned operations? Please comment if yes.

No.

Page 4: Leak Detection Service Description

Q13

Is your method or technology compliant with AER Directive 60 leak detection methods (e.g., Method 21) or is it intended to be applied in an AltFEMP?

AltFEMP

Q14

Define your method in detail, including what equipment is used and how it is deployed. Points to address include (but are not limited to):

a. Does your organization offer a technology or a method?	**Unique approach to ultrasonic leak detection, direction and quantification.**
b. Does your organization offer a product (for sale?), a service, or a combination?	**Yes, combination of [redacted] and record and data management offline to support resolution management.**
c. Is the method mobile or stationary?	**Mobile, hand-held.**
d. Does your method require site access or does it measure remotely?	**Site access required.**

Q15

What deployment platform(s) is/are used? (for example: hand-held, aerial, truck-mounted, UAV, fixed sensor, portable and temporary on-site mount). If multiple deployment platforms are used, explain them all and how they work together.

Hand-held unit which attaches to an [redacted] tablet [redacted] (cell phone).

Q16

What is the specific work practice associated with your methane leak detection method/technology? Several key elements of the work practice are listed below. Please add and comment on any others you feel are pertinent to your offering.

a. At what distances from source are measurements taken?	**Typically from 0.4m to 2m…. but detection at greater distance.**
b. What sensors are employed and how?	**Highly sensitive microphones in a designed arrangement.**
c. How many people comprise one field crew? What are their roles?	**Our approach can be used by existing facility personnel. No special crew required.**
d. How much time is spent surveying each potential source?	**Between 2-4 minutes.**
e. How much training are field staff required to have?	**Very little. One 5 minute YouTube clip would cover all instruction.**
f. What output data are generated and reported?	**All data is available on a cloud based backend. Every piece of info on the tablet is replicated and can be extracted in csv or pdf. Back end allows data sorting, charting and establishment of key metrics for user or company.**
Additional work practice details	**Only additional requirements would be linking to our solutions to the facility or company plan.**

Q17

Has your method or technology been included in a successful AltFEMP proposal or application with a provincial regulator e.g., AER accepted Alternative FEMP Proposal, as described in the AER's Submission Checklist for Directive 060: Alternative FEMP Proposals? If yes, please state the jurisdiction, regulator and scale of adoption by clients/duty-holder.

No,

If no, is your organization planning to be involved in an Alternative FEMP Proposal in 2021 or later? Please provide specifics of your participation but do not reference duty holder(s).:

Yes, we plan to submit an Alternative FEMP Proposal in 2021.

Page 5: Involvement in an LDAR Program

Q18

What scale(s) i.e., component, equipment, facility does your method/technology target? Note that 'component' means inspectors can confirm, diagnose and tag individual leaks.

Component

Q19

Is your leak detection method/technology able to distinguish vented from fugitive emissions?

No

Q20

Does the work practice lead to diagnosis and tagging of individual leaks?

Yes,

If yes, how? Please describe in detail the process of going from measurement to tagging of leaks. If no, how does the information generated lead to the mitigation of fugitive emissions/leaks?:
Each leak is quantified, tagged, photo record taken and all details specific to the leak source recorded by user for off-line access. Location is also tagged to support remediation and periodic monitoring and the application included a process for managing corrective actions.

Page 6: Leak Detection Service Description

Q21

For methods that are unable to confirm and tag individual leaks (i.e. “screening” methods), please define any relevant follow-up work practices used. For example, are follow-up OGI crews sent to high-emitting sites to tag leaks? (N/A, unknown, decline to answer)

N/A

Q22

What criteria are used to determine which sites receive follow-up visits? Examples could include:a. Site-level emissions thresholds to trigger follow-ups (in which case, what thresholds are used?)b. Follow-up ratios, such that the top 50% of emitting sites surveyed in a day receive follow-up surveys (if so, what ratios are used?)(N/A, unknown, decline to answer)

Decline to answer

Q23

What are the roles/tasks of follow-up crews when onsite? For example, do they conduct classic facility-wide OGI surveys, looking for all leaks, or do they target large emitters?a. If following a non-standard work practice, what are the details?b. If not immediate, what is the time interval between screening measurement and follow-up tagging of leaks (in days). Please explain how this delay is estimated.(N/A, unknown, decline to answer)

Our device provides GPS, photo, tag, date of leak, priority of repair and actions required. Once complete the repair can be directly logged in our device and the device used to scan and confirm zero leakage.

Page 7: Technical Specifications

Q24

What is the methane sensor that is used? Where applicable, specify brand or type.

NA

Q25

Does your surveying result in a quantified flow rate? If no, please skip to next page.

Yes

Q26

What are the minimum and maximum measurable flow rates of your method (m3/day to align with AER regulations - please note if using another unit of measurement e.g., SCFH)? (N/A, unknown, decline to answer)

decline to answer

Q27

Please state its median detection limit (i.e. the flow rate corresponding to a 50% detection probability - please specify a corresponding distance and windspeed)? (N/A, unknown, decline to answer)

Decline to answer

Q28

What is the uncertainty/quantification accuracy of flow rate estimates?

decline to answer

Q29

Are emissions quantified at the component, equipment or facility level? (N/A, unknown, decline to answer)

Component

Q30

Has your organization developed detection probability curves for your method? (N/A, unknown, decline to answer)

Decline to Answer

Q31

Does your method require environmental data? If so, what types of data required and how are they collected?

Ambient temperature which can be user defined for weather app linked.

Q32

Can your organization provide results from controlled release testing (CRT) and/or field performance? Please provide information on methods (e.g. Who conducted the testing? Was it performed indoors or outdoors? Under what range of environmental conditions?)If this information will be or has been published in academic papers, please indicate the paper/project. (N/A, unknown, decline to answer)

decline to answer

Q33

Has controlled release testing data or performance data on your organization's method been used in modelling or computer simulations? Were the model results used for AltFEMP proposals (N/A, unknown, decline to answer)

decline to answer

Page 8: Environmental and Operational Constraints

Q34

Under what environmental and operational conditions does your organization not operate in the field (please provide specifics)?

N/A, all conditions are acceptable.

Q35

What environmental conditions affect your method's performance (e.g., temperature, precipitation, wind)? For each condition, how is performance impacted?

Only temperature, below -20C battery life is reduced.

Q36

Please declare the following (qualifying responses if necessary) (N/A, unknown, decline to answer where necessary):

What is the range of temperatures where the technology is operational (°C, max and min)?	**decline to answer**
What is the range of wind speed where the technology is operational (kmph, max and min)?	**decline to answer**
How much active rain is tolerated (None, light, medium, heavy)?	**N/A**
What is the maximum deployment humidity (%)?	**N/A**
How much falling snow is tolerated (none, light, medium, heavy)?	**N/A**
How much snow can be tolerated on the ground (none, patchy, thin cover, deep)?	**N/A**

Q37

How long does it take to deploy at the start of the day (exclude time spent driving to individual sites, if that is a part of the method) in minutes?

1 minute.

Q38

How long is take-down at the end of the day (exclude time spent driving to individual sites, if that is a part of the method) in minutes?

1 minute.

Q39

Is deployment required at each individual site? If so, how long does set-up/take-down take (in minutes)?

No, hand-held, pick up and go.

Q40

From the day of measurement, what is the guaranteed reporting timeline (in days)? If multiple reports are generated/provided, please explain what information they contain, and the number of days required for delivery of each report. (if a null response please enter N/A, unknown, decline to answer)

Every piece of data entered or provided by the user or generated by the tablet at the leak event source is location and time stamped and saved. Data can be sored for as long as the client requires.

Q41

What is the factor most limiting to safe and efficient field performance leading to high-quality results? (if a null response please enter N/A, unknown, decline to answer)

N/A

Page 9: Supply and Scalability of Service Offering

Q42

Using single-well batteries as a baseline, approximately how many facilities can each crew inspect in a typical day, week, month, and/or year? (if a null response please enter N/A, unknown, decline to answer)

N/A, clients personnel can carry our device and can complete inspection at any time they are normally at the location.

Q43

How many independent crews fully equipped with deployment platform, sensor, and trained personnel are currently available for simultaneous deployment? (if a null response please enter N/A, unknown, decline to answer)

N/A, clients personnel can carry our device and can complete inspection at any time they are normally at the location.

Q44

What is your organization’s capacity to scale operations to meet your planned/desired market share of leak detection demand in Alberta? Using single well batteries to normalize site counts, how many do you project your operation to service in 2021, 2022, 2023 at 1 event per year (if this measurement of frequency doesn't apply to your method please explain)? (if a null response please enter N/A, unknown, decline to answer)

Our limitation is only how many of our products we can manufacture and distribute. As such we have no barrier to scale for Alberta.

Q45

How many quarters in 2021 or years (if beyond) 2021 do you believe it will take to scale your operation to planned capacity based on projected market conditions?

We will scale to meet the demand of the market.

Q46

Does your organization expect any changes in its overall work capacity (e.g., number of crews, equipment stock, etc.) in the next 5 years? (N/A, unknown, decline to answer)

N/A

Q47

What are your biggest barriers to scaling (e.g. investment, manufacturing of sensors, training of personnel)?

[redacted]

Page 10: Productivity and Cost (Optional):

Q48

What is your method’s approximate all-inclusive cost per day (single value or range) in 2021 Canadian dollars (please state assumed currency exchange if Canada is not your host country) under typical operating conditions in areas with facility densities up to 0.5 per square km? (if a null response please enter N/A, unknown, decline to answer)

NA

Q49

How would this cost per day change if your organization is contracted for multiple days, weeks, months, or years? (N/A, unknown, decline to answer

N/A

Page 11: Productivity and Cost (Optional):

Q50

Approximately how many sites/day/crew can your technology/method survey for AER Facility Subtype 311/351 (Single well)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

Respondent skipped this question

Q51

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 321/361 (Multi-well group battery)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

Respondent skipped this question

Q52

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 401 (Gas Plant - Sweet)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

Respondent skipped this question

Q53

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 601 (Compressor Station)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

Respondent skipped this question

Q54

If your technology or method is not readily quantified using the 4 questions above, please describe your approach to capturing and conveying leak detection efficiencies to your clients (duty holders) and the indicative performance.

We sell our hardware, application and data management access to our clients and they perform the site activities. With our solution their personnel are able to locate and repair leaks directly, monitor annual surveyed sources to reduce recurrence time and find, report and manage new leaks in the 364 days between annual surveys. This may allow then eventually to eliminate some of their expensive external consultant costs.

Page 12: Data Management

Q55

Have LDAR-based data management services been a core requirement of your client/s?

Yes,
If yes/no/varied, are there any key reasons?:
Our product is a hand-held leak detection device but the value is in effective resolution. Event data management is key.

Q56

Have your clients set specific requirements regarding data management, quality assessment/control, other requirements? Please explain if possible.

No

Q57

What LDAR-based data management services does your organization offer?

All leak event data which is record at he source is available in our backend. We transfer this data in the format that our clients want for their analysis.

Vendor #4 Response

Collector: [redacted]
Started: [redacted]
Last Modified: [redacted]
Time Spent: [redacted]

Page 2: Introduction

Q1

Contact Information (For Administrative Purposes Only - All Responses Are Anonymized)

Respondent Organization:	[redacted]
Respondent Name:	Vendor 4
Respondent Role:	[redacted]
E-mail:	[redacted]
Phone:	[redacted]
Website:	[redacted]
Response Date (yy/mm/dd):	[redacted]

Q2

Please confirm your understanding that all data collected as a part of this study are anonymous - check "Yes" to confirm.

Yes

Q3

Are you interested in being contacted for future PTAC methane emissions management research including, potential field campaigns?

Yes

Q4

Please indicate if you would like your organization to be publicly listed as a participant in this study. In this scenario, your organization would be identified as a participant that contributed data, but your organization's name is not associated with data you have submitted (data anonymity is preserved).

Yes

Page 3: General Information and Logistics

Q5

Does your organization have commercial LDAR surveying experience? If yes, please describe e.g., types of LDAR services provided, core markets (industry and/or locations), years of corporate experience with LDAR services.

Yes,

If yes, please describe::

LDAR services provided: [redacted] provides a vehicle-based emissions monitoring service to the upstream and midstream energy industry in Western Canada. We specialize in providing alternative solutions to fugitive emission management programs (FEMP), leak detection and repair (LDAR) programs using our [redacted] emissions detection vehicle. The [redacted] truck is a higher-order emissions screening tool used to quantify methane emissions at the facililty level. [redacted]

Q6

Does your organization participate in methane measurement markets outside of Alberta? If you intend to enter new methane measurement markets in 2021 or later please answer - Yes.

Yes,

If yes, which markets? (Optional):

[redacted]

Q7

Is your organization able (legally/logistically/etc.) to work in Canada?

Yes

Q8

Is your organization able (legally/logistically/etc.) to work in the United States?

Unknown

Q9

Please describe any safety concerns, risks, interruptions or annoyances (for duty holders/operators and/or local residents/communities) possibly introduced by your product/service when completing LDAR surveys (e.g., noise, airspace, road/site congestion).

- Driving hazards
- Road/site congestion

Q10

Has the COVID-19 outbreak and/or recent market conditions affected your operations re. LDAR services or is it expected to affect your operations? Please provide a comment if answering yes.

No

Q11

Has the establishment of equivalency with federal methane regulations in Alberta and Saskatchewan affected your operations? e.g., scale, frequency, jurisdictions? Please comment if yes.

Yes, due to the perceived decreased regulatory risk of conducting an alt-FEMP

Q12

Have methane-related Canadian provincial and federal programs affected your operations or planned operations? Please comment if yes.

Yes, some ongoing and future work is funded via Canadian provincial programs

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Page 4: Leak Detection Service Description

Q13

Is your method or technology compliant with AER Directive 60 leak detection methods (e.g., Method 21) or is it intended to be applied in an AltFEMP?

AltFEMP

Q14

Define your method in detail, including what equipment is used and how it is deployed. Points to address include (but are not limited to):

a. Does your organization offer a technology or a method?	**Both**
b. Does your organization offer a product (for sale?), a service, or a combination?	**Service**
c. Is the method mobile or stationary?	**Mobile**
d. Does your method require site access or does it measure remotely?	**On-site and public/lease road monitoring both applicable**

Q15

What deployment platform(s) is/are used? (for example: hand-held, aerial, truck-mounted, UAV, fixed sensor, portable and temporary on-site mount). If multiple deployment platforms are used, explain them all and how they work together.

Truck-mounted sensors

Q16

What is the specific work practice associated with your methane leak detection method/technology? Several key elements of the work practice are listed below. Please add and comment on any others you feel are pertinent to your offering.

a. At what distances from source are measurements taken?	**10-500m**
b. What sensors are employed and how?	**--**
c. How many people comprise one field crew? What are their roles?	**2 (shared role)**
d. How much time is spent surveying each potential source?	**Less than 5 minutes**
e. How much training are field staff required to have?	**--**
f. What output data are generated and reported?	**Dependent on client needs but generally: date, time, facility name, location, coordinates of detections, emission rate in m3CH4/day, confidence intervals, distance to source, measured methane concentration**
Additional work practice details	**--**

Q17

Has your method or technology been included in a successful AltFEMP proposal or application with a provincial regulator e.g., AER accepted Alternative FEMP Proposal, as described in the AER's Submission Checklist for Directive 060: Alternative FEMP Proposals? If yes, please state the jurisdiction, regulator and scale of adoption by clients/duty-holder.

No,

If no, is your organization planning to be involved in an Alternative FEMP Proposal in 2021 or later? Please provide specifics of your participation but do not reference duty holder(s).:

Yes, we are planning to be involved in an Alternative FEMP Proposal in 2021. Details are unable to be shared currently.

Page 5: Involvement in an LDAR Program

Q18

What scale(s) i.e., component, equipment, facility does your method/technology target? Note that 'component' means inspectors can confirm, diagnose and tag individual leaks.

Facility

Q19

Is your leak detection method/technology able to distinguish vented from fugitive emissions?

No

Q20

Does the work practice lead to diagnosis and tagging of individual leaks?

Yes,

If yes, how? Please describe in detail the process of going from measurement to tagging of leaks. If no, how does the information generated lead to the mitigation of fugitive emissions/leaks?:

Facility level screening technology generally requires follow up with OGI or another component-level monitoring technology to tag and diagnose leaks. The follow-up procedure/frequency is developed via an alt-FEMP model.

Page 6: Leak Detection Service Description

Q21

For methods that are unable to confirm and tag individual leaks (i.e. “screening” methods), please define any relevant follow-up work practices used. For example, are follow-up OGI crews sent to high-emitting sites to tag leaks? (N/A, unknown, decline to answer)

Client and alt-FEMP model dependent but follow up with OGI may occur

Q22

What criteria are used to determine which sites receive follow-up visits? Examples could include:a. Site-level emissions thresholds to trigger follow-ups (in which case, what thresholds are used?)b. Follow-up ratios, such that the top 50% of emitting sites surveyed in a day receive follow-up surveys (if so, what ratios are used?)(N/A, unknown, decline to answer)

Client and alt-FEMP model dependent but follow up criteria may include:

- Top X% of emitters
- Emitters above a specific emission rate threshold

Q23

What are the roles/tasks of follow-up crews when onsite? For example, do they conduct classic facility-wide OGI surveys, looking for all leaks, or do they target large emitters?a. If following a non-standard work practice, what are the details?b. If not immediate, what is the time interval between screening measurement and follow-up tagging of leaks (in days). Please explain how this delay is estimated.(N/A, unknown, decline to answer)

Client and alt-FEMP model dependent

Page 7: Technical Specifications

Q24

What is the methane sensor that is used? Where applicable, specify brand or type.

Picarro G2201i

Q25

Does your surveying result in a quantified flow rate? If no, please skip to next page.

Yes

Q26

What are the minimum and maximum measurable flow rates of your method (m3/day to align with AER regulations - please note if using another unit of measurement e.g., SCFH)? (N/A, unknown, decline to answer)

Minimum detection limit: 0.2 gCH4/hr

Q27

Please state its median detection limit (i.e. the flow rate corresponding to a 50% detection probability - please specify a corresponding distance and windspeed)? (N/A, unknown, decline to answer)

Unknown

Q28

What is the uncertainty/quantification accuracy of flow rate estimates?

+/- 60%

Q29

Are emissions quantified at the component, equipment or facility level? (N/A, unknown, decline to answer)

Facility level

Q30

Has your organization developed detection probability curves for your method? (N/A, unknown, decline to answer)

Decline to Answer

Q31

Does your method require environmental data? If so, what types of data required and how are they collected?

Wind speed (measured)
Wind direction (measured)
Atmospheric stability class (inferred)

Q32

Can your organization provide results from controlled release testing (CRT) and/or field performance? Please provide information on methods (e.g. Who conducted the testing? Was it performed indoors or outdoors? Under what range of environmental conditions?)If this information will be or has been published in academic papers, please indicate the paper/project. (N/A, unknown, decline to answer)

- Yes
- St FX University
- Outdoors
- See O'Connell et al. 2019
- Publication: O'Connell, E, et al. 2019. Methane emissions from contrasting production
regions within Alberta, Canada: Implications under incoming federal methane
regulations. Elem Sci Anth, 7: 3. DOI: https://doi.org/10.1525/elementa.341

Q33

Has controlled release testing data or performance data on your organization's method been used in modelling or computer simulations? Were the model results used for AltFEMP proposals (N/A, unknown, decline to answer)

-Yes
-Unknown

Page 8: Environmental and Operational Constraints

Q34

Under what environmental and operational conditions does your organization not operate in the field (please provide specifics)?

NA

Q35

What environmental conditions affect your method's performance (e.g., temperature, precipitation, wind)? For each condition, how is performance impacted?

- Low wind impacts plume dispersion
- Temperature impacts plume dispersion

Q36

Please declare the following (qualifying responses if necessary) (N/A, unknown, decline to answer where necessary):

What is the range of temperatures where the technology is operational (°C, max and min)?	**-40°C to +40°C**
What is the range of wind speed where the technology is operational (kmph, max and min)?	**Benefits from wind speeds greater than 0.8 m/s and must be able to get downwind of an emission source**
How much active rain is tolerated (None, light, medium, heavy)?	**Minimal limitations, can survey in light to moderate rainfall**
What is the maximum deployment humidity (%)?	**No limitations**
How much falling snow is tolerated (none, light, medium, heavy)?	**Minimal limitations, can survey in light to moderate snowfall**
How much snow can be tolerated on the ground (none, patchy, thin cover, deep)?	**Minimal limitations, any road conditions that affect a 4x4 truck would have an impact on the ability to survey**

Q37

How long does it take to deploy at the start of the day (exclude time spent driving to individual sites, if that is a part of the method) in minutes?

30

Q38

How long is take-down at the end of the day (exclude time spent driving to individual sites, if that is a part of the method) in minutes?

15

Q39

Is deployment required at each individual site? If so, how long does set-up/take-down take (in minutes)?

No

Q40

From the day of measurement, what is the guaranteed reporting timeline (in days)? If multiple reports are generated/provided, please explain what information they contain, and the number of days required for delivery of each report. (if a null response please enter N/A, unknown, decline to answer)

14 days

Q41

What is the factor most limiting to safe and efficient field performance leading to high-quality results? (if a null response please enter N/A, unknown, decline to answer)

Site access

Page 9: Supply and Scalability of Service Offering

Q42

Using single-well batteries as a baseline, approximately how many facilities can each crew inspect in a typical day, week, month, and/or year? (if a null response please enter N/A, unknown, decline to answer)

Day: 50-75

Q43

How many independent crews fully equipped with deployment platform, sensor, and trained personnel are currently available for simultaneous deployment? (if a null response please enter N/A, unknown, decline to answer)

2

Q44

What is your organization's capacity to scale operations to meet your planned/desired market share of leak detection demand in Alberta? Using single well batteries to normalize site counts, how many do you project your operation to service in 2021, 2022, 2023 at 1 event per year (if this measurement of frequency doesn't apply to your method please explain)? (if a null response please enter N/A, unknown, decline to answer)

unknown

Q45

How many quarters in 2021 or years (if beyond) 2021 do you believe it will take to scale your operation to planned capacity based on projected market conditions?

decline to answer

Q46

Does your organization expect any changes in its overall work capacity (e.g., number of crews, equipment stock, etc.) in the next 5 years? (N/A, unknown, decline to answer)

decline to answer

Q47

What are your biggest barriers to scaling (e.g. investment, manufacturing of sensors, training of personnel)?

decline to answer

Page 10: Productivity and Cost (Optional):

Q48

What is your method's approximate all-inclusive cost per day (single value or range) in 2021 Canadian dollars (please state assumed currency exchange if Canada is not your host country) under typical operating conditions in areas with facility densities up to 0.5 per square km? (if a null response please enter N/A, unknown, decline to answer)

decline to answer

Q49

How would this cost per day change if your organization is contracted for multiple days, weeks, months, or years? (N/A, unknown, decline to answer

decline to answer

Page 11: Productivity and Cost (Optional):

Q50

Approximately how many sites/day/crew can your technology/method survey for AER Facility Subtype 311/351 (Single well)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

21+,
Survey time per site, cost per site (optional), and additional comments::
Less than 5 minutes per site, assumption is that the region has moderate to high density of sites.

Q51

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 321/361 (Multi-well group battery)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

21+,
Survey time per site, cost per site (optional), and additional comments::
Less than 5 minutes per site, assumption is that the region has moderate to high density of sites.

Q52

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 401 (Gas Plant - Sweet)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

21+,
Survey time per site, cost per site (optional), and additional comments::
10-15 minutes per site, gas plants are not the ideal target for our monitoring technology, assumption is that the region has moderate to high density of sites.

Q53

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 601 (Compressor Station)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

21+,
Survey time per site, cost per site (optional), and additional comments::
Less than 5 minutes, assumption is that the region has moderate to high density of sites.

Q54

If your technology or method is not readily quantified using the 4 questions above, please describe your approach to capturing and conveying leak detection efficiencies to your clients (duty holders) and the indicative performance.

Respondent skipped this question

Page 12: Data Management

Q55

Have LDAR-based data management services been a core requirement of your client/s?

Varied,

If yes/no/varied, are there any key reasons?:
Some clients are developing or have their own data management tools

Q56

Have your clients set specific requirements regarding data management, quality assessment/control, other requirements? Please explain if possible.

Yes, many clients require standardization at some level to integrate with their data processing/handling/management tools.

Q57

What LDAR-based data management services does your organization offer?

ESRI-based data management and reporting tools

Vendor #5 Response

Collector: [redacted]
Started: [redacted]
Last Modified: [redacted]
Time Spent: [redacted]

Page 2: Introduction

Q1

Contact Information (For Administrative Purposes Only - All Responses Are Anonymized)

Respondent Organization:	[redacted]
Respondent Name:	Vendor 5
Respondent Role:	[redacted]
E-mail:	[redacted]
Phone:	[redacted]
Website:	[redacted]
Response Date (yy/mm/dd):	[redacted]

Q2

Please confirm your understanding that all data collected as a part of this study are anonymous - check "Yes" to confirm.

Yes

Q3

Are you interested in being contacted for future PTAC methane emissions management research including, potential field campaigns?

Yes

Q4

Please indicate if you would like your organization to be publicly listed as a participant in this study. In this scenario, your organization would be identified as a participant that contributed data, but your organization's name is not associated with data you have submitted (data anonymity is preserved).

No

Page 3: General Information and Logistics

Q5

Does your organization have commercial LDAR surveying experience? If yes, please describe e.g., types of LDAR services provided, core markets (industry and/or locations), years of corporate experience with LDAR services.

No

Q6

Does your organization participate in methane measurement markets outside of Alberta? If you intend to enter new methane measurement markets in 2021 or later please answer - Yes.

Yes

Q7

Is your organization able (legally/logistically/etc.) to work in Canada?

Yes

Q8

Is your organization able (legally/logistically/etc.) to work in the United States?

Yes

Q9

Please describe any safety concerns, risks, interruptions or annoyances (for duty holders/operators and/or local residents/communities) possibly introduced by your product/service when completing LDAR surveys (e.g., noise, airspace, road/site congestion).

Road access is required.

Q10

Has the COVID-19 outbreak and/or recent market conditions affected your operations re. LDAR services or is it expected to affect your operations? Please provide a comment if answering yes.

No

Q11

Has the establishment of equivalency with federal methane regulations in Alberta and Saskatchewan affected your operations? e.g., scale, frequency, jurisdictions? Please comment if yes.

No

Q12

Have methane-related Canadian provincial and federal programs affected your operations or planned operations? Please comment if yes.

No

Page 4: Leak Detection Service Description

Q13

Is your method or technology compliant with AER Directive 60 leak detection methods (e.g., Method 21) or is it intended to be applied in an AltFEMP?

AltFEMP

Q14

Define your method in detail, including what equipment is used and how it is deployed. Points to address include (but are not limited to):

a. Does your organization offer a technology or a method?

[redacted]

b. Does your organization offer a product (for sale?), a service, or a combination?

[redacted]

c. Is the method mobile or stationary?

Technology is a truck based system

d. Does your method require site access or does it measure remotely?

Technology requires site access to produce accurate data, but can measure without site access less accurately.

Q15

What deployment platform(s) is/are used? (for example: hand-held, aerial, truck-mounted, UAV, fixed sensor, portable and temporary on-site mount). If multiple deployment platforms are used, explain them all and how they work together.

Technology is a vehicle based system system for rapid triaging of emissions sources on upstream pads.

Q16

What is the specific work practice associated with your methane leak detection method/technology? Several key elements of the work practice are listed below. Please add and comment on any others you feel are pertinent to your offering.

a. At what distances from source are measurements taken?	**Measurements are taken from the vehicle at 7-25 m from sources.**
b. What sensors are employed and how?	[redacted] **are fused to measure the location of sources and emissions rates.**
c. How many people comprise one field crew? What are their roles?	**One crew member is used to drive the vehicle and operate the system.**
d. How much time is spent surveying each potential source?	**Each source requires less than 30 seconds of data.**
e. How much training are field staff required to have?	**Field staff require approximately 2 days of training.**
f. What output data are generated and reported?	**Emissions locations, approximate emissions quantifications for follow up triage purposes.**
Additional work practice details	**We recommend using a 'one visit model' with** [redacted] Technology **Operator arrives, circles the site several times, and then performs follow-up OGI surveys only on the equipments that are emitting.**

Q17

Has your method or technology been included in a successful AltFEMP proposal or application with a provincial regulator e.g., AER accepted Alternative FEMP Proposal, as described in the AER’s Submission Checklist for Directive 060: Alternative FEMP Proposals? If yes, please state the jurisdiction, regulator and scale of adoption by clients/duty-holder.

Yes

Page 5: Involvement in an LDAR Program

Q18

What scale(s) i.e., component, equipment, facility does your method/technology target? Note that ‘component’ means inspectors can confirm, diagnose and tag individual leaks.

Equipment

Q19

Is your leak detection method/technology able to distinguish vented from fugitive emissions?

No

Q20

Does the work practice lead to diagnosis and tagging of individual leaks?

Yes,

If yes, how? Please describe in detail the process of going from measurement to tagging of leaks. If no, how does the information generated lead to the mitigation of fugitive emissions/leaks?:
The Technology [redacted] maps emitting equipment on sites. Equipment that is not emitting can be skipped from follow-up. Equipment that is emitting can be surveyed with conventional, widely understood, and easy to apply D060 compliant OGI surveys. From these OGI survey tags can be issued.

Page 6: Leak Detection Service Description

Q21

For methods that are unable to confirm and tag individual leaks (i.e. "screening" methods), please define any relevant follow-up work practices used. For example, are follow-up OGI crews sent to high-emitting sites to tag leaks? (N/A, unknown, decline to answer)

Technology [redacted] is part of a one visit model, OGI is deployed to follow up immediately and as part of the survey.

Q22

What criteria are used to determine which sites receive follow-up visits? Examples could include:a. Site-level emissions thresholds to trigger follow-ups (in which case, what thresholds are used?)b. Follow-up ratios, such that the top 50% of emitting sites surveyed in a day receive follow-up surveys (if so, what ratios are used?)(N/A, unknown, decline to answer)

We recommend all anomalies be followed up immediately, onsite. Operators can use different work practices if they choose to, such as different triage schemes, but this is a decision of the operator.

Q23

What are the roles/tasks of follow-up crews when onsite? For example, do they conduct classic facility-wide OGI surveys, looking for all leaks, or do they target large emitters?a. If following a non-standard work practice, what are the details?b. If not immediate, what is the time interval between screening measurement and follow-up tagging of leaks (in days). Please explain how this delay is estimated.(N/A, unknown, decline to answer)

Crews operate the system and follow up on identified anomalies with a chosen work practice. Follow-up is suggested to be conducted with D060 close range survey or some user defined follow up method. There is no suggested delay between measurement and follow-up. We suggest identifying emitting equipment, triaging, and follow-up to be completed in one visit.

Page 7: Technical Specifications

Q24

What is the methane sensor that is used? Where applicable, specify brand or type.

[redacted]

Q25

Does your surveying result in a quantified flow rate? If no, please skip to next page.

Yes

Q26

What are the minimum and maximum measurable flow rates of your method (m3/day to align with AER regulations - please note if using another unit of measurement e.g., SCFH)? (N/A, unknown, decline to answer)

We have detected and measured emissions rates of [redacted] methane.

Q27

Please state its median detection limit (i.e. the flow rate corresponding to a 50% detection probability - please specify a corresponding distance and windspeed)? (N/A, unknown, decline to answer)

We have performed detection limit testing at METEC. We could not identify a median detection limit as the median detection limit of Technology is below what METEC can meter. We measured a minimum emissions rate of [redacted] methane - we expect the median detection limit to be below this value. We cannot provide a detection limit surface as a function of distance or wind speed as we cannot provide a median detection limit.

Q28

What is the uncertainty/quantification accuracy of flow rate estimates?

We do not provide uncertainty estimates on flow rate quantifications at present.

Q29

Are emissions quantified at the component, equipment or facility level? (N/A, unknown, decline to answer)

Emissions can be quantified at the equipment scale.

Q30

Has your organization developed detection probability curves for your method? (N/A, unknown, decline to answer)

No

Q31

Does your method require environmental data? If so, what types of data required and how are they collected?

All data required for the system are automatically collected. We use temperature, pressure, methane concentrations, location, measured wind speed and directions.

Q32

Can your organization provide results from controlled release testing (CRT) and/or field performance? Please provide information on methods (e.g. Who conducted the testing? Was it performed indoors or outdoors? Under what range of environmental conditions?)If this information will be or has been published in academic papers, please indicate the paper/project. (N/A, unknown, decline to answer)

The most relevant and accurate data on Technology performance was collected in a single-blind study conducted at [redacted]

[redacted]

Q33

Has controlled release testing data or performance data on your organization's method been used in modelling or computer simulations? Were the model results used for AltFEMP proposals (N/A, unknown, decline to answer)

Performance data has been used in computer simulations and AltFEMP applications.

Page 8: Environmental and Operational Constraints

Q34

Under what environmental and operational conditions does your organization not operate in the field (please provide specifics)?

The Technology system cannot operate below -25 degrees C, above 40 degrees C, in strong rain or snowfall, or in conditions where lightning is possible.

Q35

What environmental conditions affect your method's performance (e.g., temperature, precipitation, wind)? For each condition, how is performance impacted?

The Technology system functions poorly in conditions of no wind.

Q36

Please declare the following (qualifying responses if necessary) (N/A, unknown, decline to answer where necessary):

What is the range of temperatures where the technology is operational (°C, max and min)?	**-25 - 40 degrees C**
What is the range of wind speed where the technology is operational (kmph, max and min)?	**0 - 100 kmph (upper limit untested)**
How much active rain is tolerated (None, light, medium, heavy)?	**Light rain is tolerable.**
What is the maximum deployment humidity (%)?	**100%**
How much falling snow is tolerated (none, light, medium, heavy)?	**Light falling snow is tolerable.**
How much snow can be tolerated on the ground (none, patchy, thin cover, deep)?	**Deep snow can be tolerated.**

Q37

How long does it take to deploy at the start of the day (exclude time spent driving to individual sites, if that is a part of the method) in minutes?

Initial setup on the vehicle takes between 0 minutes (no setup required), to 5 minutes (full setup required).

Q38

How long is take-down at the end of the day (exclude time spent driving to individual sites, if that is a part of the method) in minutes?

Take-down time takes from 0 minutes (no takedown required), to 5 minutes (full take-down required).

Q39

Is deployment required at each individual site? If so, how long does set-up/take-down take (in minutes)?

No deployment actions are required when arriving at site - system functions at all times on the roof of the vehicle.

Q40

From the day of measurement, what is the guaranteed reporting timeline (in days)? If multiple reports are generated/provided, please explain what information they contain, and the number of days required for delivery of each report. (if a null response please enter N/A, unknown, decline to answer)

Reports are provided immediately after surveying from the system on the truck. No post-processing or office work is required.

Q41

What is the factor most limiting to safe and efficient field performance leading to high-quality results? (if a null response please enter N/A, unknown, decline to answer)

N/A

Page 9: Supply and Scalability of Service Offering

Q42

Using single-well batteries as a baseline, approximately how many facilities can each crew inspect in a typical day, week, month, and/or year? (if a null response please enter N/A, unknown, decline to answer)

This depends on the work practice and is not explicitly related to the technology. How you use Technology, how you follow up, how far away sites are from each other, etc. - these are the things that control survey time.

Q43

How many independent crews fully equipped with deployment platform, sensor, and trained personnel are currently available for simultaneous deployment? (if a null response please enter N/A, unknown, decline to answer)

Currently there are [redacted] simultaneous deployment, involved in various deployments.

Q44

What is your organization's capacity to scale operations to meet your planned/desired market share of leak detection demand in Alberta? Using single well batteries to normalize site counts, how many do you project your operation to service in 2021, 2022, 2023 at 1 event per year (if this measurement of frequency doesn't apply to your method please explain)? (if a null response please enter N/A, unknown, decline to answer)

N/A

Q45

How many quarters in 2021 or years (if beyond) 2021 do you believe it will take to scale your operation to planned capacity based on projected market conditions?

N/A

Q46

Does your organization expect any changes in its overall work capacity (e.g., number of crews, equipment stock, etc.) in the next 5 years? (N/A, unknown, decline to answer)

N/A

Q47

What are your biggest barriers to scaling (e.g. investment, manufacturing of sensors, training of personnel)?

Investment.

Page 10: Productivity and Cost (Optional):

Q48

What is your method's approximate all-inclusive cost per day (single value or range) in 2021 Canadian dollars (please state assumed currency exchange if Canada is not your host country) under typical operating conditions in areas with facility densities up to 0.5 per square km? (if a null response please enter N/A, unknown, decline to answer)

Cost is proportional to time, time is proportional to deployed work practice. Deployed work practice depends on how the user intends to use the system.

Q49

How would this cost per day change if your organization is contracted for multiple days, weeks, months, or years? (N/A, unknown, decline to answer

Cost would reduce as a function of deployment time due to efficiencies associated with reduced training and shipping overhead.

Page 11: Productivity and Cost (Optional):

Q50

Approximately how many sites/day/crew can your technology/method survey for AER Facility Subtype 311/351 (Single well)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

21+,
Survey time per site, cost per site (optional), and additional comments::
N/A - survey cost depends on work practice.

Q51

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 321/361 (Multi-well group battery)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

21+,
Survey time per site, cost per site (optional), and additional comments::
N/A - survey cost depends on work practice.

Q52

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 401 (Gas Plant - Sweet)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

21+,
Survey time per site, cost per site (optional), and additional comments::
N/A - survey cost depends on work practice.

Q53

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 601 (Compressor Station)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

21+,
Survey time per site, cost per site (optional), and additional comments::
N/A - survey cost depends on work practice.

Q54

If your technology or method is not readily quantified using the 4 questions above, please describe your approach to capturing and conveying leak detection efficiencies to your clients (duty holders) and the indicative performance.

The costs per site are dependent on the work practice that is utilized. Our recommended work practice involves immediate follow-up of detected anomalies. The per site time relates to how the operator chooses to follow up on these anomalies, and the number of anomalies.

Page 12: Data Management

Q55

Have LDAR-based data management services been a core requirement of your client/s?

Decline to answer,

If yes/no/varied, are there any key reasons?:
N/A

Q56

Have your clients set specific requirements regarding data management, quality assessment/control, other requirements? Please explain if possible.

N/A

Q57

What LDAR-based data management services does your organization offer?

N/A

Vendor #6 Response

Collector: [redacted]
Started: [redacted]
Last Modified: [redacted]
Time Spent: [redacted]

Page 2: Introduction

Q1

Contact Information (For Administrative Purposes Only - All Responses Are Anonymized)

Respondent Organization:	[redacted]
Respondent Name:	Vendor 6
E-mail:	[redacted]
Response Date (yy/mm/dd):	[redacted]

Q2

Yes

Please confirm your understanding that all data collected as a part of this study are anonymous - check "Yes" to confirm.

Q3

Yes

Are you interested in being contacted for future PTAC methane emissions management research including, potential field campaigns?

Q4

No

Please indicate if you would like your organization to be publicly listed as a participant in this study. In this scenario, your organization would be identified as a participant that contributed data, but your organization's name is not associated with data you have submitted (data anonymity is preserved).

Page 3: General Information and Logistics

Q5

Does your organization have commercial LDAR surveying experience? If yes, please describe e.g., types of LDAR services provided, core markets (industry and/or locations), years of corporate experience with LDAR services.

No

Q6

Does your organization participate in methane measurement markets outside of Alberta? If you intend to enter new methane measurement markets in 2021 or later please answer - Yes.

Yes

Q7

Is your organization able (legally/logistically/etc.) to work in Canada?

Yes

Q8

Is your organization able (legally/logistically/etc.) to work in the United States?

Yes

Q9

Please describe any safety concerns, risks, interruptions or annoyances (for duty holders/operators and/or local residents/communities) possibly introduced by your product/service when completing LDAR surveys (e.g., noise, airspace, road/site congestion).

no concerns at all.

Q10

Has the COVID-19 outbreak and/or recent market conditions affected your operations re. LDAR services or is it expected to affect your operations? Please provide a comment if answering yes.

N/A

Q11

Has the establishment of equivalency with federal methane regulations in Alberta and Saskatchewan affected your operations? e.g., scale, frequency, jurisdictions? Please comment if yes.

N/A

Q12

Have methane-related Canadian provincial and federal programs affected your operations or planned operations? Please comment if yes.

n/a

Page 4: Leak Detection Service Description

Q13

Is your method or technology compliant with AER Directive 60 leak detection methods (e.g., Method 21) or is it intended to be applied in an AltFEMP?

AltFEMP

Q14

Define your method in detail, including what equipment is used and how it is deployed. Points to address include (but are not limited to):

a. Does your organization offer a technology or a method?	**Yes**
b. Does your organization offer a product (for sale?), a service, or a combination?	**Yes**
c. Is the method mobile or stationary?	**It is a satellite constellation.**
d. Does your method require site access or does it measure remotely?	**see c. above**

Q15

What deployment platform(s) is/are used? (for example: hand-held, aerial, truck-mounted, UAV, fixed sensor, portable and temporary on-site mount). If multiple deployment platforms are used, explain them all and how they work together.

Satellite constellation with [redacted].

Q16

What is the specific work practice associated with your methane leak detection method/technology? Several key elements of the work practice are listed below. Please add and comment on any others you feel are pertinent to your offering.

a. At what distances from source are measurements taken?	**we measure from a low Earth orbit (500-500km)**
b. What sensors are employed and how?	**hyperspectral and super-spectral sensors, by satellite.**
c. How many people comprise one field crew? What are their roles?	**We do not have a field crew**
d. How much time is spent surveying each potential source?	**We will cover the complete global infrastructure in 5 days.**
e. How much training are field staff required to have?	**n/a**
f. What output data are generated and reported?	**That is a NDA question.**
Additional work practice details	**PTAC [redacted] We are happy to set up a meeting to provide more detail on measurements.**

Q17

Has your method or technology been included in a successful AltFEMP proposal or application with a provincial regulator e.g., AER accepted Alternative FEMP Proposal, as described in the AER's Submission Checklist for Directive 060: Alternative FEMP Proposals? If yes, please state the jurisdiction, regulator and scale of adoption by clients/duty-holder.

No,

If no, is your organization planning to be involved in an Alternative FEMP Proposal in 2021 or later? Please provide specifics of your participation but do not reference duty holder(s).:

Satellites are listed in the latest manuals by AER. However, they all do not represent accurately what space companies and satellite companies are capable of and are working on.

Page 5: Involvement in an LDAR Program

Q18

What scale(s) i.e., component, equipment, facility does your method/technology target? Note that 'component' means inspectors can confirm, diagnose and tag individual leaks.

Component,

Equipment,

Facility

Q19

Is your leak detection method/technology able to distinguish vented from fugitive emissions?

Yes,

If yes, how? If not, how does it account for potential false positives?:

That is again a NDA questions. It is a very complex process to monitor emissions from space. We have implemented a feasibility study with world-class experts and our technology partners.

Q20

Does the work practice lead to diagnosis and tagging of individual leaks?

Yes,

If yes, how? Please describe in detail the process of going from measurement to tagging of leaks. If no, how does the information generated lead to the mitigation of fugitive emissions/leaks?:
Again, a NDA question.

Page 6: Leak Detection Service Description

Q21

For methods that are unable to confirm and tag individual leaks (i.e. “screening” methods), please define any relevant follow-up work practices used. For example, are follow-up OGI crews sent to high-emitting sites to tag leaks? (N/A, unknown, decline to answer)

We will offer a holistic system. Satellites can scan all infrastructure of our customers in 5 days. Incident detection can be early. That depends on when emissions or leaks occur and when satellites pass over the facility or pipeline. We will offer a holistic and systematic approach. AI will after a while learn to trigger the next step. There is a lot of infrastructure to cover, 100,000s or wells for example. We are not merely focusing on super-emitters like our competitors. Our detection will be superior.

Q22

What criteria are used to determine which sites receive follow-up visits? Examples could include:a. Site-level emissions thresholds to trigger follow-ups (in which case, what thresholds are used?)b. Follow-up ratios, such that the top 50% of emitting sites surveyed in a day receive follow-up surveys (if so, what ratios are used?)(N/A, unknown, decline to answer)

See above. If we will cover in 5 days all of the Canadian infrastructure, there will be a holistic and intelligent follow-up plan in place. When we will measure something, that means that a follow-up crew needs to be deployed.

Q23

What are the roles/tasks of follow-up crews when onsite? For example, do they conduct classic facility-wide OGI surveys, looking for all leaks, or do they target large emitters?a. If following a non-standard work practice, what are the details?b. If not immediate, what is the time interval between screening measurement and follow-up tagging of leaks (in days). Please explain how this delay is estimated.(N/A, unknown, decline to answer)

That depends on the incident. Let's say, we will see emissions of 500kg/hr or 100kg/hr or 50kg/hr, I do argue that someone will go out there to deal with the incident.

Page 7: Technical Specifications

Q24

What is the methane sensor that is used? Where applicable, specify brand or type.

NDA Question. It is a super-spectral sensor.

Q25

Does your surveying result in a quantified flow rate? If no, please skip to next page.

Respondent skipped this question

Q26

What are the minimum and maximum measurable flow rates of your method (m3/day to align with AER regulations - please note if using another unit of measurement e.g., SCFH)? (N/A, unknown, decline to answer)

That is a NDA question. Scientific method of measurement is kg/h.

Q27

Please state its median detection limit (i.e. the flow rate corresponding to a 50% detection probability - please specify a corresponding distance and windspeed)? (N/A, unknown, decline to answer)

Respondent skipped this question

Q28

What is the uncertainty/quantification accuracy of flow rate estimates?

Respondent skipped this question

Q29

Are emissions quantified at the component, equipment or facility level? (N/A, unknown, decline to answer)

Quantification by satellites are part of our approach.

Q30

Has your organization developed detection probability curves for your method? (N/A, unknown, decline to answer)

If yes, which variables contribute to your detection probabilities?:
NDA

Q31

Does your method require environmental data? If so, what types of data required and how are they collected?

We are creating environmental data with our satellites ourselves but apply data fusion with available third-party data.

Q32

Can your organization provide results from controlled release testing (CRT) and/or field performance? Please provide information on methods (e.g. Who conducted the testing? Was it performed indoors or outdoors? Under what range of environmental conditions?)If this information will be or has been published in academic papers, please indicate the paper/project. (N/A, unknown, decline to answer)

We have done tests and are planning more tests via breadboarding.

Q33

Has controlled release testing data or performance data on your organization's method been used in modelling or computer simulations? Were the model results used for AltFEMP proposals (N/A, unknown, decline to answer)

Yes, we have conducted a significant and complex feasibility study. [redacted] Another comment about regulations: Companies need to follow regulations, investors care more about ESG and the overall reputation of companies and their emissions as an industry. This is frankly too much ignored by regulators.

Page 8: Environmental and Operational Constraints

Q34

Under what environmental and operational conditions does your organization not operate in the field (please provide specifics)?

n/a

Q35

What environmental conditions affect your method's performance (e.g., temperature, precipitation, wind)? For each condition, how is performance impacted?

we work with an optical instrument. The weather has an effect on our satellite measurement.

Q36

Please declare the following (qualifying responses if necessary) (N/A, unknown, decline to answer where necessary):

What is the range of temperatures where the technology is operational (°C, max and min)?	**n/a**
What is the range of wind speed where the technology is operational (kmph, max and min)?	**NDA**
How much active rain is tolerated (None, light, medium, heavy)?	**NDA**
What is the maximum deployment humidity (%)?	**NDA**
How much falling snow is tolerated (none, light, medium, heavy)?	**NDA**
How much snow can be tolerated on the ground (none, patchy, thin cover, deep)?	**NDA**

Q37

How long does it take to deploy at the start of the day (exclude time spent driving to individual sites, if that is a part of the method) in minutes?

n/a.

Q38

How long is take-down at the end of the day (exclude time spent driving to individual sites, if that is a part of the method) in minutes?

n/a

Q39

Is deployment required at each individual site? If so, how long does set-up/take-down take (in minutes)?

n/a

Q40

From the day of measurement, what is the guaranteed reporting timeline (in days)? If multiple reports are generated/provided, please explain what information they contain, and the number of days required for delivery of each report. (if a null response please enter N/A, unknown, decline to answer)

We will cover with our capacities all infrastructure in 5 days.

Q41

What is the factor most limiting to safe and efficient field performance leading to high-quality results? (if a null response please enter N/A, unknown, decline to answer)

n/a

Page 9: Supply and Scalability of Service Offering

Q42

Respondent skipped this question

Using single-well batteries as a baseline, approximately how many facilities can each crew inspect in a typical day, week, month, and/or year? (if a null response please enter N/A, unknown, decline to answer)

Q43

Respondent skipped this question

How many independent crews fully equipped with deployment platform, sensor, and trained personnel are currently available for simultaneous deployment? (if a null response please enter N/A, unknown, decline to answer)

Q44

What is your organization's capacity to scale operations to meet your planned/desired market share of leak detection demand in Alberta? Using single well batteries to normalize site counts, how many do you project your operation to service in 2021, 2022, 2023 at 1 event per year (if this measurement of frequency doesn't apply to your method please explain)? (if a null response please enter N/A, unknown, decline to answer)

Respondent skipped this question

Q45

How many quarters in 2021 or years (if beyond) 2021 do you believe it will take to scale your operation to planned capacity based on projected market conditions?

Respondent skipped this question

Q46

Does your organization expect any changes in its overall work capacity (e.g., number of crews, equipment stock, etc.) in the next 5 years? (N/A, unknown, decline to answer)

Respondent skipped this question

Q47

What are your biggest barriers to scaling (e.g. investment, manufacturing of sensors, training of personnel)?

we will launch the first two satellites end of next year. The full constellation in 2024. More via NDA.

Page 10: Productivity and Cost (Optional):

Q48

What is your method's approximate all-inclusive cost per day (single value or range) in 2021 Canadian dollars (please state assumed currency exchange if Canada is not your host country) under typical operating conditions in areas with facility densities up to 0.5 per square km? (if a null response please enter N/A, unknown, decline to answer)

NDA

Q49

How would this cost per day change if your organization is contracted for multiple days, weeks, months, or years? (N/A, unknown, decline to answer

NDA

Page 11: Productivity and Cost (Optional):

Q50

Approximately how many sites/day/crew can your technology/method survey for AER Facility Subtype 311/351 (Single well)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

Survey time per site, cost per site (optional), and additional comments::
see above about the topic of site coverage.

Q51

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 321/361 (Multi-well group battery)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

Survey time per site, cost per site (optional), and additional comments::
see above

Q52

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 401 (Gas Plant - Sweet)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

Survey time per site, cost per site (optional), and additional comments::
see above

Q53

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 601 (Compressor Station)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

Respondent skipped this question

Q54

If your technology or method is not readily quantified using the 4 questions above, please describe your approach to capturing and conveying leak detection efficiencies to your clients (duty holders) and the indicative performance.

I think that most questions do not relate to remote sensing via airborne or satellite systems.

Page 12: Data Management

Q55

Have LDAR-based data management services been a core requirement of your client/s?

N/A

Q56

Have your clients set specific requirements regarding data management, quality assessment/control, other requirements? Please explain if possible.

Respondent skipped this question

Q57

What LDAR-based data management services does your organization offer?

We will offer a client an online data platform to inform about incidences that we were able to detect.

Vendor #7 Response

Collector: [redacted]
Started: [redacted]
Last Modified: [redacted]
Time Spent: [redacted]

Page 2: Introduction

Q1

Contact Information (For Administrative Purposes Only - All Responses Are Anonymized)

Respondent Organization:	[redacted]
Respondent Name:	Vendor 7
Respondent Role:	[redacted]
E-mail:	[redacted]
Phone:	[redacted]
Website:	[redacted]
Response Date (yy/mm/dd):	[redacted]

Q2

Please confirm your understanding that all data collected as a part of this study are anonymous - check "Yes" to confirm.

Yes

Q3

Are you interested in being contacted for future PTAC methane emissions management research including, potential field campaigns?

Yes

Q4

Please indicate if you would like your organization to be publicly listed as a participant in this study. In this scenario, your organization would be identified as a participant that contributed data, but your organization's name is not associated with data you have submitted (data anonymity is preserved).

Yes

Page 3: General Information and Logistics

Q5

Does your organization have commercial LDAR surveying experience? If yes, please describe e.g., types of LDAR services provided, core markets (industry and/or locations), years of corporate experience with LDAR services.

Yes,

If yes, please describe::

[redacted] provides methane monitoring hardware and data tools. We work with service providers and operators to support methane management with passive monitoring tools. Our instrument is installed on any vehicle and measures methane along with regular site work. [redacted]

Q6

Does your organization participate in methane measurement markets outside of Alberta? If you intend to enter new methane measurement markets in 2021 or later please answer - Yes.

Yes,

If yes, which markets? (Optional):

US and EU

Q7

Is your organization able (legally/logistically/etc.) to work in Canada?

Yes

Q8

Is your organization able (legally/logistically/etc.) to work in the United States?

Yes

Q9

Please describe any safety concerns, risks, interruptions or annoyances (for duty holders/operators and/or local residents/communities) possibly introduced by your product/service when completing LDAR surveys (e.g., noise, airspace, road/site congestion).

We don't anticipate any major safety concerns, risks or interruptions with the instrument. A safety concern would be related to the height of the mast and the risk of hitting any low hanging obstructions on a site. Duty holders might be annoyed if site data is requested or a facility inventory. Another challenge might be related to using the vehicle power output which might be occupied by a phone charger or other instrumentation on a fleet vehicle. Finally, the installation takes 20 minutes and space inside of the vehicle or outside might need to re-arranged to make space for the hardware (it's about the size of two briefcases).

Otherwise, it's intended to run with minimal input.

Q10

Has the COVID-19 outbreak and/or recent market conditions affected your operations re. LDAR services or is it expected to affect your operations? Please provide a comment if answering yes.

Yes, ongoing,

If Yes, please explain.:

Vendor 7 is based in [redacted] so it's been challenging [redacted] to develop our business.

Q11

Has the establishment of equivalency with federal methane regulations in Alberta and Saskatchewan affected your operations? e.g., scale, frequency, jurisdictions? Please comment if yes.

We are happy to see that the equivalent regulations include opportunities for alternative LDAR programs.

Q12

Have methane-related Canadian provincial and federal programs affected your operations or planned operations? Please comment if yes.

The imposition of federal methane regulations in the first place has been a positive for our business. We can plan to develop our business knowing that methane will need to be monitored for the foreseeable future.

Page 4: Leak Detection Service Description

Q13

Is your method or technology compliant with AER Directive 60 leak detection methods (e.g., Method 21) or is it intended to be applied in an AltFEMP?

Respondent skipped this question

Q14

Define your method in detail, including what equipment is used and how it is deployed. Points to address include (but are not limited to):

Respondent skipped this question

Q15

What deployment platform(s) is/are used? (for example: hand-held, aerial, truck-mounted, UAV, fixed sensor, portable and temporary on-site mount). If multiple deployment platforms are used, explain them all and how they work together.

Respondent skipped this question

Q16

What is the specific work practice associated with your methane leak detection method/technology? Several key elements of the work practice are listed below. Please add and comment on any others you feel are pertinent to your offering.

Respondent skipped this question

Q17

Respondent skipped this question

Has your method or technology been included in a successful AltFEMP proposal or application with a provincial regulator e.g., AER accepted Alternative FEMP Proposal, as described in the AER's Submission Checklist for Directive 060: Alternative FEMP Proposals? If yes, please state the jurisdiction, regulator and scale of adoption by clients/duty-holder.

Page 5: Involvement in an LDAR Program

Q18

Respondent skipped this question

What scale(s) i.e., component, equipment, facility does your method/technology target? Note that 'component' means inspectors can confirm, diagnose and tag individual leaks.

Q19

Respondent skipped this question

Is your leak detection method/technology able to distinguish vented from fugitive emissions?

Q20

Respondent skipped this question

Does the work practice lead to diagnosis and tagging of individual leaks?

Page 6: Leak Detection Service Description

Q21

Respondent skipped this question

For methods that are unable to confirm and tag individual leaks (i.e. "screening" methods), please define any relevant follow-up work practices used. For example, are follow-up OGI crews sent to high-emitting sites to tag leaks? (N/A, unknown, decline to answer)

Q22

Respondent skipped this question

What criteria are used to determine which sites receive follow-up visits? Examples could include:a. Site-level emissions thresholds to trigger follow-ups (in which case, what thresholds are used?)b. Follow-up ratios, such that the top 50% of emitting sites surveyed in a day receive follow-up surveys (if so, what ratios are used?)(N/A, unknown, decline to answer)

Q23

What are the roles/tasks of follow-up crews when onsite? For example, do they conduct classic facility-wide OGI surveys, looking for all leaks, or do they target large emitters?a. If following a non-standard work practice, what are the details?b. If not immediate, what is the time interval between screening measurement and follow-up tagging of leaks (in days). Please explain how this delay is estimated.(N/A, unknown, decline to answer)

Respondent skipped this question

Page 7: Technical Specifications

Q24

What is the methane sensor that is used? Where applicable, specify brand or type.

Respondent skipped this question

Q25

Does your surveying result in a quantified flow rate? If no, please skip to next page.

Respondent skipped this question

Q26

What are the minimum and maximum measurable flow rates of your method (m3/day to align with AER regulations - please note if using another unit of measurement e.g., SCFH)? (N/A, unknown, decline to answer)

Respondent skipped this question

Q27

Please state its median detection limit (i.e. the flow rate corresponding to a 50% detection probability - please specify a corresponding distance and windspeed)? (N/A, unknown, decline to answer)

Respondent skipped this question

Q28

What is the uncertainty/quantification accuracy of flow rate estimates?

Respondent skipped this question

Q29

Are emissions quantified at the component, equipment or facility level? (N/A, unknown, decline to answer)

Respondent skipped this question

Q30

Has your organization developed detection probability curves for your method? (N/A, unknown, decline to answer)

Respondent skipped this question

Q31

Does your method require environmental data? If so, what types of data required and how are they collected?

Respondent skipped this question

Q32

Can your organization provide results from controlled release testing (CRT) and/or field performance? Please provide information on methods (e.g. Who conducted the testing? Was it performed indoors or outdoors? Under what range of environmental conditions?)If this information will be or has been published in academic papers, please indicate the paper/project. (N/A, unknown, decline to answer)

Respondent skipped this question

Q33

Has controlled release testing data or performance data on your organization's method been used in modelling or computer simulations? Were the model results used for AltFEMP proposals (N/A, unknown, decline to answer)

Respondent skipped this question

Page 8: Environmental and Operational Constraints

Q34

Under what environmental and operational conditions does your organization not operate in the field (please provide specifics)?

Respondent skipped this question

Q35

What environmental conditions affect your method's performance (e.g., temperature, precipitation, wind)? For each condition, how is performance impacted?

Respondent skipped this question

Q36

Please declare the following (qualifying responses if necessary) (N/A, unknown, decline to answer where necessary):

Respondent skipped this question

Q37

How long does it take to deploy at the start of the day (exclude time spent driving to individual sites, if that is a part of the method) in minutes?

Respondent skipped this question

Q38

How long is take-down at the end of the day (exclude time spent driving to individual sites, if that is a part of the method) in minutes?

Respondent skipped this question

Q39

Is deployment required at each individual site? If so, how long does set-up/take-down take (in minutes)?

Respondent skipped this question

Q40

From the day of measurement, what is the guaranteed reporting timeline (in days)? If multiple reports are generated/provided, please explain what information they contain, and the number of days required for delivery of each report. (if a null response please enter N/A, unknown, decline to answer)

Respondent skipped this question

Q41

What is the factor most limiting to safe and efficient field performance leading to high-quality results? (if a null response please enter N/A, unknown, decline to answer)

Respondent skipped this question

Page 9: Supply and Scalability of Service Offering

Q42

Using single-well batteries as a baseline, approximately how many facilities can each crew inspect in a typical day, week, month, and/or year? (if a null response please enter N/A, unknown, decline to answer)

Respondent skipped this question

Q43

How many independent crews fully equipped with deployment platform, sensor, and trained personnel are currently available for simultaneous deployment? (if a null response please enter N/A, unknown, decline to answer)

Respondent skipped this question

Q44

What is your organization's capacity to scale operations to meet your planned/desired market share of leak detection demand in Alberta? Using single well batteries to normalize site counts, how many do you project your operation to service in 2021, 2022, 2023 at 1 event per year (if this measurement of frequency doesn't apply to your method please explain)? (if a null response please enter N/A, unknown, decline to answer)

Respondent skipped this question

Q45

How many quarters in 2021 or years (if beyond) 2021 do you believe it will take to scale your operation to planned capacity based on projected market conditions?

Respondent skipped this question

Q46

Does your organization expect any changes in its overall work capacity (e.g., number of crews, equipment stock, etc.) in the next 5 years? (N/A, unknown, decline to answer)

Respondent skipped this question

Q47

What are your biggest barriers to scaling (e.g. investment, manufacturing of sensors, training of personnel)?

Respondent skipped this question

Page 10: Productivity and Cost (Optional):

Q48

What is your method's approximate all-inclusive cost per day (single value or range) in 2021 Canadian dollars (please state assumed currency exchange if Canada is not your host country) under typical operating conditions in areas with facility densities up to 0.5 per square km? (if a null response please enter N/A, unknown, decline to answer)

Respondent skipped this question

Q49

How would this cost per day change if your organization is contracted for multiple days, weeks, months, or years? (N/A, unknown, decline to answer

Respondent skipped this question

Page 11: Productivity and Cost (Optional):

Q50

Approximately how many sites/day/crew can your technology/method survey for AER Facility Subtype 311/351 (Single well)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

Respondent skipped this question

Q51

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 321/361 (Multi-well group battery)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

Respondent skipped this question

Q52

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 401 (Gas Plant - Sweet)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

Respondent skipped this question

Q53

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 601 (Compressor Station)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

Respondent skipped this question

Q54

If your technology or method is not readily quantified using the 4 questions above, please describe your approach to capturing and conveying leak detection efficiencies to your clients (duty holders) and the indicative performance.

Respondent skipped this question

Page 12: Data Management

Q55

Have LDAR-based data management services been a core requirement of your client/s?

Respondent skipped this question

Q56

Have your clients set specific requirements regarding data management, quality assessment/control, other requirements? Please explain if possible.

Respondent skipped this question

Q57

What LDAR-based data management services does your organization offer?

Respondent skipped this question

Vendor #8 Response

Collector: [redacted]
Started: [redacted]
Last Modified: [redacted]
Time Spent: [redacted]

Page 2: Introduction

Q1

Contact Information (For Administrative Purposes Only - All Responses Are Anonymized)

Respondent Organization:	[redacted]
Respondent Name:	Vendor 8
Respondent Role:	[redacted]
E-mail:	[redacted]
Phone:	[redacted]
Website:	[redacted]
Response Date (yy/mm/dd):	[redacted]

Q2

Please confirm your understanding that all data collected as a part of this study are anonymous - check "Yes" to confirm.

Yes

Q3

Are you interested in being contacted for future PTAC methane emissions management research including, potential field campaigns?

Yes

Q4

Please indicate if you would like your organization to be publicly listed as a participant in this study. In this scenario, your organization would be identified as a participant that contributed data, but your organization's name is not associated with data you have submitted (data anonymity is preserved).

Yes

Page 3: General Information and Logistics

Q5

Does your organization have commercial LDAR surveying experience? If yes, please describe e.g., types of LDAR services provided, core markets (industry and/or locations), years of corporate experience with LDAR services.

Yes,

If yes, please describe::
[redacted] dedicated leak detection company covering everything from pipelines to facilities. We conduct facility inspections for troubleshooting, regulatory and specialize in start-up/commissioning with our proprietary tracer gas system. We utilize both FLIR and OpGal OGI cameras as well as a suite of laser, ultrasonic and thermal conductivity detection devices. We typically quantify with the High flow sampler, various vent gas data logging systems and plume calculation software informally called photonics.

Q6

Does your organization participate in methane measurement markets outside of Alberta? If you intend to enter new methane measurement markets in 2021 or later please answer - Yes.

Yes,

If yes, which markets? (Optional):
[redacted]

Q7

Is your organization able (legally/logistically/etc.) to work in Canada?

Yes

Q8

Is your organization able (legally/logistically/etc.) to work in the United States?

Yes

Q9

Please describe any safety concerns, risks, interruptions or annoyances (for duty holders/operators and/or local residents/communities) possibly introduced by your product/service when completing LDAR surveys (e.g., noise, airspace, road/site congestion).

Unnecessary flaring overwhelms sensors, too many people (black body baseline) and vehicles in the area can obscure small emission sources and fatigue the operator. As little background movement as possible is best.

Q10

Has the COVID-19 outbreak and/or recent market conditions affected your operations re. LDAR services or is it expected to affect your operations? Please provide a comment if answering yes.

Yes, ongoing,

If Yes, please explain.:
Additional safety measures and the costs born from them. Some companies were permitted to skip inspections.

Q11

Has the establishment of equivalency with federal methane regulations in Alberta and Saskatchewan affected your operations? e.g., scale, frequency, jurisdictions? Please comment if yes.

Mandated frequency has obviously increased.

Q12

Have methane-related Canadian provincial and federal programs affected your operations or planned operations? Please comment if yes.

Yes. While there is more work, every laid off engineer in Calgary bought a camera and is taking a stab at it. With that goes profit. More work to bid on but at very thin margins.

Page 4: Leak Detection Service Description

Q13

Is your method or technology compliant with AER Directive 60 leak detection methods (e.g., Method 21) or is it intended to be applied in an AltFEMP?

AER Directive 60 Compliant / Method 21

Q14

Define your method in detail, including what equipment is used and how it is deployed. Points to address include (but are not limited to):

a. Does your organization offer a technology or a method?	**Yes**
b. Does your organization offer a product (for sale?), a service, or a combination?	**Combo**
c. Is the method mobile or stationary?	**Mobile**
d. Does your method require site access or does it measure remotely?	**N/A**

Q15

What deployment platform(s) is/are used? (for example: hand-held, aerial, truck-mounted, UAV, fixed sensor, portable and temporary on-site mount). If multiple deployment platforms are used, explain them all and how they work together.

Hand held, truck/ATV mounted, UAV, pipeline GPS inspection software

Q16

What is the specific work practice associated with your methane leak detection method/technology? Several key elements of the work practice are listed below. Please add and comment on any others you feel are pertinent to your offering.

a. At what distances from source are measurements taken?	**Most are captured as they come to atmosphere. Others, like photonics, can be several meters away.**
b. What sensors are employed and how?	**Varies**
c. How many people comprise one field crew? What are their roles?	**1-3 depending on a la carte**
d. How much time is spent surveying each potential source?	**Depends on size. Small ones are as quick as 5 minutes. Some (compressor seals)**
e. How much training are field staff required to have?	**1-3 years depending on aptitude**
f. What output data are generated and reported?	**We are customer #2 [redacted] the very best data collection and analysis product out there.**

Q17

Decline to Answer

Has your method or technology been included in a successful AltFEMP proposal or application with a provincial regulator e.g., AER accepted Alternative FEMP Proposal, as described in the AER's Submission Checklist for Directive 060: Alternative FEMP Proposals? If yes, please state the jurisdiction, regulator and scale of adoption by clients/duty-holder.

Page 5: Involvement in an LDAR Program

Q18

Facility

What scale(s) i.e., component, equipment, facility does your method/technology target? Note that 'component' means inspectors can confirm, diagnose and tag individual leaks.

Q19

Decline to answer

Is your leak detection method/technology able to distinguish vented from fugitive emissions?

Q20

Does the work practice lead to diagnosis and tagging of individual leaks?

Yes,

If yes, how? Please describe in detail the process of going from measurement to tagging of leaks. If no, how does the information generated lead to the mitigation of fugitive emissions/leaks?:
Source identified, measured, data (pic, video, description, flow rate) inputted into intrinsically safe tablet, Bluetooth printed on a thermal tag and affixed to the leak source with flagging.

Page 6: Leak Detection Service Description

Q21

For methods that are unable to confirm and tag individual leaks (i.e. "screening" methods), please define any relevant follow-up work practices used. For example, are follow-up OGI crews sent to high-emitting sites to tag leaks? (N/A, unknown, decline to answer)

Decline

Q22

What criteria are used to determine which sites receive follow-up visits? Examples could include:a. Site-level emissions thresholds to trigger follow-ups (in which case, what thresholds are used?)b. Follow-up ratios, such that the top 50% of emitting sites surveyed in a day receive follow-up surveys (if so, what ratios are used?)(N/A, unknown, decline to answer)

Budget. Typically there balking at any duplicative visit to a site.

Q23

What are the roles/tasks of follow-up crews when onsite? For example, do they conduct classic facility-wide OGI surveys, looking for all leaks, or do they target large emitters?a. If following a non-standard work practice, what are the details?b. If not immediate, what is the time interval between screening measurement and follow-up tagging of leaks (in days). Please explain how this delay is estimated.(N/A, unknown, decline to answer)

Decline

Page 7: Technical Specifications

Q24

What is the methane sensor that is used? Where applicable, specify brand or type.

Decline

Q25

Does your surveying result in a quantified flow rate? If no, please skip to next page.

Yes

Q26

What are the minimum and maximum measurable flow rates of your method (m3/day to align with AER regulations - please note if using another unit of measurement e.g., SCFH)? (N/A, unknown, decline to answer)

Decline

Q27

Please state its median detection limit (i.e. the flow rate corresponding to a 50% detection probability - please specify a corresponding distance and windspeed)? (N/A, unknown, decline to answer)

D

Q28

What is the uncertainty/quantification accuracy of flow rate estimates?

D

Q29

Are emissions quantified at the component, equipment or facility level? (N/A, unknown, decline to answer)

Comp

Q30

Has your organization developed detection probability curves for your method? (N/A, unknown, decline to answer)

Decline to Answer

Q31

Does your method require environmental data? If so, what types of data required and how are they collected?

D

Q32

Can your organization provide results from controlled release testing (CRT) and/or field performance? Please provide information on methods (e.g. Who conducted the testing? Was it performed indoors or outdoors? Under what range of environmental conditions?)If this information will be or has been published in academic papers, please indicate the paper/project. (N/A, unknown, decline to answer)

Done several. Cannot share.

Q33

Has controlled release testing data or performance data on your organization's method been used in modelling or computer simulations? Were the model results used for AltFEMP proposals (N/A, unknown, decline to answer)

D

Page 8: Environmental and Operational Constraints

Q34

Under what environmental and operational conditions does your organization not operate in the field (please provide specifics)?

Super snow conditions overwhelm the IT sensors. Very windy conditions can blow dirt on equipment.

Q35

What environmental conditions affect your method's performance (e.g., temperature, precipitation, wind)? For each condition, how is performance impacted?

Nothing works in the cold. Rain isn't good on equipment. Wind is too dusty and makes small emission sources difficult to see.

Q36

Please declare the following (qualifying responses if necessary) (N/A, unknown, decline to answer where necessary):

What is the range of temperatures where the technology is operational (°C, max and min)?	**-30 to +40**
What is the range of wind speed where the technology is operational (kmph, max and min)?	**Max 30/hr average.**
How much active rain is tolerated (None, light, medium, heavy)?	**Light**
What is the maximum deployment humidity (%)?	**Any**
How much falling snow is tolerated (none, light, medium, heavy)?	**Light**
How much snow can be tolerated on the ground (none, patchy, thin cover, deep)?	**Depends. If it covers connections it's too deep.**

Q37

How long does it take to deploy at the start of the day (exclude time spent driving to individual sites, if that is a part of the method) in minutes?

After FLHA and permitting, we're ready to do spect in 10min.

Q38

How long is take-down at the end of the day (exclude time spent driving to individual sites, if that is a part of the method) in minutes?

10min

Q39

Is deployment required at each individual site? If so, how long does set-up/take-down take (in minutes)?

10min

Q40

From the day of measurement, what is the guaranteed reporting timeline (in days)? If multiple reports are generated/provided, please explain what information they contain, and the number of days required for delivery of each report. (if a null response please enter N/A, unknown, decline to answer)

D

Q41

What is the factor most limiting to safe and efficient field performance leading to high-quality results? (if a null response please enter N/A, unknown, decline to answer)

D.

Page 9: Supply and Scalability of Service Offering

Q42

Using single-well batteries as a baseline, approximately how many facilities can each crew inspect in a typical day, week, month, and/or year? (if a null response please enter N/A, unknown, decline to answer)

D

Q43

How many independent crews fully equipped with deployment platform, sensor, and trained personnel are currently available for simultaneous deployment? (if a null response please enter N/A, unknown, decline to answer)

6

Q44

What is your organization’s capacity to scale operations to meet your planned/desired market share of leak detection demand in Alberta? Using single well batteries to normalize site counts, how many do you project your operation to service in 2021, 2022, 2023 at 1 event per year (if this measurement of frequency doesn't apply to your method please explain)? (if a null response please enter N/A, unknown, decline to answer)

D

Q45

How many quarters in 2021 or years (if beyond) 2021 do you believe it will take to scale your operation to planned capacity based on projected market conditions?

D

Q46

Does your organization expect any changes in its overall work capacity (e.g., number of crews, equipment stock, etc.) in the next 5 years? (N/A, unknown, decline to answer)

Yes

Q47

What are your biggest barriers to scaling (e.g. investment, manufacturing of sensors, training of personnel)?

Profitability. As mentioned, everyone has gotten into the business and lowered the prices at a time when the prices should be holding sting as demand surges.

Page 10: Productivity and Cost (Optional):

Q48

What is your method’s approximate all-inclusive cost per day (single value or range) in 2021 Canadian dollars (please state assumed currency exchange if Canada is not your host country) under typical operating conditions in areas with facility densities up to 0.5 per square km? (if a null response please enter N/A, unknown, decline to answer)

D

Q49

How would this cost per day change if your organization is contracted for multiple days, weeks, months, or years? (N/A, unknown, decline to answer

D

Page 11: Productivity and Cost (Optional):

Q50

Approximately how many sites/day/crew can your technology/method survey for AER Facility Subtype 311/351 (Single well)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

6-10

Q51

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 321/361 (Multi-well group battery)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

1-5

Q52

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 401 (Gas Plant - Sweet)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

1-5

Q53

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 601 (Compressor Station)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

1-5

Q54

If your technology or method is not readily quantified using the 4 questions above, please describe your approach to capturing and conveying leak detection efficiencies to your clients (duty holders) and the indicative performance.

Respondent skipped this question

Page 12: Data Management

Q55

Have LDAR-based data management services been a core requirement of your client/s?

Yes

Q56

Have your clients set specific requirements regarding data management, quality assessment/control, other requirements? Please explain if possible.

Respondent skipped this question

Q57

What LDAR-based data management services does your organization offer?

[redacted]

Vendor #9 Response

Collector: [redacted]
[redacted]

Page 2: Introduction

Q1

Contact Information (For Administrative Purposes Only - All Responses Are Anonymized)

Respondent Organization:	[redacted]
Respondent Name:	Vendor 9
Respondent Role:	[redacted]
E-mail:	[redacted]
Phone:	[redacted]
Website:	[redacted]
Response Date (yy/mm/dd):	[redacted]

Q2

Please confirm your understanding that all data collected as a part of this study are anonymous - check "Yes" to confirm.

Yes

Q3

Are you interested in being contacted for future PTAC methane emissions management research including, potential field campaigns?

Yes

Q4

Please indicate if you would like your organization to be publicly listed as a participant in this study. In this scenario, your organization would be identified as a participant that contributed data, but your organization's name is not associated with data you have submitted (data anonymity is preserved).

Yes

Page 3: General Information and Logistics

Q5

Does your organization have commercial LDAR surveying experience? If yes, please describe e.g., types of LDAR services provided, core markets (industry and/or locations), years of corporate experience with LDAR services.

Yes,
If yes, please describe::
Pipeline and facility leak survey and data management. Wide area mapping and leak detection. Alberta, BC, Saskatchewan.

Q6

Does your organization participate in methane measurement markets outside of Alberta? If you intend to enter new methane measurement markets in 2021 or later please answer - Yes.

Yes,
If yes, which markets? (Optional):
BC/Saskatchewan

Q7

Is your organization able (legally/logistically/etc.) to work in Canada?

Yes

Q8

Is your organization able (legally/logistically/etc.) to work in the United States?

Yes

Q9

Please describe any safety concerns, risks, interruptions or annoyances (for duty holders/operators and/or local residents/communities) possibly introduced by your product/service when completing LDAR surveys (e.g., noise, airspace, road/site congestion).

Occasional staff walking on customer property.

Q10

Has the COVID-19 outbreak and/or recent market conditions affected your operations re. LDAR services or is it expected to affect your operations? Please provide a comment if answering yes.

Yes, ongoing,
If Yes, please explain.:
Several clients postponing/cancelling leak detection projects.

Q11

Has the establishment of equivalency with federal methane regulations in Alberta and Saskatchewan affected your operations? e.g., scale, frequency, jurisdictions? Please comment if yes.

No

Q12

Have methane-related Canadian provincial and federal programs affected your operations or planned operations? Please comment if yes.

Not yet.

Page 4: Leak Detection Service Description

Q13

Is your method or technology compliant with AER Directive 60 leak detection methods (e.g., Method 21) or is it intended to be applied in an AltFEMP?

Respondent skipped this question

Q14

Define your method in detail, including what equipment is used and how it is deployed. Points to address include (but are not limited to):

Respondent skipped this question

Q15

What deployment platform(s) is/are used? (for example: hand-held, aerial, truck-mounted, UAV, fixed sensor, portable and temporary on-site mount). If multiple deployment platforms are used, explain them all and how they work together.

Respondent skipped this question

Q16

What is the specific work practice associated with your methane leak detection method/technology? Several key elements of the work practice are listed below. Please add and comment on any others you feel are pertinent to your offering.

Respondent skipped this question

Q17

Has your method or technology been included in a successful AltFEMP proposal or application with a provincial regulator e.g., AER accepted Alternative FEMP Proposal, as described in the AER's Submission Checklist for Directive 060: Alternative FEMP Proposals? If yes, please state the jurisdiction, regulator and scale of adoption by clients/duty-holder.

Respondent skipped this question

Page 5: Involvement in an LDAR Program

Q18

What scale(s) i.e., component, equipment, facility does your method/technology target? Note that ‘component’ means inspectors can confirm, diagnose and tag individual leaks.

Respondent skipped this question

Q19

Is your leak detection method/technology able to distinguish vented from fugitive emissions?

Respondent skipped this question

Q20

Does the work practice lead to diagnosis and tagging of individual leaks?

Respondent skipped this question

Page 6: Leak Detection Service Description

Q21

For methods that are unable to confirm and tag individual leaks (i.e. “screening” methods), please define any relevant follow-up work practices used. For example, are follow-up OGI crews sent to high-emitting sites to tag leaks? (N/A, unknown, decline to answer)

Respondent skipped this question

Q22

What criteria are used to determine which sites receive follow-up visits? Examples could include:a. Site-level emissions thresholds to trigger follow-ups (in which case, what thresholds are used?)b. Follow-up ratios, such that the top 50% of emitting sites surveyed in a day receive follow-up surveys (if so, what ratios are used?)(N/A, unknown, decline to answer)

Respondent skipped this question

Q23

What are the roles/tasks of follow-up crews when onsite? For example, do they conduct classic facility-wide OGI surveys, looking for all leaks, or do they target large emitters?a. If following a non-standard work practice, what are the details?b. If not immediate, what is the time interval between screening measurement and follow-up tagging of leaks (in days). Please explain how this delay is estimated.(N/A, unknown, decline to answer)

Respondent skipped this question

Page 7: Technical Specifications

Q24

What is the methane sensor that is used? Where applicable, specify brand or type.

Respondent skipped this question

Q25

Does your surveying result in a quantified flow rate? If no, please skip to next page.

Respondent skipped this question

Q26

What are the minimum and maximum measurable flow rates of your method (m3/day to align with AER regulations - please note if using another unit of measurement e.g., SCFH)? (N/A, unknown, decline to answer)

Respondent skipped this question

Q27

Please state its median detection limit (i.e. the flow rate corresponding to a 50% detection probability - please specify a corresponding distance and windspeed)? (N/A, unknown, decline to answer)

Respondent skipped this question

Q28

What is the uncertainty/quantification accuracy of flow rate estimates?

Respondent skipped this question

Q29

Are emissions quantified at the component, equipment or facility level? (N/A, unknown, decline to answer)

Respondent skipped this question

Q30

Has your organization developed detection probability curves for your method? (N/A, unknown, decline to answer)

Respondent skipped this question

Q31

Does your method require environmental data? If so, what types of data required and how are they collected?

Respondent skipped this question

Q32

Can your organization provide results from controlled release testing (CRT) and/or field performance? Please provide information on methods (e.g. Who conducted the testing? Was it performed indoors or outdoors? Under what range of environmental conditions?)If this information will be or has been published in academic papers, please indicate the paper/project. (N/A, unknown, decline to answer)

Respondent skipped this question

Q33

Has controlled release testing data or performance data on your organization's method been used in modelling or computer simulations? Were the model results used for AltFEMP proposals (N/A, unknown, decline to answer)

Respondent skipped this question

Page 8: Environmental and Operational Constraints

Q34

Under what environmental and operational conditions does your organization not operate in the field (please provide specifics)?

Respondent skipped this question

Q35

What environmental conditions affect your method's performance (e.g., temperature, precipitation, wind)? For each condition, how is performance impacted?

Respondent skipped this question

Q36

Please declare the following (qualifying responses if necessary) (N/A, unknown, decline to answer where necessary):

Respondent skipped this question

Q37

How long does it take to deploy at the start of the day (exclude time spent driving to individual sites, if that is a part of the method) in minutes?

Respondent skipped this question

Q38

How long is take-down at the end of the day (exclude time spent driving to individual sites, if that is a part of the method) in minutes?

Respondent skipped this question

Q39

Is deployment required at each individual site? If so, how long does set-up/take-down take (in minutes)?

Respondent skipped this question

Q40

From the day of measurement, what is the guaranteed reporting timeline (in days)? If multiple reports are generated/provided, please explain what information they contain, and the number of days required for delivery of each report. (if a null response please enter N/A, unknown, decline to answer)

Respondent skipped this question

Q41

What is the factor most limiting to safe and efficient field performance leading to high-quality results? (if a null response please enter N/A, unknown, decline to answer)

Respondent skipped this question

Page 9: Supply and Scalability of Service Offering

Q42

Using single-well batteries as a baseline, approximately how many facilities can each crew inspect in a typical day, week, month, and/or year? (if a null response please enter N/A, unknown, decline to answer)

Respondent skipped this question

Q43

How many independent crews fully equipped with deployment platform, sensor, and trained personnel are currently available for simultaneous deployment? (if a null response please enter N/A, unknown, decline to answer)

Respondent skipped this question

Q44

What is your organization’s capacity to scale operations to meet your planned/desired market share of leak detection demand in Alberta? Using single well batteries to normalize site counts, how many do you project your operation to service in 2021, 2022, 2023 at 1 event per year (if this measurement of frequency doesn't apply to your method please explain)? (if a null response please enter N/A, unknown, decline to answer)

Respondent skipped this question

Q45

How many quarters in 2021 or years (if beyond) 2021 do you believe it will take to scale your operation to planned capacity based on projected market conditions?

Respondent skipped this question

Q46

Does your organization expect any changes in its overall work capacity (e.g., number of crews, equipment stock, etc.) in the next 5 years? (N/A, unknown, decline to answer)

Respondent skipped this question

Q47

What are your biggest barriers to scaling (e.g. investment, manufacturing of sensors, training of personnel)?

Respondent skipped this question

Page 10: Productivity and Cost (Optional):

Q48

What is your method's approximate all-inclusive cost per day (single value or range) in 2021 Canadian dollars (please state assumed currency exchange if Canada is not your host country) under typical operating conditions in areas with facility densities up to 0.5 per square km? (if a null response please enter N/A, unknown, decline to answer)

Respondent skipped this question

Q49

How would this cost per day change if your organization is contracted for multiple days, weeks, months, or years? (N/A, unknown, decline to answer

Respondent skipped this question

Page 11: Productivity and Cost (Optional):

Q50

Approximately how many sites/day/crew can your technology/method survey for AER Facility Subtype 311/351 (Single well)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

Respondent skipped this question

Q51

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 321/361 (Multi-well group battery)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

Respondent skipped this question

Q52

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 401 (Gas Plant - Sweet)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

Respondent skipped this question

Q53

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 601 (Compressor Station)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

Respondent skipped this question

Q54

If your technology or method is not readily quantified using the 4 questions above, please describe your approach to capturing and conveying leak detection efficiencies to your clients (duty holders) and the indicative performance.

Respondent skipped this question

Page 12: Data Management

Q55

Have LDAR-based data management services been a core requirement of your client/s?

Respondent skipped this question

Q56

Have your clients set specific requirements regarding data management, quality assessment/control, other requirements? Please explain if possible.

Respondent skipped this question

Q57

What LDAR-based data management services does your organization offer?

Respondent skipped this question

Vendor #10 Response

Collector: [redacted]

[redacted]

Page 2: Introduction

Q1

Contact Information (For Administrative Purposes Only - All Responses Are Anonymized)

Respondent Organization:	[redacted]
Respondent Name:	Vendor 10
Respondent Role:	[redacted]
E-mail:	[redacted]
Phone:	[redacted]
Website:	[redacted]
Response Date (yy/mm/dd):	[redacted]

Q2

Please confirm your understanding that all data collected as a part of this study are anonymous - check "Yes" to confirm.

Yes

Q3

Are you interested in being contacted for future PTAC methane emissions management research including, potential field campaigns?

Yes

Q4

Please indicate if you would like your organization to be publicly listed as a participant in this study. In this scenario, your organization would be identified as a participant that contributed data, but your organization's name is not associated with data you have submitted (data anonymity is preserved).

Yes

Page 3: General Information and Logistics

Q5

Does your organization have commercial LDAR surveying experience? If yes, please describe e.g., types of LDAR services provided, core markets (industry and/or locations), years of corporate experience with LDAR services.

Yes,

If yes, please describe::

[redacted] provides continuous monitoring using low-cost IoT devices that are installed around the fence line of a LDAR compliant site. Our continuous monitoring solution enables real-time detection of leaks that lead to faster repair and a greater reduction in GHG emitted to the atmosphere. Our sensors are capable of detecting methane, H_2S, SO_2, NO and CO as well as measuring meteorological data such as wind speed and direction that is necessary for quantifying and locating leak sources. To date we have [redacted] deployments across Alberta.

Q6

Does your organization participate in methane measurement markets outside of Alberta? If you intend to enter new methane measurement markets in 2021 or later please answer - Yes.

Yes,

If yes, which markets? (Optional):

US

Q7

Is your organization able (legally/logistically/etc.) to work in Canada?

Yes

Q8

Is your organization able (legally/logistically/etc.) to work in the United States?

Yes

Q9

Please describe any safety concerns, risks, interruptions or annoyances (for duty holders/operators and/or local residents/communities) possibly introduced by your product/service when completing LDAR surveys (e.g., noise, airspace, road/site congestion).

No. Our devices are designed to be low power and low maintenance with very little chance of triggering any sparks. We are in the process of getting class 1 div 2 safety certification.

Q10

Has the COVID-19 outbreak and/or recent market conditions affected your operations re. LDAR services or is it expected to affect your operations? Please provide a comment if answering yes.

No

Q11

Has the establishment of equivalency with federal methane regulations in Alberta and Saskatchewan affected your operations? e.g., scale, frequency, jurisdictions? Please comment if yes.

We have submitted [redacted] (Alt-FEMP) Pilot as of [redacted] and aim to launch our pilot in [redacted]. We plan to use our experience with the AER to apply for additional Alt-FEMPs with other operators in Alberta as well as in other provinces with equivalency frameworks

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Q12

Have methane-related Canadian provincial and federal programs affected your operations or planned operations? Please comment if yes.

We have been the recipients of federal and provincial funding programs [redacted] to help develop and deploy our technology with industry partners

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Page 4: Leak Detection Service Description

Q13

Is your method or technology compliant with AER Directive 60 leak detection methods (e.g., Method 21) or is it intended to be applied in an AltFEMP?

AltFEMP

Q14

Define your method in detail, including what equipment is used and how it is deployed. Points to address include (but are not limited to):

a. Does your organization offer a technology or a method?	**Technology: IoT device deployed at site, cloud platform for storing and analyzing data and web-based dashboard for viewing data and insights**
b. Does your organization offer a product (for sale?), a service, or a combination?	**Combination of products (e.g., IoT device, dashboard) and service (e.g., install, calibration and maintenance of devices deployed in the field)**
c. Is the method mobile or stationary?	**Stationary as its meant to continuously monitor when deployed but can be moved to other sites relatively easy**
d. Does your method require site access or does it measure remotely?	**Can measure remotely but should be deployed between 10-100m from physical asset. We typically deploy around the fence line of a site**

Q15

What deployment platform(s) is/are used? (for example: hand-held, aerial, truck-mounted, UAV, fixed sensor, portable and temporary on-site mount). If multiple deployment platforms are used, explain them all and how they work together.

[redacted] provides continuous monitoring using low-cost IoT devices that are installed around the fence line of a LDAR compliant site. Our continuous monitoring solution enables real-time detection of leaks that lead to faster repair and a greater reduction in GHG emitted to the atmosphere. Our sensors are capable of detecting methane, H2S, SO2, NO and CO as well as measuring meteorological data such as wind speed and direction that is necessary for quantifying and locating leak sources

Q16

What is the specific work practice associated with your methane leak detection method/technology? Several key elements of the work practice are listed below. Please add and comment on any others you feel are pertinent to your offering.

a. At what distances from source are measurements taken?	**Ideally between 10-100m**
b. What sensors are employed and how?	**A mix of electrochemical and metal oxide gas sensors are continuously measuring concentrations while compensating for temperature and humidity**
c. How many people comprise one field crew? What are their roles?	**Two. Installation, calibration and field testing**
d. How much time is spent surveying each potential source?	**Continuously 24hrs per day sampling up to every second if required**
e. How much training are field staff required to have?	**Minimal. They need to know how to install a device on the fence line**
f. What output data are generated and reported?	**Time series gas concentration data across 5+ gases along with local meteorological conditions (temperature, wind speed/direction, humidity, pressure)**
Additional work practice details	[redacted] **employs a proprietary alerting system which has various levels that get triggered depending on IoT measurements (e.g., level 1 indicates a peak of 2x the standard deviation above a rolling 5-day average, level 3 indicates repeatability of level 1 alert given similar meteorological conditions)**

Q17

Has your method or technology been included in a successful AltFEMP proposal or application with a provincial regulator e.g., AER accepted Alternative FEMP Proposal, as described in the AER's Submission Checklist for Directive 060: Alternative FEMP Proposals? If yes, please state the jurisdiction, regulator and scale of adoption by clients/duty-holder.

Yes,

If no, is your organization planning to be involved in an Alternative FEMP Proposal in 2021 or later? Please provide specifics of your participation but do not reference duty holder(s).:

We have submitted Alberta's [redacted] Alt-FEMP pilot. The pilot is scheduled to kick off in [redacted]

Page 5: Involvement in an LDAR Program

Q18

What scale(s) i.e., component, equipment, facility does your method/technology target? Note that 'component' means inspectors can confirm, diagnose and tag individual leaks.

Component,

Equipment,

Facility

Q19

Is your leak detection method/technology able to distinguish vented from fugitive emissions?

Yes,

If yes, how? If not, how does it account for potential false positives?:

We are developing [redacted] to quantify, locate and classify leaks. The leak classification model aims to distinguish vented from fugitive emissions by incorporating operational data and observing changes in the temporal nature of leak detection events.

Q20

Does the work practice lead to diagnosis and tagging of individual leaks?

Yes,

If yes, how? Please describe in detail the process of going from measurement to tagging of leaks. If no, how does the information generated lead to the mitigation of fugitive emissions/leaks?:

Currently, our system issues a series of alerts that dictate when and where an OGI follow-up is required. This enables us to provide a service that not only reduces unnecessary OGI visits but also leads to faster response to leak events. In the future, we would like to identify the location of the leak without requiring an OGI follow using our AI/ML models.

Page 6: Leak Detection Service Description

Q21

For methods that are unable to confirm and tag individual leaks (i.e. "screening" methods), please define any relevant follow-up work practices used. For example, are follow-up OGI crews sent to high-emitting sites to tag leaks? (N/A, unknown, decline to answer)

Our current work practices dictate follow-up OGI crews will be sent to sites with confirmed leaks. In the future we aim to use AI/ML to confirm and tag individual leaks

Q22

What criteria are used to determine which sites receive follow-up visits? Examples could include:a. Site-level emissions thresholds to trigger follow-ups (in which case, what thresholds are used?)b. Follow-up ratios, such that the top 50% of emitting sites surveyed in a day receive follow-up surveys (if so, what ratios are used?)(N/A, unknown, decline to answer)

We are still determining if a generalized threshold is applicable given the variety in facility types and sizes. We do have the flexibility of measuring many different factors (e.g., numerous gases and meteorological conditions) which enable us to test different site-level emissions thresholds to see what works and what doesn't. We also have our own controlled release testing facility to confirm such thresholds. Same thing applies with follow-up ratios.

Q23

What are the roles/tasks of follow-up crews when onsite? For example, do they conduct classic facility-wide OGI surveys, looking for all leaks, or do they target large emitters?a. If following a non-standard work practice, what are the details?b. If not immediate, what is the time interval between screening measurement and follow-up tagging of leaks (in days). Please explain how this delay is estimated.(N/A, unknown, decline to answer)

Follow-up crews on site will visit any sites that where 10 devices indicate that a follow-up is required (e.g., alert level 4). We aim to follow up within 15 days of alert and repair with 30 days of a confirmed leak.

Page 7: Technical Specifications

Q24

What is the methane sensor that is used? Where applicable, specify brand or type.

Proprietary

Q25

Does your surveying result in a quantified flow rate? If no, please skip to next page.

Yes

Q26

What are the minimum and maximum measurable flow rates of your method (m3/day to align with AER regulations - please note if using another unit of measurement e.g., SCFH)? (N/A, unknown, decline to answer)

Proprietary

Q27

Please state its median detection limit (i.e. the flow rate corresponding to a 50% detection probability - please specify a corresponding distance and windspeed)? (N/A, unknown, decline to answer)

Proprietary

Q28

What is the uncertainty/quantification accuracy of flow rate estimates?

Same as OGI

Q29

Are emissions quantified at the component, equipment or facility level? (N/A, unknown, decline to answer)

Component level during OGI follow-up

Q30

Has your organization developed detection probability curves for your method? (N/A, unknown, decline to answer)

If yes, which variables contribute to your detection probabilities?:
We have theoretical detection probability curves and are developing them based on tests at our proprietary controlled release testing facility. We aim to refine these results through the Alt-FEMP pilot.

Q31

Does your method require environmental data? If so, what types of data required and how are they collected?

Yes, wind speed/direction, temperature, humidity and pressure

Q32

Can your organization provide results from controlled release testing (CRT) and/or field performance? Please provide information on methods (e.g. Who conducted the testing? Was it performed indoors or outdoors? Under what range of environmental conditions?)If this information will be or has been published in academic papers, please indicate the paper/project. (N/A, unknown, decline to answer)

Yes, our controlled release testing facility is capable of both indoor and outdoor testing but results are kept confidential for now as we continue to refine our technology

Q33

Has controlled release testing data or performance data on your organization’s method been used in modelling or computer simulations? Were the model results used for AltFEMP proposals (N/A, unknown, decline to answer)

Yes, results from dispersion models and simulations were included in our Alt-FEMP pilot application

Page 8: Environmental and Operational Constraints

Q34

Under what environmental and operational conditions does your organization not operate in the field (please provide specifics)?

We currently have devices operating continuously in the field for the past 4 months when temperatures have dipped below <-40C. We have an upper designed temperature limit of +50C

Q35

What environmental conditions affect your method’s performance (e.g., temperature, precipitation, wind)? For each condition, how is performance impacted?

Our sensors are sensitivity to relative humidity and temperature. We compensate for this using proprietary calibration processes and compensation curves

---

Q36

Please declare the following (qualifying responses if necessary) (N/A, unknown, decline to answer where necessary):

What is the range of temperatures where the technology is operational (°C, max and min)?	**-40C to +50C**
What is the range of wind speed where the technology is operational (kmph, max and min)?	**0 - 230km/h**
How much active rain is tolerated (None, light, medium, heavy)?	**Heavy**
What is the maximum deployment humidity (%)?	**100%**
How much falling snow is tolerated (none, light, medium, heavy)?	**Heavy, though some snow may new to brushed off our solar panel arrays which we can detect remotely**
How much snow can be tolerated on the ground (none, patchy, thin cover, deep)?	**Deep, our devices typically sit on top of the fence line between 2-3 meters above ground**

Q37

How long does it take to deploy at the start of the day (exclude time spent driving to individual sites, if that is a part of the method) in minutes?

One time installation of 30-60min per device depending on the site

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Q38

How long is take-down at the end of the day (exclude time spent driving to individual sites, if that is a part of the method) in minutes?

N/A, our sensors are stationary and meant to deployed continously

---

Q39

Is deployment required at each individual site? If so, how long does set-up/take-down take (in minutes)?

Yes, each site requires roughly 3-5 devices and each device requires 30-60min to install

Q40

From the day of measurement, what is the guaranteed reporting timeline (in days)? If multiple reports are generated/provided, please explain what information they contain, and the number of days required for delivery of each report. (if a null response please enter N/A, unknown, decline to answer)

Data is continuously available on our dashboard and updated every minute. Custom reports can also be created from this data at will

Q41

What is the factor most limiting to safe and efficient field performance leading to high-quality results? (if a null response please enter N/A, unknown, decline to answer)

Our technology requires some wind to fully perform as designed. Most of Alberta has a prevailing wind from the West that averages 8-11 km/h for most of the year

Page 9: Supply and Scalability of Service Offering

Q42

Using single-well batteries as a baseline, approximately how many facilities can each crew inspect in a typical day, week, month, and/or year? (if a null response please enter N/A, unknown, decline to answer)

N/A, [redacted] requires 3-5 devices per site. For smaller sites 1-2 devices could even suffice if placed downwind from prevailing wind direction

Q43

How many independent crews fully equipped with deployment platform, sensor, and trained personnel are currently available for simultaneous deployment? (if a null response please enter N/A, unknown, decline to answer)

We currently have 2 crews available. A single crew can install and setup a facility in 2-4 hours. Depending on the relative distances between sites, each crew can service 1-3 sites per day

Q44

What is your organization's capacity to scale operations to meet your planned/desired market share of leak detection demand in Alberta? Using single well batteries to normalize site counts, how many do you project your operation to service in 2021, 2022, 2023 at 1 event per year (if this measurement of frequency doesn't apply to your method please explain)? (if a null response please enter N/A, unknown, decline to answer)

We have funding and capacity to deploy [redacted] (100-400 facilities

Q45

How many quarters in 2021 or years (if beyond) 2021 do you believe it will take to scale your operation to planned capacity based on projected market conditions?

2 years

Q46

Does your organization expect any changes in its overall work capacity (e.g., number of crews, equipment stock, etc.) in the next 5 years? (N/A, unknown, decline to answer)

Yes, we expect to scale our field workforce and device inventory in line with expected deployments

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Q47

What are your biggest barriers to scaling (e.g. investment, manufacturing of sensors, training of personnel)?

Manufacturing of sensors

Page 10: Productivity and Cost (Optional):

Q48

What is your method's approximate all-inclusive cost per day (single value or range) in 2021 Canadian dollars (please state assumed currency exchange if Canada is not your host country) under typical operating conditions in areas with facility densities up to 0.5 per square km? (if a null response please enter N/A, unknown, decline to answer)

We typically charge a one-time mobilization fee of [redacted] and a on-going monitoring fee of [redacted]

Q49

How would this cost per day change if your organization is contracted for multiple days, weeks, months, or years? (N/A, unknown, decline to answer

We plan to offer discounts on the mobilization fee depending on order volumes and contract duration

---

Page 11: Productivity and Cost (Optional):

Q50

Approximately how many sites/day/crew can your technology/method survey for AER Facility Subtype 311/351 (Single well)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

Survey time per site, cost per site (optional), and additional comments::

1-2 devices depending on size and and surrounding topography

Q51

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 321/361 (Multi-well group battery)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

Survey time per site, cost per site (optional), and additional comments::
2-4 devices depending on size and and surrounding topography

Q52

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 401 (Gas Plant - Sweet)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

Survey time per site, cost per site (optional), and additional comments::
3-5 devices depending on size and and surrounding topography

Q53

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 601 (Compressor Station)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

Survey time per site, cost per site (optional), and additional comments::
2-4 devices depending on size and and surrounding topography

Q54

If your technology or method is not readily quantified using the 4 questions above, please describe your approach to capturing and conveying leak detection efficiencies to your clients (duty holders) and the indicative performance.

Respondent skipped this question

Page 12: Data Management

Q55

Have LDAR-based data management services been a core requirement of your client/s?

Yes

Q56

Have your clients set specific requirements regarding data management, quality assessment/control, other requirements? Please explain if possible.

Respondent skipped this question

Q57

What LDAR-based data management services does your organization offer?

Respondent skipped this question

Vendor #11 Response

Collector: [redacted]

[redacted]

Page 2: Introduction

Q1

Contact Information (For Administrative Purposes Only - All Responses Are Anonymized)

Respondent Organization:	[redacted]
Respondent Name:	Vendor 11
Respondent Role:	[redacted]
E-mail:	[redacted]
Phone:	[redacted]
Website:	[redacted]
Response Date (yy/mm/dd):	[redacted]

Q2

Please confirm your understanding that all data collected as a part of this study are anonymous - check "Yes" to confirm.

Yes

Q3

Are you interested in being contacted for future PTAC methane emissions management research including, potential field campaigns?

Yes

Q4

Please indicate if you would like your organization to be publicly listed as a participant in this study. In this scenario, your organization would be identified as a participant that contributed data, but your organization's name is not associated with data you have submitted (data anonymity is preserved).

Yes

Page 3: General Information and Logistics

Q5

Does your organization have commercial LDAR surveying experience? If yes, please describe e.g., types of LDAR services provided, core markets (industry and/or locations), years of corporate experience with LDAR services.

Yes,

If yes, please describe::

As your global service provider in the oil & gas and (petro)chemical industry, [redacted] is committed to helping you realize your environmental, sustainability, and integrity ambitions. We develop and execute best-in-class emission management and pipeline integrity programs with a meaningful impact on safety, compliance, environmental footprint, and business profitability. Our team of more than [redacted] emission reduction surveys and pipeline integrity projects in more than 35 countries across the globe. Our customers value [redacted] in-depth knowledge, dedicated people, innovative approach, and reliable, accredited processes.

Q6

Does your organization participate in methane measurement markets outside of Alberta? If you intend to enter new methane measurement markets in 2021 or later please answer - Yes.

Yes,

If yes, which markets? (Optional):

Globally

Q7

Is your organization able (legally/logistically/etc.) to work in Canada?

Yes

Q8

Is your organization able (legally/logistically/etc.) to work in the United States?

Yes

Q9

Please describe any safety concerns, risks, interruptions or annoyances (for duty holders/operators and/or local residents/communities) possibly introduced by your product/service when completing LDAR surveys (e.g., noise, airspace, road/site congestion).

[redacted] are a field based approach to fugitive emission management. We travel to site by vehicle and preform our duties onsite in operating conditions.

Q10

Has the COVID-19 outbreak and/or recent market conditions affected your operations re. LDAR services or is it expected to affect your operations? Please provide a comment if answering yes.

Yes, ongoing,

If Yes, please explain.:

Federal recommended travel restrictions has limited international travel has impacted scheduling of LDAR programs.

Q11

Has the establishment of equivalency with federal methane regulations in Alberta and Saskatchewan affected your operations? e.g., scale, frequency, jurisdictions? Please comment if yes.

No.

Q12

Have methane-related Canadian provincial and federal programs affected your operations or planned operations? Please comment if yes.

The roll out of the Federal and Provincial programs have delayed decisions and start times.

Page 4: Leak Detection Service Description

Q13

Is your method or technology compliant with AER Directive 60 leak detection methods (e.g., Method 21) or is it intended to be applied in an AltFEMP?

AltFEMP

Q14

Define your method in detail, including what equipment is used and how it is deployed. Points to address include (but are not limited to):

b. Does your organization offer a product (for sale?), a service, or a combination?	**Service**
c. Is the method mobile or stationary?	**Mobile**
d. Does your method require site access or does it measure remotely?	**Site Assess**

Q15

What deployment platform(s) is/are used? (for example: hand-held, aerial, truck-mounted, UAV, fixed sensor, portable and temporary on-site mount). If multiple deployment platforms are used, explain them all and how they work together.

[redacted] ALT FEMP proposes an optimized LDAR program, which consists of one high quality onsite survey per year, combining several measurement technologies. A smart combination of OGI and FID technology for leak detection forms the basis of the optimized program. A detailed source-based inventory and SFEMP software are also essential components of the program.

Our best practices in LDAR programs demonstrate that when certain quality features are present in an LDAR program, average results of 60% - 90% of emission reduction are achieved with one survey per year, combined with attention for leak follow up.

Q16

What is the specific work practice associated with your methane leak detection method/technology? Several key elements of the work practice are listed below. Please add and comment on any others you feel are pertinent to your offering.

a. At what distances from source are measurements taken?	**Point source**
b. What sensors are employed and how?	**FID Devices**
c. How many people comprise one field crew? What are their roles?	**(1-2) Field Technicians for OGI & FID surveys. (1) technician inventory management.**
d. How much time is spent surveying each potential source?	**This depends on the manufactures recommendation of the device being used.**
e. How much training are field staff required to have?	**min. 2 years training.**
f. What output data are generated and reported?	**Complete inventory management at all sites is obtain for the clients. This includes identification of all potential leaks sources. Repair reports, as defined by the client repair threshold are generated for field and corporate office. Corporate office will receive an full overview of all leaks and recommendation for repair and emission reduction program. The data is owned by the client.**

Q17

Has your method or technology been included in a successful AltFEMP proposal or application with a provincial regulator e.g., AER accepted Alternative FEMP Proposal, as described in the AER's Submission Checklist for Directive 060: Alternative FEMP Proposals? If yes, please state the jurisdiction, regulator and scale of adoption by clients/duty-holder.

Yes

Page 5: Involvement in an LDAR Program

Q18

What scale(s) i.e., component, equipment, facility does your method/technology target? Note that 'component' means inspectors can confirm, diagnose and tag individual leaks.

Component

Q19

Is your leak detection method/technology able to distinguish vented from fugitive emissions?

Yes

Q20

Does the work practice lead to diagnosis and tagging of individual leaks?

Yes,

If yes, how? Please describe in detail the process of going from measurement to tagging of leaks. If no, how does the information generated lead to the mitigation of fugitive emissions/leaks?:

After project preparation, all detailed information for each potential leaking source is registered by the FEM technicians in a digital inventory for the identification of sources. This identification is preferably performed onsite for the highest accuracy. All potentially leaking equipment will be given a unique Leak Equipment Code (LEC). A LEC is followed by a source identification number. This number is used to make the distinction between all different sources on a single equipment.

Page 6: Leak Detection Service Description

Q21

For methods that are unable to confirm and tag individual leaks (i.e. “screening” methods), please define any relevant follow-up work practices used. For example, are follow-up OGI crews sent to high-emitting sites to tag leaks? (N/A, unknown, decline to answer)

OGI Camera -Optical Gas Imaging by Infrared Camera is a great addition to other (LDAR) measurements, and suitable for fast discovery of larger leaks in both accessible and non-accessible areas.

Q22

What criteria are used to determine which sites receive follow-up visits? Examples could include:a. Site-level emissions thresholds to trigger follow-ups (in which case, what thresholds are used?)b. Follow-up ratios, such that the top 50% of emitting sites surveyed in a day receive follow-up surveys (if so, what ratios are used?)(N/A, unknown, decline to answer)

Regulator reporting requirements, Clients protocols.
The ALT FEMP program designates requirements of 75%.

Q23

What are the roles/tasks of follow-up crews when onsite? For example, do they conduct classic facility-wide OGI surveys, looking for all leaks, or do they target large emitters?a. If following a non-standard work practice, what are the details?b. If not immediate, what is the time interval between screening measurement and follow-up tagging of leaks (in days). Please explain how this delay is estimated.(N/A, unknown, decline to answer)

All immediate repairs completed activate second recordings which are posted to software. All remissions above the threshold and repaired at a latter data will be tested through OGI, FID, or HFS. HFS. All later repair dates are posted within the software, once retest are completed these results are post dated.

Page 7: Technical Specifications

Q24

What is the methane sensor that is used? Where applicable, specify brand or type.

[redacted] are agnostic to the methane device for the client. We select the best device for the situation.

Q25

Does your surveying result in a quantified flow rate? If no, please skip to next page.

Yes

Q26

What are the minimum and maximum measurable flow rates of your method (m3/day to align with AER regulations - please note if using another unit of measurement e.g., SCFH)? (N/A, unknown, decline to answer)

minimum - 200l/min.

Q27

Please state its median detection limit (i.e. the flow rate corresponding to a 50% detection probability - please specify a corresponding distance and windspeed)? (N/A, unknown, decline to answer)

N/A

Q28

What is the uncertainty/quantification accuracy of flow rate estimates?

N/A

Q29

Are emissions quantified at the component, equipment or facility level? (N/A, unknown, decline to answer)

Component

Q30

Has your organization developed detection probability curves for your method? (N/A, unknown, decline to answer)

Decline to Answer

Q31

Does your method require environmental data? If so, what types of data required and how are they collected?

Source product

Q32

Can your organization provide results from controlled release testing (CRT) and/or field performance? Please provide information on methods (e.g. Who conducted the testing? Was it performed indoors or outdoors? Under what range of environmental conditions?)If this information will be or has been published in academic papers, please indicate the paper/project. (N/A, unknown, decline to answer)

Yes.

Q33

Has controlled release testing data or performance data on your organization's method been used in modelling or computer simulations? Were the model results used for AltFEMP proposals (N/A, unknown, decline to answer)

Yes to both.

Page 8: Environmental and Operational Constraints

Q34

Under what environmental and operational conditions does your organization not operate in the field (please provide specifics)?

< -25C and > 50C

Q35

What environmental conditions affect your method's performance (e.g., temperature, precipitation, wind)? For each condition, how is performance impacted?

Temperature.

Q36

Please declare the following (qualifying responses if necessary) (N/A, unknown, decline to answer where necessary):

What is the range of temperatures where the technology is operational (°C, max and min)?	**dependent to the equipment being used. < -25C and > 50C**
What is the range of wind speed where the technology is operational (kmph, max and min)?	**dependent to the equipment being used.**
How much active rain is tolerated (None, light, medium, heavy)?	**dependent to the equipment being used.**
What is the maximum deployment humidity (%)?	**dependent to the equipment being used.**
How much falling snow is tolerated (none, light, medium, heavy)?	**dependent to the equipment being used.**
How much snow can be tolerated on the ground (none, patchy, thin cover, deep)?	**dependent to the equipment being used.**

Q37

How long does it take to deploy at the start of the day (exclude time spent driving to individual sites, if that is a part of the method) in minutes?

30 mins.

Q38

How long is take-down at the end of the day (exclude time spent driving to individual sites, if that is a part of the method) in minutes?

30 mins.

Q39

Is deployment required at each individual site? If so, how long does set-up/take-down take (in minutes)?

5 mins

Q40

From the day of measurement, what is the guaranteed reporting timeline (in days)? If multiple reports are generated/provided, please explain what information they contain, and the number of days required for delivery of each report. (if a null response please enter N/A, unknown, decline to answer)

Field Repair Reports provide to operations same day or next day if required. Repair reports include but not limited too -a picture, P&ID drawing, location of leak source component and leak rate.
Corporate aggregated reports are 4 weeks total emission summary from all locations and leak sources.

Q41

What is the factor most limiting to safe and efficient field performance leading to high-quality results? (if a null response please enter N/A, unknown, decline to answer)

Most limiting factor is assess to components.

Page 9: Supply and Scalability of Service Offering

Q42

Using single-well batteries as a baseline, approximately how many facilities can each crew inspect in a typical day, week, month, and/or year? (if a null response please enter N/A, unknown, decline to answer)

9 per day

Q43

How many independent crews fully equipped with deployment platform, sensor, and trained personnel are currently available for simultaneous deployment? (if a null response please enter N/A, unknown, decline to answer)

[redacted] 4 person crews.

Q44

What is your organization's capacity to scale operations to meet your planned/desired market share of leak detection demand in Alberta? Using single well batteries to normalize site counts, how many do you project your operation to service in 2021, 2022, 2023 at 1 event per year (if this measurement of frequency doesn't apply to your method please explain)? (if a null response please enter N/A, unknown, decline to answer)

Decline

Q45

How many quarters in 2021 or years (if beyond) 2021 do you believe it will take to scale your operation to planned capacity based on projected market conditions?

We are confident with our finances to scale to market conditions.

Q46

Does your organization expect any changes in its overall work capacity (e.g., number of crews, equipment stock, etc.) in the next 5 years? (N/A, unknown, decline to answer)

We expect increase in personnel and capital equipment in 2021 and beyond.

Q47

What are your biggest barriers to scaling (e.g. investment, manufacturing of sensors, training of personnel)?

Regulatory changes and enforcement.

Page 10: Productivity and Cost (Optional):

Q48

What is your method's approximate all-inclusive cost per day (single value or range) in 2021 Canadian dollars (please state assumed currency exchange if Canada is not your host country) under typical operating conditions in areas with facility densities up to 0.5 per square km? (if a null response please enter N/A, unknown, decline to answer)

decline

Q49

How would this cost per day change if your organization is contracted for multiple days, weeks, months, or years? (N/A, unknown, decline to answer

Multi year contracts reduce costs 40% from year 1 to year 2.

Page 11: Productivity and Cost (Optional):

Q50

Approximately how many sites/day/crew can your technology/method survey for AER Facility Subtype 311/351 (Single well)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

Respondent skipped this question

Q51

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 321/361 (Multi-well group battery)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

Respondent skipped this question

Q52

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 401 (Gas Plant - Sweet)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

Respondent skipped this question

Q53

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 601 (Compressor Station)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

Respondent skipped this question

Q54

If your technology or method is not readily quantified using the 4 questions above, please describe your approach to capturing and conveying leak detection efficiencies to your clients (duty holders) and the indicative performance.

Respondent skipped this question

Page 12: Data Management

Q55

Have LDAR-based data management services been a core requirement of your client/s?

Varied

Q56

Have your clients set specific requirements regarding data management, quality assessment/control, other requirements? Please explain if possible.

Some clients request their data management software tie into other environmental reports issued to AER.

Q57

What LDAR-based data management services does your organization offer?

[redacted] 11's data management service

Vendor #12 Response

Collector: [redacted]

[redacted]

Page 2: Introduction

Q1

Contact Information (For Administrative Purposes Only - All Responses Are Anonymized)

Respondent Organization:	[redacted]
Respondent Name:	Vendor 12
Respondent Role:	[redacted]
E-mail:	[redacted]
Phone:	[redacted]
Website:	[redacted]
Response Date (yy/mm/dd):	[redacted]

Q2

Please confirm your understanding that all data collected as a part of this study are anonymous - check "Yes" to confirm.

Yes

Q3

Are you interested in being contacted for future PTAC methane emissions management research including, potential field campaigns?

Yes

Q4

Please indicate if you would like your organization to be publicly listed as a participant in this study. In this scenario, your organization would be identified as a participant that contributed data, but your organization's name is not associated with data you have submitted (data anonymity is preserved).

Yes

Page 3: General Information and Logistics

Q5

Does your organization have commercial LDAR surveying experience? If yes, please describe e.g., types of LDAR services provided, core markets (industry and/or locations), years of corporate experience with LDAR services.

Yes,

If yes, please describe::
[redacted] offers traditional LDAR services globally including Canada. [redacted] uses OGI and Method 21 instruments to complete LDAR surveys. In Canada, core markets include AB, BC, SK, MB and are looking to expand monitoring services to Eastern Canada. [redacted] has over

Q6

Does your organization participate in methane measurement markets outside of Alberta? If you intend to enter new methane measurement markets in 2021 or later please answer - Yes.

Yes,

If yes, which markets? (Optional):
[redacted] currently offers LDAR in Manitoba and Saskatchewan. [redacted] is highly interested to expand the service across entire Canada and also offers services in other countries in Europe, Asia, and other parts of the world.

Q7

Is your organization able (legally/logistically/etc.) to work in Canada?

Yes

Q8

Is your organization able (legally/logistically/etc.) to work in the United States?

No

Q9

Please describe any safety concerns, risks, interruptions or annoyances (for duty holders/operators and/or local residents/communities) possibly introduced by your product/service when completing LDAR surveys (e.g., noise, airspace, road/site congestion).

[redacted] uses a traditional method to survey therefore does not face major risks o concerns other than human risks/errors.

Q10

Has the COVID-19 outbreak and/or recent market conditions affected your operations re. LDAR services or is it expected to affect your operations? Please provide a comment if answering yes.

Yes, ongoing,

If Yes, please explain.:
We saw decreased number of duty holders show interest.

Q11

Has the establishment of equivalency with federal methane regulations in Alberta and Saskatchewan affected your operations? e.g., scale, frequency, jurisdictions? Please comment if yes.

No.

Q12

Have methane-related Canadian provincial and federal programs affected your operations or planned operations? Please comment if yes.

No.

Page 4: Leak Detection Service Description

Q13

Is your method or technology compliant with AER Directive 60 leak detection methods (e.g., Method 21) or is it intended to be applied in an AltFEMP?

AER Directive 60 Compliant / Method 21

Q14

Define your method in detail, including what equipment is used and how it is deployed. Points to address include (but are not limited to):

a. Does your organization offer a technology or a method?	**[redacted] offers a method to complete LDAR survey.**
b. Does your organization offer a product (for sale?), a service, or a combination?	**A Service**
c. Is the method mobile or stationary?	**Mobile**
d. Does your method require site access or does it measure remotely?	**Require site access**

Q15

What deployment platform(s) is/are used? (for example: hand-held, aerial, truck-mounted, UAV, fixed sensor, portable and temporary on-site mount). If multiple deployment platforms are used, explain them all and how they work together.

[redacted] uses a hand-held device to complete a full survey at a site.

Q16

What is the specific work practice associated with your methane leak detection method/technology? Several key elements of the work practice are listed below. Please add and comment on any others you feel are pertinent to your offering.

a. At what distances from source are measurements taken?	**2-15m**
c. How many people comprise one field crew? What are their roles?	**1. A technician completes a survey as per Directive60 and records necessary data/videos.**
d. How much time is spent surveying each potential source?	**2 seconds - 30 seconds**
e. How much training are field staff required to have?	**At least 2 weeks or 500hrs with the OGI camera.**
f. What output data are generated and reported?	[redacted] **CNTRAL platform to generate a report which can be shared to the client. Reports are also available in excel, PDF, and all the data is also available online.**
Additional work practice details	[redacted] **quantification services using Providence Photonics QL320, Method 21 verifications, and gas analysis where needed.**

Q17

Has your method or technology been included in a successful AltFEMP proposal or application with a provincial regulator e.g., AER accepted Alternative FEMP Proposal, as described in the AER's Submission Checklist for Directive 060: Alternative FEMP Proposals? If yes, please state the jurisdiction, regulator and scale of adoption by clients/duty-holder.

No,

If no, is your organization planning to be involved in an Alternative FEMP Proposal in 2021 or later? Please provide specifics of your participation but do not reference duty holder(s).:

No, [redacted] offers traditional "Boots on the ground" method servey

Page 5: Involvement in an LDAR Program

Q18

What scale(s) i.e., component, equipment, facility does your method/technology target? Note that 'component' means inspectors can confirm, diagnose and tag individual leaks.

Component

Q19

Is your leak detection method/technology able to distinguish vented from fugitive emissions?

Yes,

If yes, how? If not, how does it account for potential false positives?:

Experts are in the field investigating and diagnosing the source, therefore, better understand the process and situation of the leak or potential false positives.

Q20

Does the work practice lead to diagnosis and tagging of individual leaks?

Yes,

If yes, how? Please describe in detail the process of going from measurement to tagging of leaks. If no, how does the information generated lead to the mitigation of fugitive emissions/leaks?:
When leak/fugitive emission is suspected, a trained technician then investigates the leak further pinpointing the source. After investigation, the leak is recorded and a leak tag is put on the source with leak details.

Page 6: Leak Detection Service Description

Q21

For methods that are unable to confirm and tag individual leaks (i.e. “screening” methods), please define any relevant follow-up work practices used. For example, are follow-up OGI crews sent to high-emitting sites to tag leaks? (N/A, unknown, decline to answer)

N/A

Q22

What criteria are used to determine which sites receive follow-up visits? Examples could include:a. Site-level emissions thresholds to trigger follow-ups (in which case, what thresholds are used?)b. Follow-up ratios, such that the top 50% of emitting sites surveyed in a day receive follow-up surveys (if so, what ratios are used?)(N/A, unknown, decline to answer)

N/A

Q23

What are the roles/tasks of follow-up crews when onsite? For example, do they conduct classic facility-wide OGI surveys, looking for all leaks, or do they target large emitters?a. If following a non-standard work practice, what are the details?b. If not immediate, what is the time interval between screening measurement and follow-up tagging of leaks (in days). Please explain how this delay is estimated.(N/A, unknown, decline to answer)

N/A

Page 7: Technical Specifications

Q24

What is the methane sensor that is used? Where applicable, specify brand or type.

FLIR OGI GFx320

Q25

Does your surveying result in a quantified flow rate? If no, please skip to next page.

Yes

Q26

What are the minimum and maximum measurable flow rates of your method (m3/day to align with AER regulations - please note if using another unit of measurement e.g., SCFH)? (N/A, unknown, decline to answer)

Minimum: ~0.3m3/day. Maximum: ~430m3/day

Q27

Please state its median detection limit (i.e. the flow rate corresponding to a 50% detection probability - please specify a corresponding distance and windspeed)? (N/A, unknown, decline to answer)

~20m3/day at 2-3m distance with minimal wind.

Q28

What is the uncertainty/quantification accuracy of flow rate estimates?

+/- 20%

Q29

Are emissions quantified at the component, equipment or facility level? (N/A, unknown, decline to answer)

component

Q30

Has your organization developed detection probability curves for your method? (N/A, unknown, decline to answer)

Yes

Q31

Does your method require environmental data? If so, what types of data required and how are they collected?

Temperature and wind condition.

Q32

Can your organization provide results from controlled release testing (CRT) and/or field performance? Please provide information on methods (e.g. Who conducted the testing? Was it performed indoors or outdoors? Under what range of environmental conditions?)If this information will be or has been published in academic papers, please indicate the paper/project. (N/A, unknown, decline to answer)

[redacted] does not have results we are able to share at the moment however, the product studies can be found/obtained from the manufacturer.

Q33

Has controlled release testing data or performance data on your organization's method been used in modelling or computer simulations? Were the model results used for AltFEMP proposals (N/A, unknown, decline to answer)

N?A

Page 8: Environmental and Operational Constraints

Q34

Under what environmental and operational conditions does your organization not operate in the field (please provide specifics)?

[redacted] offers services in all conditions except in extreme cold (below -20'C) or when wind speed is >25MPH

Q35

What environmental conditions affect your method's performance (e.g., temperature, precipitation, wind)? For each condition, how is performance impacted?

Our method is best at -20'C-50'C, low precipitation and windspeed calmer than 25MPH.
At temperature outside of -20'C-50'C, gas may not be detected or is more difficult to "visualize" the gas on the camera.
With rain or snow, this may result in biased results when quantifying. Should have no problem with qualifying.
At windspeed above 25MPH, quantified rate may result in biased number.

Q36

Please declare the following (qualifying responses if necessary) (N/A, unknown, decline to answer where necessary):

What is the range of temperatures where the technology is operational (°C, max and min)?	**50'C maximum and -20'C minimum.**
What is the range of wind speed where the technology is operational (kmph, max and min)?	**~40km/h**
How much active rain is tolerated (None, light, medium, heavy)?	**heavy**
What is the maximum deployment humidity (%)?	**Unknown**
How much falling snow is tolerated (none, light, medium, heavy)?	**Heavy**
How much snow can be tolerated on the ground (none, patchy, thin cover, deep)?	**Deep**

Q37

How long does it take to deploy at the start of the day (exclude time spent driving to individual sites, if that is a part of the method) in minutes?

5-10 minutes.

Q38

How long is take-down at the end of the day (exclude time spent driving to individual sites, if that is a part of the method) in minutes?

1-2 minutes.

Q39

Is deployment required at each individual site? If so, how long does set-up/take-down take (in minutes)?

No, once the camera is "cooled" it is ready at next site.

Q40

From the day of measurement, what is the guaranteed reporting timeline (in days)? If multiple reports are generated/provided, please explain what information they contain, and the number of days required for delivery of each report. (if a null response please enter N/A, unknown, decline to answer)

Next business day or within 1-2 hours if rushed.
Reports include site information, inspection details such as survey time, GPS, leak/emission details with a photo, video of the leaking source and etc.

Q41

What is the factor most limiting to safe and efficient field performance leading to high-quality results? (if a null response please enter N/A, unknown, decline to answer)

Normal human risks as technicians are out in the field exposed to gases.

Page 9: Supply and Scalability of Service Offering

Q42

Using single-well batteries as a baseline, approximately how many facilities can each crew inspect in a typical day, week, month, and/or year? (if a null response please enter N/A, unknown, decline to answer)

7-8 sites a day, ~50sites a week

Q43

How many independent crews fully equipped with deployment platform, sensor, and trained personnel are currently available for simultaneous deployment? (if a null response please enter N/A, unknown, decline to answer)

[redacted]

Q44

What is your organization's capacity to scale operations to meet your planned/desired market share of leak detection demand in Alberta? Using single well batteries to normalize site counts, how many do you project your operation to service in 2021, 2022, 2023 at 1 event per year (if this measurement of frequency doesn't apply to your method please explain)? (if a null response please enter N/A, unknown, decline to answer)

The desired number is ~500-1000 sites in a year to complete a full comprehensive site-level LDAR Servey.

Q45

How many quarters in 2021 or years (if beyond) 2021 do you believe it will take to scale your operation to planned capacity based on projected market conditions?

unknown

Q46

Does your organization expect any changes in its overall work capacity (e.g., number of crews, equipment stock, etc.) in the next 5 years? (N/A, unknown, decline to answer)

Yes, [redacted] is looking to increase assets and the number of crews. However, increasing capacity is business dependant.

Q47

What are your biggest barriers to scaling (e.g. investment, manufacturing of sensors, training of personnel)?

The biggest barriers [redacted] facing is non-compliance from the companies and uncertainties. [redacted] to increase the scale of business and investments will be available once there is a business model.

Page 10: Productivity and Cost (Optional):

Q48

What is your method's approximate all-inclusive cost per day (single value or range) in 2021 Canadian dollars (please state assumed currency exchange if Canada is not your host country) under typical operating conditions in areas with facility densities up to 0.5 per square km? (if a null response please enter N/A, unknown, decline to answer)

$2000-$2400

Q49

How would this cost per day change if your organization is contracted for multiple days, weeks, months, or years? (N/A, unknown, decline to answer

[redacted] % discounts on large volume contracts and will look at a cost reduction to be competitive in the market.

Page 11: Productivity and Cost (Optional):

Q50

Approximately how many sites/day/crew can your technology/method survey for AER Facility Subtype 311/351 (Single well)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

6-10,
Survey time per site, cost per site (optional), and additional comments::
1.25hrs per site @ ~$275 per site.

Q51

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 321/361 (Multi-well group battery)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

1-5,
Survey time per site, cost per site (optional), and additional comments::
1.75-2.25hrs per site @ $450 per site

Q52

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 401 (Gas Plant - Sweet)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

1-5,
Survey time per site, cost per site (optional), and additional comments::
~3-8hrs per site @ $1000-$1800 per site

Q53

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 601 (Compressor Station)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

1-5,
Survey time per site, cost per site (optional), and additional comments::
~4-10hrs per site @ $1000-$2200 per site

Q54

If your technology or method is not readily quantified using the 4 questions above, please describe your approach to capturing and conveying leak detection efficiencies to your clients (duty holders) and the indicative performance.

N/A

Page 12: Data Management

Q55

Have LDAR-based data management services been a core requirement of your client/s?

Yes,
If yes/no/varied, are there any key reasons?:
Survey details/data is required by the regulation.

Q56

Have your clients set specific requirements regarding data management, quality assessment/control, other requirements? Please explain if possible.

Progress reports and leak reports are required by the clients.

Q57

What LDAR-based data management services does your organization offer?

[redacted] uses CNTRAL as the main LDAR-based data management services. [redacted] to the use of other data management services.

Vendor #13 Response

Collector: [redacted]

[redacted]

Page 2: Introduction

Q1

Contact Information (For Administrative Purposes Only - All Responses Are Anonymized)

Respondent Organization:	[redacted]
Respondent Name:	Vendor 13
Respondent Role:	[redacted]
E-mail:	[redacted]
Phone:	[redacted]
Website:	[redacted]
Response Date (yy/mm/dd):	[redacted]

Q2

Please confirm your understanding that all data collected as a part of this study are anonymous - check "Yes" to confirm.

Yes

Q3

Are you interested in being contacted for future PTAC methane emissions management research including, potential field campaigns?

Yes

Q4

Please indicate if you would like your organization to be publicly listed as a participant in this study. In this scenario, your organization would be identified as a participant that contributed data, but your organization's name is not associated with data you have submitted (data anonymity is preserved).

Yes

Page 3: General Information and Logistics

Q5

Does your organization have commercial LDAR surveying experience? If yes, please describe e.g., types of LDAR services provided, core markets (industry and/or locations), years of corporate experience with LDAR services.

Yes,

If yes, please describe::

[redacted] YEARS DIRECT EXPERIENCE WITH DATA COLLECTION, PROGRAM IMPLEMENTATION STRATEGY PLANNING, INVENTORY DEVELOPMENT AND MANAGEMENT EMPLOYING A VARIETY OF EMISSION MANAGEMENT SOFTWARE SOLUTIONS - PROFICIENCIES WITH INSPECTION METHODS SUCH AS OPTICAL GAS IMAGING, EPA METHOD 21, ACOUSTIC AND AOV. WE HAVE WORKED IN UPSTREAM, DOWNSTREAM AND CHEMICAL FACILITIES. WE ALSO MAINTAIN PROFICIENCIES WITH REPORTING AND AIR EMISSION CALCULATION

Q6

Does your organization participate in methane measurement markets outside of Alberta? If you intend to enter new methane measurement markets in 2021 or later please answer - Yes.

Yes,

If yes, which markets? (Optional):

ONTARIO AND NWT

Q7

Is your organization able (legally/logistically/etc.) to work in Canada?

Yes

Q8

Is your organization able (legally/logistically/etc.) to work in the United States?

Yes

Q9

Please describe any safety concerns, risks, interruptions or annoyances (for duty holders/operators and/or local residents/communities) possibly introduced by your product/service when completing LDAR surveys (e.g., noise, airspace, road/site congestion).

NONE

Q10

Has the COVID-19 outbreak and/or recent market conditions affected your operations re. LDAR services or is it expected to affect your operations? Please provide a comment if answering yes.

Yes, but resolved by year-end 2020,

If Yes, please explain.:

SMALLER WORK TEAMS - SPREAD OVER LONGER PERIODS OF TIME TO MAINTAIN SOCIAL DISTANCING AS PER PROVINCIAL STANDARDS. REGIONAL LODGING FOR REMOTE LOCATIONS

Q11

Has the establishment of equivalency with federal methane regulations in Alberta and Saskatchewan affected your operations? e.g., scale, frequency, jurisdictions? Please comment if yes.

NO

Q12

Have methane-related Canadian provincial and federal programs affected your operations or planned operations? Please comment if yes.

NO

Page 4: Leak Detection Service Description

Q13

Is your method or technology compliant with AER Directive 60 leak detection methods (e.g., Method 21) or is it intended to be applied in an AltFEMP?

AER Directive 60 Compliant / Method 21

Q14

Define your method in detail, including what equipment is used and how it is deployed. Points to address include (but are not limited to):

a. Does your organization offer a technology or a method?	**EPA METHOD 21 AND AWP IN ACCORDANCE WITH CFRO PART 40**
b. Does your organization offer a product (for sale?), a service, or a combination?	**SERVICE**
c. Is the method mobile or stationary?	**MOBILE**
d. Does your method require site access or does it measure remotely?	**SITE ACCESS AND REMOTE SERVICES OFFERED**

Q15

What deployment platform(s) is/are used? (for example: hand-held, aerial, truck-mounted, UAV, fixed sensor, portable and temporary on-site mount). If multiple deployment platforms are used, explain them all and how they work together.

PDA, PORTABLE INSTRUMENTS - ELECTRONIC DATA GATHERING AND TRANSFER /

Q16

What is the specific work practice associated with your methane leak detection method/technology? Several key elements of the work practice are listed below. Please add and comment on any others you feel are pertinent to your offering.

a. At what distances from source are measurements taken?	**CONTACT AND UP TO 6 METERS**
b. What sensors are employed and how?	**FID / IR**
c. How many people comprise one field crew? What are their roles?	**UP TO 5 - FORMAN WITH CROSS SHIFT PLUS SUPPORT RESOURCES**
d. How much time is spent surveying each potential source?	**MINIMUM 15 FOR EPA METHOD 21 AND DEPENDS ON EXTERNAL INFLUENCES FOR OTHER METHODOLOGIES**
e. How much training are field staff required to have?	**MINIMUM 40 HOURS FIELD + CLASS ROOM BASE TRAINING W/COMPETENCY CONFIRMED THROUGH WRITTEN KNOWLEDGE EXAM (PASS MARK 80 REQUIRED)**
f. What output data are generated and reported?	**SUMMARY DETAILS OF EMISISONS, AND INSPECTIONS W/FINDINGS AND MTC AND REPAIR**
Additional work practice details	**WORK STANDARDIZATION DOCUMENTS**

Q17

Has your method or technology been included in a successful AltFEMP proposal or application with a provincial regulator e.g., AER accepted Alternative FEMP Proposal, as described in the AER's Submission Checklist for Directive 060: Alternative FEMP Proposals? If yes, please state the jurisdiction, regulator and scale of adoption by clients/duty-holder.

Yes

Page 5: Involvement in an LDAR Program

Q18

What scale(s) i.e., component, equipment, facility does your method/technology target? Note that 'component' means inspectors can confirm, diagnose and tag individual leaks.

Component,

Equipment,

Facility

Q19

Is your leak detection method/technology able to distinguish vented from fugitive emissions?

Yes,

If yes, how? If not, how does it account for potential false positives?:

VISUAL AND/OR THROUGH FLOW METER QA/QC REVIEW FIELD LABOR COMPETENCY WITH PROCESS EQUIPMENT OPERATION

Q20

Does the work practice lead to diagnosis and tagging of individual leaks?

Yes,

If yes, how? Please describe in detail the process of going from measurement to tagging of leaks. If no, how does the information generated lead to the mitigation of fugitive emissions/leaks?:
WE WORK TO INTEGRATE SYSTEM WITH SITE ASSET MANAGEMENT PLATFORMS LEAK IDENTIFIED - IMMEDIATE REPAIR - FAILED REPAIR - TAG LEAK - BUILD LEAK PACKAGE W/DETAILS ENTER WORK ORDER FOR REPAIR

Page 6: Leak Detection Service Description

Q21

For methods that are unable to confirm and tag individual leaks (i.e. “screening” methods), please define any relevant follow-up work practices used. For example, are follow-up OGI crews sent to high-emitting sites to tag leaks? (N/A, unknown, decline to answer)

ALL LEAKS ARE ABLE TO BE INVENTORIED AND IDENTIFIED FOR FOLLOW UP REPAIR

Q22

What criteria are used to determine which sites receive follow-up visits? Examples could include:a. Site-level emissions thresholds to trigger follow-ups (in which case, what thresholds are used?)b. Follow-up ratios, such that the top 50% of emitting sites surveyed in a day receive follow-up surveys (if so, what ratios are used?)(N/A, unknown, decline to answer)

WE QA ALL SITES

Q23

What are the roles/tasks of follow-up crews when onsite? For example, do they conduct classic facility-wide OGI surveys, looking for all leaks, or do they target large emitters?a. If following a non-standard work practice, what are the details?b. If not immediate, what is the time interval between screening measurement and follow-up tagging of leaks (in days). Please explain how this delay is estimated.(N/A, unknown, decline to answer)

ALL SOURCES ARE INPSECTED AS PER THE SITE DESIGNATED REGULATORY REQUIRMENTS

Page 7: Technical Specifications

Q24

What is the methane sensor that is used? Where applicable, specify brand or type.

FID / THERMO SCIENTIFIC

Q25

Does your surveying result in a quantified flow rate? If no, please skip to next page.

No

Q26

What are the minimum and maximum measurable flow rates of your method (m3/day to align with AER regulations - please note if using another unit of measurement e.g., SCFH)? (N/A, unknown, decline to answer)

DEPENDS ON TESTING TYPE (M3/DAY)

Q27

Please state its median detection limit (i.e. the flow rate corresponding to a 50% detection probability - please specify a corresponding distance and windspeed)? (N/A, unknown, decline to answer)

Respondent skipped this question

Q28

What is the uncertainty/quantification accuracy of flow rate estimates?

2%

Q29

Are emissions quantified at the component, equipment or facility level? (N/A, unknown, decline to answer)

COMPONENT OR FACILITY

Q30

Has your organization developed detection probability curves for your method? (N/A, unknown, decline to answer)

Yes

Q31

Does your method require environmental data? If so, what types of data required and how are they collected?

SCREENING DATA

Q32

Can your organization provide results from controlled release testing (CRT) and/or field performance? Please provide information on methods (e.g. Who conducted the testing? Was it performed indoors or outdoors? Under what range of environmental conditions?)If this information will be or has been published in academic papers, please indicate the paper/project. (N/A, unknown, decline to answer)

Respondent skipped this question

Q33

Has controlled release testing data or performance data on your organization’s method been used in modelling or computer simulations? Were the model results used for AltFEMP proposals (N/A, unknown, decline to answer)

Respondent skipped this question

Page 8: Environmental and Operational Constraints

Q34

Under what environmental and operational conditions does your organization not operate in the field (please provide specifics)?

ANY EXTERNAL INFLUENCES THAT WILL INFLUENCE SAMPLES (OPERATIONS, PROCESS PRESSURE, WEATHER)

Q35

What environmental conditions affect your method’s performance (e.g., temperature, precipitation, wind)? For each condition, how is performance impacted?

WORK IS RE-SCHEDULED TO MORE SUITABLE TIMEFRAME

Q36

Please declare the following (qualifying responses if necessary) (N/A, unknown, decline to answer where necessary):

What is the range of temperatures where the technology is operational (°C, max and min)?	**-10**
What is the range of wind speed where the technology is operational (kmph, max and min)?	**25kmph**
How much active rain is tolerated (None, light, medium, heavy)?	**light**
What is the maximum deployment humidity (%)?	**n/a**
How much falling snow is tolerated (none, light, medium, heavy)?	**none**
How much snow can be tolerated on the ground (none, patchy, thin cover, deep)?	**n/a snow on ground not an influence / instrument manufacture operating spec determine instrument performance / process speciation determines HC volatility**

Q37

How long does it take to deploy at the start of the day (exclude time spent driving to individual sites, if that is a part of the method) in minutes?

1.5 hrs

Q38

Respondent skipped this question

How long is take-down at the end of the day (exclude time spent driving to individual sites, if that is a part of the method) in minutes?

Q39

Is deployment required at each individual site? If so, how long does set-up/take-down take (in minutes)?

1.5 -2 hours

Q40

From the day of measurement, what is the guaranteed reporting timeline (in days)? If multiple reports are generated/provided, please explain what information they contain, and the number of days required for delivery of each report. (if a null response please enter N/A, unknown, decline to answer)

daily reporting - semi annual or annual

Q41

What is the factor most limiting to safe and efficient field performance leading to high-quality results? (if a null response please enter N/A, unknown, decline to answer)

people and accountability!!

Page 9: Supply and Scalability of Service Offering

Q42

Using single-well batteries as a baseline, approximately how many facilities can each crew inspect in a typical day, week, month, and/or year? (if a null response please enter N/A, unknown, decline to answer)

depends on the program set up and results - more leaks take more time

Q43

How many independent crews fully equipped with deployment platform, sensor, and trained personnel are currently available for simultaneous deployment? (if a null response please enter N/A, unknown, decline to answer)

[redacted] crews

Q44

What is your organization's capacity to scale operations to meet your planned/desired market share of leak detection demand in Alberta? Using single well batteries to normalize site counts, how many do you project your operation to service in 2021, 2022, 2023 at 1 event per year (if this measurement of frequency doesn't apply to your method please explain)? (if a null response please enter N/A, unknown, decline to answer)

n/a

Q45

How many quarters in 2021 or years (if beyond) 2021 do you believe it will take to scale your operation to planned capacity based on projected market conditions?

we are ready now

Q46

Does your organization expect any changes in its overall work capacity (e.g., number of crews, equipment stock, etc.) in the next 5 years? (N/A, unknown, decline to answer)

decline to answer

Q47

What are your biggest barriers to scaling (e.g. investment, manufacturing of sensors, training of personnel)?

regulations and interpretation -

Page 10: Productivity and Cost (Optional):

Q48

What is your method's approximate all-inclusive cost per day (single value or range) in 2021 Canadian dollars (please state assumed currency exchange if Canada is not your host country) under typical operating conditions in areas with facility densities up to 0.5 per square km? (if a null response please enter N/A, unknown, decline to answer)

Lump sum pricing

Q49

How would this cost per day change if your organization is contracted for multiple days, weeks, months, or years? (N/A, unknown, decline to answer

piece work

Page 11: Productivity and Cost (Optional):

Q50

Approximately how many sites/day/crew can your technology/method survey for AER Facility Subtype 311/351 (Single well)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

1-5,
Survey time per site, cost per site (optional), and additional comments::
depends on the findings more leaks mean more time logging results our teams find leaks!

Q51

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 321/361 (Multi-well group battery)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

6-10,
Survey time per site, cost per site (optional), and additional comments::
depends on the findings more leaks mean more time logging results our teams find leaks!

Q52

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 401 (Gas Plant - Sweet)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

6-10,
Survey time per site, cost per site (optional), and additional comments::
depends on the findings more leaks mean more time logging results our teams find leaks!

Q53

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 601 (Compressor Station)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

6-10,
Survey time per site, cost per site (optional), and additional comments::
depends on the findings more leaks mean more time logging results our teams find leaks!

Q54

If your technology or method is not readily quantified using the 4 questions above, please describe your approach to capturing and conveying leak detection efficiencies to your clients (duty holders) and the indicative performance.

we have daily work performance variables that are tracked through daily KPI reporting - we are always on time and on budget

Page 12: Data Management

Q55

Have LDAR-based data management services been a core requirement of your client/s?

Yes

Q56

Have your clients set specific requirements regarding data management, quality assessment/control, other requirements? Please explain if possible.

Yes we work with our customers to develop implementation strategy plans that assign key roles and responsibilites

Q57

What LDAR-based data management services does your organization offer?

Formal reporting or support as required

Vendor #14 Response

Collector: [redacted]

[redacted]

Page 2: Introduction

Q1

Contact Information (For Administrative Purposes Only - All Responses Are Anonymized)

Respondent Organization:	[redacted]
Respondent Name:	Vendor 14
Respondent Role:	[redacted]
E-mail:	[redacted]
Phone:	[redacted]
Website:	[redacted]
Response Date (yy/mm/dd):	[redacted]

Q2

Please confirm your understanding that all data collected as a part of this study are anonymous - check "Yes" to confirm.

Yes

Q3

Are you interested in being contacted for future PTAC methane emissions management research including, potential field campaigns?

Yes

Q4

Please indicate if you would like your organization to be publicly listed as a participant in this study. In this scenario, your organization would be identified as a participant that contributed data, but your organization’s name is not associated with data you have submitted (data anonymity is preserved).

Yes

Page 3: General Information and Logistics

Q5

Does your organization have commercial LDAR surveying experience? If yes, please describe e.g., types of LDAR services provided, core markets (industry and/or locations), years of corporate experience with LDAR services.

Yes,
If yes, please describe::
We have sold [redacted] detection instruments to the natural gas utility market for 10 years. In addition, our leak survey team has performed surveys across Alberta, Northern BC, Manitoba, and Ontario.

Q6

Does your organization participate in methane measurement markets outside of Alberta? If you intend to enter new methane measurement markets in 2021 or later please answer - Yes.

Yes,
If yes, which markets? (Optional):
National

Q7

Is your organization able (legally/logistically/etc.) to work in Canada?

Yes

Q8

Is your organization able (legally/logistically/etc.) to work in the United States?

Yes

Q9

Please describe any safety concerns, risks, interruptions or annoyances (for duty holders/operators and/or local residents/communities) possibly introduced by your product/service when completing LDAR surveys (e.g., noise, airspace, road/site congestion).

None

Q10

Has the COVID-19 outbreak and/or recent market conditions affected your operations re. LDAR services or is it expected to affect your operations? Please provide a comment if answering yes.

No

Q11

Has the establishment of equivalency with federal methane regulations in Alberta and Saskatchewan affected your operations? e.g., scale, frequency, jurisdictions? Please comment if yes.

No

Q12

Have methane-related Canadian provincial and federal programs affected your operations or planned operations? Please comment if yes.

No

Page 4: Leak Detection Service Description

Q13

Is your method or technology compliant with AER Directive 60 leak detection methods (e.g., Method 21) or is it intended to be applied in an AltFEMP?

AER Directive 60 Compliant / Method 21

Q14

Define your method in detail, including what equipment is used and how it is deployed. Points to address include (but are not limited to):

a. Does your organization offer a technology or a method?	**technology**
b. Does your organization offer a product (for sale?), a service, or a combination?	**product**
c. Is the method mobile or stationary?	**mobile**
d. Does your method require site access or does it measure remotely?	**requires site access**

Q15

What deployment platform(s) is/are used? (for example: hand-held, aerial, truck-mounted, UAV, fixed sensor, portable and temporary on-site mount). If multiple deployment platforms are used, explain them all and how they work together.

We have handheld units as well as other instruments that are capable of being mounted on an ATV or truck. We employ a variety of technologies to measure and quantify leaks from mechanical sensors to infra red absorption spectroscopy.

Q16

What is the specific work practice associated with your methane leak detection method/technology? Several key elements of the work practice are listed below. Please add and comment on any others you feel are pertinent to your offering.

a. At what distances from source are measurements taken?	**depending on detection threshold - we can be meters away, or in the plume.**
b. What sensors are employed and how?	**typically our survey tools use infra-red absorption spectroscopy**
c. How many people comprise one field crew? What are their roles?	**2 people - one on the instrument, one recording data and field observations**
d. How much time is spent surveying each potential source?	**this is dependent on the reporting required and site conditions**
e. How much training are field staff required to have?	**1 week leak survey, 1 day bear awareness, 1 day general field practices**
f. What output data are generated and reported?	**multiple datasets are possible - depending on customer needs**

Q17

Has your method or technology been included in a successful AltFEMP proposal or application with a provincial regulator e.g., AER accepted Alternative FEMP Proposal, as described in the AER's Submission Checklist for Directive 060: Alternative FEMP Proposals? If yes, please state the jurisdiction, regulator and scale of adoption by clients/duty-holder.

No,

If no, is your organization planning to be involved in an Alternative FEMP Proposal in 2021 or later? Please provide specifics of your participation but do not reference duty holder(s).:

Not at this time.

Page 5: Involvement in an LDAR Program

Q18

What scale(s) i.e., component, equipment, facility does your method/technology target? Note that 'component' means inspectors can confirm, diagnose and tag individual leaks.

Component,

Equipment,

Facility

Q19

Is your leak detection method/technology able to distinguish vented from fugitive emissions?

Yes,

If yes, how? If not, how does it account for potential false positives?:

Utilizing an Ethane detection instrument, we can distinguish between 'line gas' which contains ethane, and 'natural' methane, which does not contain ethane.

Q20

Does the work practice lead to diagnosis and tagging of individual leaks?

Yes,

If yes, how? Please describe in detail the process of going from measurement to tagging of leaks. If no, how does the information generated lead to the mitigation of fugitive emissions/leaks?:

A wide area survey can indicate a gas plume. The site undergoes a visual inspection to try and identify any possible leak sources, which are then investigated at close range to determine if any are contributing to the overall plume on site. Anything discovered can then be tagged with the survey date and on-site measurements of the gas detected at that time.

Page 6: Leak Detection Service Description

Q21

For methods that are unable to confirm and tag individual leaks (i.e. “screening” methods), please define any relevant follow-up work practices used. For example, are follow-up OGI crews sent to high-emitting sites to tag leaks? (N/A, unknown, decline to answer)

unknown

Q22

What criteria are used to determine which sites receive follow-up visits? Examples could include:a. Site-level emissions thresholds to trigger follow-ups (in which case, what thresholds are used?)b. Follow-up ratios, such that the top 50% of emitting sites surveyed in a day receive follow-up surveys (if so, what ratios are used?)(N/A, unknown, decline to answer)

unknown

Q23

What are the roles/tasks of follow-up crews when onsite? For example, do they conduct classic facility-wide OGI surveys, looking for all leaks, or do they target large emitters?a. If following a non-standard work practice, what are the details?b. If not immediate, what is the time interval between screening measurement and follow-up tagging of leaks (in days). Please explain how this delay is estimated.(N/A, unknown, decline to answer)

unknown

Page 7: Technical Specifications

Q24

What is the methane sensor that is used? Where applicable, specify brand or type.

infra red tunable laser, or Pellistor sensor

Q25

Does your surveying result in a quantified flow rate? If no, please skip to next page.

No

Q26

What are the minimum and maximum measurable flow rates of your method (m3/day to align with AER regulations - please note if using another unit of measurement e.g., SCFH)? (N/A, unknown, decline to answer)

Respondent skipped this question

Q27

Please state its median detection limit (i.e. the flow rate corresponding to a 50% detection probability - please specify a corresponding distance and windspeed)? (N/A, unknown, decline to answer)

Respondent skipped this question

Q28

What is the uncertainty/quantification accuracy of flow rate estimates?

Respondent skipped this question

Q29

Are emissions quantified at the component, equipment or facility level? (N/A, unknown, decline to answer)

Respondent skipped this question

Q30

Has your organization developed detection probability curves for your method? (N/A, unknown, decline to answer)

Respondent skipped this question

Q31

Does your method require environmental data? If so, what types of data required and how are they collected?

Respondent skipped this question

Q32

Can your organization provide results from controlled release testing (CRT) and/or field performance? Please provide information on methods (e.g. Who conducted the testing? Was it performed indoors or outdoors? Under what range of environmental conditions?)If this information will be or has been published in academic papers, please indicate the paper/project. (N/A, unknown, decline to answer)

Respondent skipped this question

Q33

Has controlled release testing data or performance data on your organization's method been used in modelling or computer simulations? Were the model results used for AltFEMP proposals (N/A, unknown, decline to answer)

Respondent skipped this question

Page 8: Environmental and Operational Constraints

Q34

Under what environmental and operational conditions does your organization not operate in the field (please provide specifics)?

driving rain, wind in excess of 30 km/hr, temps below minus 15c

---

Q35

What environmental conditions affect your method's performance (e.g., temperature, precipitation, wind)? For each condition, how is performance impacted?

wind is the largest factor. High winds will spread the plume to a non-detectable threshold, making survey work inconclusive. Rain or snow can interfere with laser based measurements.

Q36

Please declare the following (qualifying responses if necessary) (N/A, unknown, decline to answer where necessary):

What is the range of temperatures where the technology is operational (°C, max and min)?	**-15 - +40**
What is the range of wind speed where the technology is operational (kmph, max and min)?	**0-20**
How much active rain is tolerated (None, light, medium, heavy)?	**light**
What is the maximum deployment humidity (%)?	**no restriction**
How much falling snow is tolerated (none, light, medium, heavy)?	**light**
How much snow can be tolerated on the ground (none, patchy, thin cover, deep)?	**thin cover**

Q37

How long does it take to deploy at the start of the day (exclude time spent driving to individual sites, if that is a part of the method) in minutes?

15

Q38

How long is take-down at the end of the day (exclude time spent driving to individual sites, if that is a part of the method) in minutes?

2-3 minutes

Q39

Is deployment required at each individual site? If so, how long does set-up/take-down take (in minutes)?

15

Q40

From the day of measurement, what is the guaranteed reporting timeline (in days)? If multiple reports are generated/provided, please explain what information they contain, and the number of days required for delivery of each report. (if a null response please enter N/A, unknown, decline to answer)

2 days for general site reports and notes. 2 weeks for detailed maps/drawings with notes.

Q41

What is the factor most limiting to safe and efficient field performance leading to high-quality results? (if a null response please enter N/A, unknown, decline to answer)

weather and site access

Page 9: Supply and Scalability of Service Offering

Q42

Using single-well batteries as a baseline, approximately how many facilities can each crew inspect in a typical day, week, month, and/or year? (if a null response please enter N/A, unknown, decline to answer)

unknown

Q43

How many independent crews fully equipped with deployment platform, sensor, and trained personnel are currently available for simultaneous deployment? (if a null response please enter N/A, unknown, decline to answer)

zero

Q44

What is your organization’s capacity to scale operations to meet your planned/desired market share of leak detection demand in Alberta? Using single well batteries to normalize site counts, how many do you project your operation to service in 2021, 2022, 2023 at 1 event per year (if this measurement of frequency doesn't apply to your method please explain)? (if a null response please enter N/A, unknown, decline to answer)

Size of potential contract would determine staffing needs.

Q45

How many quarters in 2021 or years (if beyond) 2021 do you believe it will take to scale your operation to planned capacity based on projected market conditions?

Scope of project would determine staffing needs

Q46

Does your organization expect any changes in its overall work capacity (e.g., number of crews, equipment stock, etc.) in the next 5 years? (N/A, unknown, decline to answer)

Scope of project would determine staffing needs

Q47

What are your biggest barriers to scaling (e.g. investment, manufacturing of sensors, training of personnel)?

availability of personnel

Page 10: Productivity and Cost (Optional):

Q48

What is your method’s approximate all-inclusive cost per day (single value or range) in 2021 Canadian dollars (please state assumed currency exchange if Canada is not your host country) under typical operating conditions in areas with facility densities up to 0.5 per square km? (if a null response please enter N/A, unknown, decline to answer)

decline to answer

Q49

How would this cost per day change if your organization is contracted for multiple days, weeks, months, or years? (N/A, unknown, decline to answer

decline to answer

Page 11: Productivity and Cost (Optional):

Q50

Approximately how many sites/day/crew can your technology/method survey for AER Facility Subtype 311/351 (Single well)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

Survey time per site, cost per site (optional), and additional comments::
This is impossible to determine without complete knowledge of the site layout and reporting requirements.

Q51

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 321/361 (Multi-well group battery)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

Survey time per site, cost per site (optional), and additional comments::
This is impossible to determine without complete knowledge of the site layout and reporting requirements.

Q52

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 401 (Gas Plant - Sweet)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

Survey time per site, cost per site (optional), and additional comments::
This is impossible to determine without complete knowledge of the site layout and reporting requirements.

Q53

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 601 (Compressor Station)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

Survey time per site, cost per site (optional), and additional comments::
This is impossible to determine without complete knowledge of the site layout and reporting requirements.

Q54

If your technology or method is not readily quantified using the 4 questions above, please describe your approach to capturing and conveying leak detection efficiencies to your clients (duty holders) and the indicative performance.

This is impossible to determine without complete knowledge of the site layout and reporting requirements.

Page 12: Data Management

Q55

Have LDAR-based data management services been a core requirement of your client/s?

N/A

Q56

Have your clients set specific requirements regarding data management, quality assessment/control, other requirements? Please explain if possible.

Varies client to client

Q57

What LDAR-based data management services does your organization offer?

Decline to answer

Vendor #15 Response

Collector: [redacted]

[redacted]

Page 2: Introduction

Q1

Contact Information (For Administrative Purposes Only - All Responses Are Anonymized)

Respondent Organization:	[redacted]
Respondent Name:	Vendor 15
Respondent Role:	[redacted]
E-mail:	[redacted]
Phone:	[redacted]
Website:	[redacted]
Response Date (yy/mm/dd):	[redacted]

Q2

Please confirm your understanding that all data collected as a part of this study are anonymous - check "Yes" to confirm.

Yes

Q3

Are you interested in being contacted for future PTAC methane emissions management research including, potential field campaigns?

Yes

Q4

Please indicate if you would like your organization to be publicly listed as a participant in this study. In this scenario, your organization would be identified as a participant that contributed data, but your organization's name is not associated with data you have submitted (data anonymity is preserved).

Yes

Page 3: General Information and Logistics

Q5

Does your organization have commercial LDAR surveying experience? If yes, please describe e.g., types of LDAR services provided, core markets (industry and/or locations), years of corporate experience with LDAR services.

Yes,
If yes, please describe::
Vendor 15's specific offerings [redacted] Satellites have worked globally in Oil +Gas, Waste Management, Power Generation, Mining and Agriculture The Aircraft Variant has worked in Canada and the USA primarily in Oil and Gas

---

Q6

Does your organization participate in methane measurement markets outside of Alberta? If you intend to enter new methane measurement markets in 2021 or later please answer - Yes.

Yes,
If yes, which markets? (Optional):
Global

Q7

Is your organization able (legally/logistically/etc.) to work in Canada?

Yes

Q8

Is your organization able (legally/logistically/etc.) to work in the United States?

Yes

Q9

Please describe any safety concerns, risks, interruptions or annoyances (for duty holders/operators and/or local residents/communities) possibly introduced by your product/service when completing LDAR surveys (e.g., noise, airspace, road/site congestion).

None based on the altitude we fly the aircraft

Q10

Has the COVID-19 outbreak and/or recent market conditions affected your operations re. LDAR services or is it expected to affect your operations? Please provide a comment if answering yes.

No

Q11

Has the establishment of equivalency with federal methane regulations in Alberta and Saskatchewan affected your operations? e.g., scale, frequency, jurisdictions? Please comment if yes.

No

Q12

Have methane-related Canadian provincial and federal programs affected your operations or planned operations? Please comment if yes.

Not aside from interest in Alt-FEMP programs

Page 4: Leak Detection Service Description

Q13

Is your method or technology compliant with AER Directive 60 leak detection methods (e.g., Method 21) or is it intended to be applied in an AltFEMP?

AltFEMP

Q14

Define your method in detail, including what equipment is used and how it is deployed. Points to address include (but are not limited to):

a. Does your organization offer a technology or a method?	**Technology and Method**
b. Does your organization offer a product (for sale?), a service, or a combination?	**Service**
c. Is the method mobile or stationary?	**Mobile**
d. Does your method require site access or does it measure remotely?	**Remotely**

Q15

What deployment platform(s) is/are used? (for example: hand-held, aerial, truck-mounted, UAV, fixed sensor, portable and temporary on-site mount). If multiple deployment platforms are used, explain them all and how they work together.

Satellite - takes observations from 500km above the earth's surface. Revisits each location every two weeks through a sun synchronous polar orbit.
Aircraft Variant- uses the same instrument as the satellites, but 2-3kms above ground on demand
Analytics - Utilizes publicly available methane data, customer proprietary data and our own methane data to catalogue historical methane concentration/emission data and inform machine learning algorithms to predict where future emission risk is highest and this is used to point/cue future observations with our satellite and aircraft variant

Q16

What is the specific work practice associated with your methane leak detection method/technology? Several key elements of the work practice are listed below. Please add and comment on any others you feel are pertinent to your offering.

a. At what distances from source are measurements taken?	**Satellite - 500k, Aircraft Variant - 2-3km**
b. What sensors are employed and how?	**Wide Angle Fabry-Perot**
c. How many people comprise one field crew? What are their roles?	**0**
d. How much time is spent surveying each potential source?	**<1 minute**
e. How much training are field staff required to have?	**N/A**
f. What output data are generated and reported?	**Abundance Data Sets, Concentration Maps, Emission Rates by pixel**

Q17

Has your method or technology been included in a successful AltFEMP proposal or application with a provincial regulator e.g., AER accepted Alternative FEMP Proposal, as described in the AER's Submission Checklist for Directive 060: Alternative FEMP Proposals? If yes, please state the jurisdiction, regulator and scale of adoption by clients/duty-holder.

No,
If no, is your organization planning to be involved in an Alternative FEMP Proposal in 2021 or later? Please provide specifics of your participation but do not reference duty holder(s).:
Yes, working with various partners in pilots with this being the goal.

Page 5: Involvement in an LDAR Program

Q18

What scale(s) i.e., component, equipment, facility does your method/technology target? Note that 'component' means inspectors can confirm, diagnose and tag individual leaks.

Equipment,

Facility

Q19

Is your leak detection method/technology able to distinguish vented from fugitive emissions?

No,
If yes, how? If not, how does it account for potential false positives?:
Working with the operator.

Q20

Does the work practice lead to diagnosis and tagging of individual leaks?

No,
If yes, how? Please describe in detail the process of going from measurement to tagging of leaks. If no, how does the information generated lead to the mitigation of fugitive emissions/leaks?:
The operator would take action on our reported leak to mitigate it.

Page 6: Leak Detection Service Description

Q21

For methods that are unable to confirm and tag individual leaks (i.e. “screening” methods), please define any relevant follow-up work practices used. For example, are follow-up OGI crews sent to high-emitting sites to tag leaks? (N/A, unknown, decline to answer)

Work with operator

Q22

What criteria are used to determine which sites receive follow-up visits? Examples could include:a. Site-level emissions thresholds to trigger follow-ups (in which case, what thresholds are used?)b. Follow-up ratios, such that the top 50% of emitting sites surveyed in a day receive follow-up surveys (if so, what ratios are used?)(N/A, unknown, decline to answer)

Work with operator

Q23

What are the roles/tasks of follow-up crews when onsite? For example, do they conduct classic facility-wide OGI surveys, looking for all leaks, or do they target large emitters?a. If following a non-standard work practice, what are the details?b. If not immediate, what is the time interval between screening measurement and follow-up tagging of leaks (in days). Please explain how this delay is estimated.(N/A, unknown, decline to answer)

Dependent on operator.

Page 7: Technical Specifications

Q24

What is the methane sensor that is used? Where applicable, specify brand or type.

Wide Angle Fabry-Perot

Q25

Does your surveying result in a quantified flow rate? If no, please skip to next page.

Yes

Q26

What are the minimum and maximum measurable flow rates of your method (m3/day to align with AER regulations - please note if using another unit of measurement e.g., SCFH)? (N/A, unknown, decline to answer)

300 m3/day +

Q27

Please state its median detection limit (i.e. the flow rate corresponding to a 50% detection probability - please specify a corresponding distance and windspeed)? (N/A, unknown, decline to answer)

N/A

Q28

What is the uncertainty/quantification accuracy of flow rate estimates?

Varies

Q29

Are emissions quantified at the component, equipment or facility level? (N/A, unknown, decline to answer)

equipment to facility

Q30

Has your organization developed detection probability curves for your method? (N/A, unknown, decline to answer)

Decline to Answer

Q31

Does your method require environmental data? If so, what types of data required and how are they collected?

Wind data from various sources

Q32

Can your organization provide results from controlled release testing (CRT) and/or field performance? Please provide information on methods (e.g. Who conducted the testing? Was it performed indoors or outdoors? Under what range of environmental conditions?)If this information will be or has been published in academic papers, please indicate the paper/project. (N/A, unknown, decline to answer)

Yes we can upon request

Q33

Has controlled release testing data or performance data on your organization's method been used in modelling or computer simulations? Were the model results used for AltFEMP proposals (N/A, unknown, decline to answer)

Modelling, but not an AltFEMP proposal to date.

Page 8: Environmental and Operational Constraints

Q34

Under what environmental and operational conditions does your organization not operate in the field (please provide specifics)?

We require reflectance from the sun. We are unable to take observations at night or with significant cloud cover

---

Q35

What environmental conditions affect your method's performance (e.g., temperature, precipitation, wind)? For each condition, how is performance impacted?

Wind impacts our results, but this is mitigated with accurate wind data in our processing

---

Q36

Please declare the following (qualifying responses if necessary) (N/A, unknown, decline to answer where necessary):

What is the range of temperatures where the technology is operational (°C, max and min)?	**All**
What is the range of wind speed where the technology is operational (kmph, max and min)?	**Most, accurate wind data from weather stations improves accuracy**
How much active rain is tolerated (None, light, medium, heavy)?	**Clouds from rain would make us unable to capture data**
What is the maximum deployment humidity (%)?	**All**
How much falling snow is tolerated (none, light, medium, heavy)?	**All**
How much snow can be tolerated on the ground (none, patchy, thin cover, deep)?	**All**

Q37

How long does it take to deploy at the start of the day (exclude time spent driving to individual sites, if that is a part of the method) in minutes?

0

Q38

How long is take-down at the end of the day (exclude time spent driving to individual sites, if that is a part of the method) in minutes?

0

Q39

Is deployment required at each individual site? If so, how long does set-up/take-down take (in minutes)?

No

Q40

From the day of measurement, what is the guaranteed reporting timeline (in days)? If multiple reports are generated/provided, please explain what information they contain, and the number of days required for delivery of each report. (if a null response please enter N/A, unknown, decline to answer)

In the first 1/2 days we have a Y/N for a plume of methane. We will then have emission rates within a week.

Q41

What is the factor most limiting to safe and efficient field performance leading to high-quality results? (if a null response please enter N/A, unknown, decline to answer)

Lack of sunlight

Page 9: Supply and Scalability of Service Offering

Q42

Using single-well batteries as a baseline, approximately how many facilities can each crew inspect in a typical day, week, month, and/or year? (if a null response please enter N/A, unknown, decline to answer)

Plenty. 3 satellites orbiting the earth 15 times a day and revisiting each point every two weeks. It depends much more on the location of each individual battery.

Q43

How many independent crews fully equipped with deployment platform, sensor, and trained personnel are currently available for simultaneous deployment? (if a null response please enter N/A, unknown, decline to answer)

3 Satellites, 1 Aircraft Variant

Q44

What is your organization’s capacity to scale operations to meet your planned/desired market share of leak detection demand in Alberta? Using single well batteries to normalize site counts, how many do you project your operation to service in 2021, 2022, 2023 at 1 event per year (if this measurement of frequency doesn't apply to your method please explain)? (if a null response please enter N/A, unknown, decline to answer)

We have significant capacity to increase our market share

Q45

How many quarters in 2021 or years (if beyond) 2021 do you believe it will take to scale your operation to planned capacity based on projected market conditions?

N/A

Q46

Does your organization expect any changes in its overall work capacity (e.g., number of crews, equipment stock, etc.) in the next 5 years? (N/A, unknown, decline to answer)

We will be adding an additional [redacted] satellites. [redacted]

Q47

What are your biggest barriers to scaling (e.g. investment, manufacturing of sensors, training of personnel)?

Operator buy-in

Page 10: Productivity and Cost (Optional):

Q48

What is your method's approximate all-inclusive cost per day (single value or range) in 2021 Canadian dollars (please state assumed currency exchange if Canada is not your host country) under typical operating conditions in areas with facility densities up to 0.5 per square km? (if a null response please enter N/A, unknown, decline to answer)

Decline to answer

Q49

How would this cost per day change if your organization is contracted for multiple days, weeks, months, or years? (N/A, unknown, decline to answer

Subscriptions to service significantly decrease costs on a "per observation basis"

Page 11: Productivity and Cost (Optional):

Q50

Approximately how many sites/day/crew can your technology/method survey for AER Facility Subtype 311/351 (Single well)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

21+

Q51

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 321/361 (Multi-well group battery)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

21+

Q52

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 401 (Gas Plant - Sweet)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

21+

Q53

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 601 (Compressor Station)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

21+

Q54

If your technology or method is not readily quantified using the 4 questions above, please describe your approach to capturing and conveying leak detection efficiencies to your clients (duty holders) and the indicative performance.

Satellite - We capture 12km x 12km images
Aircraft Variant - We fly a linear area with a 750m swath

Page 12: Data Management

Q55

Have LDAR-based data management services been a core requirement of your client/s?

Yes,
If yes/no/varied, are there any key reasons?:
Looking at concentrations over time Predicting risk probability for future leaks Identifying changes to flares (Lit/Unlit) Identifying methane hot spots one week to the next

Q56

Have your clients set specific requirements regarding data management, quality assessment/control, other requirements? Please explain if possible.

Yes, see above

Q57

What LDAR-based data management services does your organization offer?

See above which is contained in our Analytics Portal and the data is also available for clients to use in their own software

Vendor #16 Response

Collector: [redacted]

[redacted]

Page 2: Introduction

Q1

Contact Information (For Administrative Purposes Only - All Responses Are Anonymized)

Respondent Organization:	[redacted]
Respondent Name:	Vendor 16
Respondent Role:	[redacted]
E-mail:	[redacted]
Phone:	[redacted]
Response Date (yy/mm/dd):	[redacted]

Q2

Please confirm your understanding that all data collected as a part of this study are anonymous - check "Yes" to confirm.

Yes

Q3

Are you interested in being contacted for future PTAC methane emissions management research including, potential field campaigns?

Yes

Q4

Please indicate if you would like your organization to be publicly listed as a participant in this study. In this scenario, your organization would be identified as a participant that contributed data, but your organization's name is not associated with data you have submitted (data anonymity is preserved).

Yes

Page 3: General Information and Logistics

Q5

Does your organization have commercial LDAR surveying experience? If yes, please describe e.g., types of LDAR services provided, core markets (industry and/or locations), years of corporate experience with LDAR services.

Yes,
If yes, please describe::
[redacted] of direct LDAR surveying experience across Alberta in [redacted] oil and gas facillities.

Q6

Does your organization participate in methane measurement markets outside of Alberta? If you intend to enter new methane measurement markets in 2021 or later please answer - Yes.

Yes,
If yes, which markets? (Optional):
Facilities in Saskatchewan and BC

Q7

Is your organization able (legally/logistically/etc.) to work in Canada?

Yes

Q8

Is your organization able (legally/logistically/etc.) to work in the United States?

Yes

Q9

Please describe any safety concerns, risks, interruptions or annoyances (for duty holders/operators and/or local residents/communities) possibly introduced by your product/service when completing LDAR surveys (e.g., noise, airspace, road/site congestion).

none

Q10

Has the COVID-19 outbreak and/or recent market conditions affected your operations re. LDAR services or is it expected to affect your operations? Please provide a comment if answering yes.

Yes, ongoing,
If Yes, please explain.:
Permitting etc.

Q11

Has the establishment of equivalency with federal methane regulations in Alberta and Saskatchewan affected your operations? e.g., scale, frequency, jurisdictions? Please comment if yes.

No

Q12

Have methane-related Canadian provincial and federal programs affected your operations or planned operations? Please comment if yes.

yes, increase survey frequencies

Page 4: Leak Detection Service Description

Q13

Is your method or technology compliant with AER Directive 60 leak detection methods (e.g., Method 21) or is it intended to be applied in an AltFEMP?

AER Directive 60 Compliant / Method 21

Q14

Define your method in detail, including what equipment is used and how it is deployed. Points to address include (but are not limited to):

a. Does your organization offer a technology or a method?	**Method 21, optical gas imaging, organic vapor analyzer**
b. Does your organization offer a product (for sale?), a service, or a combination?	**both**
c. Is the method mobile or stationary?	**mobile**
d. Does your method require site access or does it measure remotely?	**both**

Q15

What deployment platform(s) is/are used? (for example: hand-held, aerial, truck-mounted, UAV, fixed sensor, portable and temporary on-site mount). If multiple deployment platforms are used, explain them all and how they work together.

hand held for all three

Q16

What is the specific work practice associated with your methane leak detection method/technology? Several key elements of the work practice are listed below. Please add and comment on any others you feel are pertinent to your offering.

a. At what distances from source are measurements taken?	**varies fron inches to in excess of 100 meters**
b. What sensors are employed and how?	**Flir imaging, Ultrasonic detection, organic vapor 1ppm-100% by volume**
c. How many people comprise one field crew? What are their roles?	**1-2 depending on additional tasks required.**
d. How much time is spent surveying each potential source?	**varies**
e. How much training are field staff required to have?	**training is ongoing, to be deemed experienced approx 2 years plus a written exam.**
f. What output data are generated and reported?	**leak location, pictures or leak, estimate on volume. stored in a database**

Q17

Has your method or technology been included in a successful AltFEMP proposal or application with a provincial regulator e.g., AER accepted Alternative FEMP Proposal, as described in the AER's Submission Checklist for Directive 060: Alternative FEMP Proposals? If yes, please state the jurisdiction, regulator and scale of adoption by clients/duty-holder.

No,
If no, is your organization planning to be involved in an Alternative FEMP Proposal in 2021 or later? Please provide specifics of your participation but do not reference duty holder(s).:
Possibly

Page 5: Involvement in an LDAR Program

Q18

What scale(s) i.e., component, equipment, facility does your method/technology target? Note that 'component' means inspectors can confirm, diagnose and tag individual leaks.

Component

Q19

Is your leak detection method/technology able to distinguish vented from fugitive emissions?

Yes,
If yes, how? If not, how does it account for potential false positives?:
vented vs fugitive emissions are the technicians evaluation. Technicians have required training to determine which is which

Q20

Does the work practice lead to diagnosis and tagging of individual leaks?

Yes,

If yes, how? Please describe in detail the process of going from measurement to tagging of leaks. If no, how does the information generated lead to the mitigation of fugitive emissions/leaks?:
Tagged, flagged and photographed. Entry into dBase. Also provide leak tracking and oversite for clients

Page 6: Leak Detection Service Description

Q21

For methods that are unable to confirm and tag individual leaks (i.e. “screening” methods), please define any relevant follow-up work practices used. For example, are follow-up OGI crews sent to high-emitting sites to tag leaks? (N/A, unknown, decline to answer)

all leaks are identified to absolute specific component, where possible leak is identified in photograph through soaping or detailed text discription.

Q22

What criteria are used to determine which sites receive follow-up visits? Examples could include:a. Site-level emissions thresholds to trigger follow-ups (in which case, what thresholds are used?)b. Follow-up ratios, such that the top 50% of emitting sites surveyed in a day receive follow-up surveys (if so, what ratios are used?)(N/A, unknown, decline to answer)

N/A

Q23

What are the roles/tasks of follow-up crews when onsite? For example, do they conduct classic facility-wide OGI surveys, looking for all leaks, or do they target large emitters?a. If following a non-standard work practice, what are the details?b. If not immediate, what is the time interval between screening measurement and follow-up tagging of leaks (in days). Please explain how this delay is estimated.(N/A, unknown, decline to answer)

N/A

Page 7: Technical Specifications

Q24

What is the methane sensor that is used? Where applicable, specify brand or type.

GMI GT 44/43

Q25

Does your surveying result in a quantified flow rate? If no, please skip to next page.

Yes

Q26

What are the minimum and maximum measurable flow rates of your method (m3/day to align with AER regulations - please note if using another unit of measurement e.g., SCFH)? (N/A, unknown, decline to answer)

Respondent skipped this question

Q27

Please state its median detection limit (i.e. the flow rate corresponding to a 50% detection probability - please specify a corresponding distance and windspeed)? (N/A, unknown, decline to answer)

Respondent skipped this question

Q28

What is the uncertainty/quantification accuracy of flow rate estimates?

varies by increase in volume

Q29

Are emissions quantified at the component, equipment or facility level? (N/A, unknown, decline to answer)

component

Q30

Has your organization developed detection probability curves for your method? (N/A, unknown, decline to answer)

No

Q31

Does your method require environmental data? If so, what types of data required and how are they collected?

no

Q32

Can your organization provide results from controlled release testing (CRT) and/or field performance? Please provide information on methods (e.g. Who conducted the testing? Was it performed indoors or outdoors? Under what range of environmental conditions?)If this information will be or has been published in academic papers, please indicate the paper/project. (N/A, unknown, decline to answer)

Respondent skipped this question

Q33

Has controlled release testing data or performance data on your organization's method been used in modelling or computer simulations? Were the model results used for AltFEMP proposals (N/A, unknown, decline to answer)

no

Page 8: Environmental and Operational Constraints

Q34

Under what environmental and operational conditions does your organization not operate in the field (please provide specifics)?

None to date

Q35

What environmental conditions affect your method's performance (e.g., temperature, precipitation, wind)? For each condition, how is performance impacted?

Rain can affect OIC and Ultrasonic detection

Q36

Please declare the following (qualifying responses if necessary) (N/A, unknown, decline to answer where necessary):

What is the range of temperatures where the technology is operational (°C, max and min)?	**-45 to +40**
What is the range of wind speed where the technology is operational (kmph, max and min)?	**na**
How much active rain is tolerated (None, light, medium, heavy)?	**medium**
What is the maximum deployment humidity (%)?	**n/a**
How much falling snow is tolerated (none, light, medium, heavy)?	**n/a**
How much snow can be tolerated on the ground (none, patchy, thin cover, deep)?	**deep**

Q37

How long does it take to deploy at the start of the day (exclude time spent driving to individual sites, if that is a part of the method) in minutes?

5 min

Q38

How long is take-down at the end of the day (exclude time spent driving to individual sites, if that is a part of the method) in minutes?

3

Q39

Is deployment required at each individual site? If so, how long does set-up/take-down take (in minutes)?

no

Q40

From the day of measurement, what is the guaranteed reporting timeline (in days)? If multiple reports are generated/provided, please explain what information they contain, and the number of days required for delivery of each report. (if a null response please enter N/A, unknown, decline to answer)

1 day

Q41

What is the factor most limiting to safe and efficient field performance leading to high-quality results? (if a null response please enter N/A, unknown, decline to answer)

n/a

Page 9: Supply and Scalability of Service Offering

Q42

Using single-well batteries as a baseline, approximately how many facilities can each crew inspect in a typical day, week, month, and/or year? (if a null response please enter N/A, unknown, decline to answer)

15-20/day

Q43

How many independent crews fully equipped with deployment platform, sensor, and trained personnel are currently available for simultaneous deployment? (if a null response please enter N/A, unknown, decline to answer)

rely on scheduling

Q44

What is your organization's capacity to scale operations to meet your planned/desired market share of leak detection demand in Alberta? Using single well batteries to normalize site counts, how many do you project your operation to service in 2021, 2022, 2023 at 1 event per year (if this measurement of frequency doesn't apply to your method please explain)? (if a null response please enter N/A, unknown, decline to answer)

unknown...........approx 3000

Q45

How many quarters in 2021 or years (if beyond) 2021 do you believe it will take to scale your operation to planned capacity based on projected market conditions?

3 years

Q46

Does your organization expect any changes in its overall work capacity (e.g., number of crews, equipment stock, etc.) in the next 5 years? (N/A, unknown, decline to answer)

yes, an increase

Q47

What are your biggest barriers to scaling (e.g. investment, manufacturing of sensors, training of personnel)?

training of personell

Page 10: Productivity and Cost (Optional):

Q48

What is your method's approximate all-inclusive cost per day (single value or range) in 2021 Canadian dollars (please state assumed currency exchange if Canada is not your host country) under typical operating conditions in areas with facility densities up to 0.5 per square km? (if a null response please enter N/A, unknown, decline to answer)

[redacted]

Q49

How would this cost per day change if your organization is contracted for multiple days, weeks, months, or years? (N/A, unknown, decline to answer

possible slight reduction 5-10%

Page 11: Productivity and Cost (Optional):

Q50

Approximately how many sites/day/crew can your technology/method survey for AER Facility Subtype 311/351 (Single well)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

21+,
Survey time per site, cost per site (optional), and additional comments::
20-30 minutes travel included

Q51

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 321/361 (Multi-well group battery)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

11-20,
Survey time per site, cost per site (optional), and additional comments::
20-40 minutes including travel

Q52

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 401 (Gas Plant - Sweet)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

1-5,
Survey time per site, cost per site (optional), and additional comments::
1-10 hours depending on site. Nominal around 4

Q53

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 601 (Compressor Station)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

6-10,
Survey time per site, cost per site (optional), and additional comments::
1-3 hours depending on number of compressors

Q54

If your technology or method is not readily quantified using the 4 questions above, please describe your approach to capturing and conveying leak detection efficiencies to your clients (duty holders) and the indicative performance.

Respondent skipped this question

Page 12: Data Management

Q55

Have LDAR-based data management services been a core requirement of your client/s?

Yes

Q56

Have your clients set specific requirements regarding data management, quality assessment/control, other requirements? Please explain if possible.

Most utilize Cntral

Q57

What LDAR-based data management services does your organization offer?

Cntral is used the most

Vendor #17 Response

Collector: [redacted]

[redacted]

Page 2: Introduction

Q1

Contact Information (For Administrative Purposes Only - All Responses Are Anonymized)

Respondent Organization:	[redacted]
Respondent Name:	Vendor 17
Respondent Role:	[redacted]
E-mail:	[redacted]
Phone:	[redacted]
Website:	[redacted]
Response Date (yy/mm/dd):	[redacted]

Q2

Please confirm your understanding that all data collected as a part of this study are anonymous - check "Yes" to confirm.

Yes

Q3

Are you interested in being contacted for future PTAC methane emissions management research including, potential field campaigns?

Yes

Q4

Please indicate if you would like your organization to be publicly listed as a participant in this study. In this scenario, your organization would be identified as a participant that contributed data, but your organization's name is not associated with data you have submitted (data anonymity is preserved).

Yes

Page 3: General Information and Logistics

Q5

Does your organization have commercial LDAR surveying experience? If yes, please describe e.g., types of LDAR services provided, core markets (industry and/or locations), years of corporate experience with LDAR services.

Yes,

If yes, please describe::

Our organization uses a drone with an integrated Methane sensor to fly over a site to pinpoint any Methane leak locations. The sensor can detect Methane as low as 5 ppm.m. We then go to the detected leak locations with an OGI Camera for quantification of leaks. This is much faster than using just the OGI, as the setup time is quite long with the camera.

Q6

Does your organization participate in methane measurement markets outside of Alberta? If you intend to enter new methane measurement markets in 2021 or later please answer - Yes.

Yes,

If yes, which markets? (Optional):

[redacted]

Q7

Is your organization able (legally/logistically/etc.) to work in Canada?

Yes

Q8

Is your organization able (legally/logistically/etc.) to work in the United States?

Yes

Q9

Please describe any safety concerns, risks, interruptions or annoyances (for duty holders/operators and/or local residents/communities) possibly introduced by your product/service when completing LDAR surveys (e.g., noise, airspace, road/site congestion).

Since our drones are battery powered, they do not create a lot of noise. The drones also do not fly very high (30m - 50m max), so airspace is generally not a concern. We do work with the local airspace authority to get proper authorization and maintain contact where necessary. We just have a 1 vehicle crew that handles both the drone flights and OGI camera, so there is minimal interruptions.

Q10

Has the COVID-19 outbreak and/or recent market conditions affected your operations re. LDAR services or is it expected to affect your operations? Please provide a comment if answering yes.

No

Q11

Has the establishment of equivalency with federal methane regulations in Alberta and Saskatchewan affected your operations? e.g., scale, frequency, jurisdictions? Please comment if yes.

Yes, since Directive 60 has been implemented in Alberta, there has been more desire for Methane detection companies to come forth and offer services. This has allowed Vendor 17 to expand our operations very quickly.

Q12

Have methane-related Canadian provincial and federal programs affected your operations or planned operations? Please comment if yes.

Yes, our office in [redacted] has been working very closely with local companies to help comply with federal regulations.

Page 4: Leak Detection Service Description

Q13

Is your method or technology compliant with AER Directive 60 leak detection methods (e.g., Method 21) or is it intended to be applied in an AltFEMP?

AER Directive 60 Compliant / Method 21

Q14

Define your method in detail, including what equipment is used and how it is deployed. Points to address include (but are not limited to):

a. Does your organization offer a technology or a method?	**Both. We offer the technology as a method of detecting leaks**
b. Does your organization offer a product (for sale?), a service, or a combination?	**Combination. We offer the services, but are capable of selling the equipment as well.**
c. Is the method mobile or stationary?	**Mobile**
d. Does your method require site access or does it measure remotely?	**Site Access**

Q15

What deployment platform(s) is/are used? (for example: hand-held, aerial, truck-mounted, UAV, fixed sensor, portable and temporary on-site mount). If multiple deployment platforms are used, explain them all and how they work together.

We use a UAV to detect the leak, and then a ground-based OGI Camera to quantify the leak once it is detected.

Q16

What is the specific work practice associated with your methane leak detection method/technology? Several key elements of the work practice are listed below. Please add and comment on any others you feel are pertinent to your offering.

a. At what distances from source are measurements taken?	**Around 25m for the UAV sensor, and about 10-15ft with the OGI Camera**
b. What sensors are employed and how?	**U10 Methane sensor with a Matrice 300 RTK Drone**
c. How many people comprise one field crew? What are their roles?	**Our crew is 2 people. One is the Pilot in Command, and the other is the Visual Observer. Both assist with the OGI Camera as well.**
d. How much time is spent surveying each potential source?	**It depends on many factors, but normally around 20 minutes.**
e. How much training are field staff required to have?	**Our crew requires a Drone Pilot Certificate for Advanced Operations, plus training on the drones and sensors. The OGI camera also requires training. About 1 week for full training of all equipment.**
f. What output data are generated and reported?	**We have a Fugitive Emissions Dashboard that shows all leaks from all surveys at all locations on a single screen. Workflows are able to be generated for repairing equipment, and all leaks can be exported in a .xls file with the same Excel Template as the AER.**

Q17

Has your method or technology been included in a successful AltFEMP proposal or application with a provincial regulator e.g., AER accepted Alternative FEMP Proposal, as described in the AER's Submission Checklist for Directive 060: Alternative FEMP Proposals? If yes, please state the jurisdiction, regulator and scale of adoption by clients/duty-holder.

No

Page 5: Involvement in an LDAR Program

Q18

What scale(s) i.e., component, equipment, facility does your method/technology target? Note that 'component' means inspectors can confirm, diagnose and tag individual leaks.

Component,

Equipment,

Facility

Q19

Is your leak detection method/technology able to distinguish vented from fugitive emissions?

Yes,

If yes, how? If not, how does it account for potential false positives?:

The drone itself is not able to, but the trained staff can distinguish the emissions when they quantify the leak.

Q20

Does the work practice lead to diagnosis and tagging of individual leaks?

Yes,

If yes, how? Please describe in detail the process of going from measurement to tagging of leaks. If no, how does the information generated lead to the mitigation of fugitive emissions/leaks?:

Each leak is uploaded into our Fugitive Emissions Dashboard, which then creates the workflow for each leak. We have the capability of using a QR code/tagging system which allows an operator to scan the QR code with their phone and track any leaks or repairs that way.

Page 6: Leak Detection Service Description

Q21

For methods that are unable to confirm and tag individual leaks (i.e. “screening” methods), please define any relevant follow-up work practices used. For example, are follow-up OGI crews sent to high-emitting sites to tag leaks? (N/A, unknown, decline to answer)

The leak points from the drone are still uploaded to the Fugitive Emissions Dashboard. If the OGI crew is unable to get to the leak location, then it would be noted on the dashboard. If OGI crew is capable of getting to the area, then they will quantify the leak and upload the data to the dashboard.

Q22

What criteria are used to determine which sites receive follow-up visits? Examples could include:a. Site-level emissions thresholds to trigger follow-ups (in which case, what thresholds are used?)b. Follow-up ratios, such that the top 50% of emitting sites surveyed in a day receive follow-up surveys (if so, what ratios are used?)(N/A, unknown, decline to answer)

Our clients will generate a list of sites that require follow-up. Some sites will require 1 survey, while others may require 3 surveys per year.

Q23

What are the roles/tasks of follow-up crews when onsite? For example, do they conduct classic facility-wide OGI surveys, looking for all leaks, or do they target large emitters?a. If following a non-standard work practice, what are the details?b. If not immediate, what is the time interval between screening measurement and follow-up tagging of leaks (in days). Please explain how this delay is estimated.(N/A, unknown, decline to answer)

Our OGI crew will target any detected leak points from the drone-based Methane sensor. Since the drone does an overhead, top-down flight, all GPS points are tagged on the map so the OGI crew can take the camera to those locations. This is done in tandem with the drone flights, so there is no delay. If repairs are required, the workflows are created in our Fugitive Emissions Dashboard, which allows operators to check off if a repair has been complete, and if/how they plan on validating the repair when it is done.

Page 7: Technical Specifications

Q24

What is the methane sensor that is used? Where applicable, specify brand or type.

[redacted] sensor that integrates with a drone.

Q25

Does your surveying result in a quantified flow rate? If no, please skip to next page.

Yes

Q26

What are the minimum and maximum measurable flow rates of your method (m3/day to align with AER regulations - please note if using another unit of measurement e.g., SCFH)? (N/A, unknown, decline to answer)

Unknown. FLIR does not post a minimum or maximum flow rate, but it seems to be very low to almost unlimited.

Q27

Please state its median detection limit (i.e. the flow rate corresponding to a 50% detection probability - please specify a corresponding distance and windspeed)? (N/A, unknown, decline to answer)

Detection median is temperature difference between the measured gas and the ambient gas.

Q28

What is the uncertainty/quantification accuracy of flow rate estimates?

±1°C (±1.8°F) for temperature range (0°C to 100°C, 32°F to 212°F) or ±2% of reading for temperature range (>100°C, >212°F).

Q29

Are emissions quantified at the component, equipment or facility level? (N/A, unknown, decline to answer)

All of the above. We will breakdown each individual component or equipment on our Fugitive Emissions Dashboard, but it does also provide data for each well pad, site, or facility.

Q30

Has your organization developed detection probability curves for your method? (N/A, unknown, decline to answer)

If yes, which variables contribute to your detection probabilities?:
We are working on an AI Platform that will help detect future Methane leaks based on equipment type, damages, etc. This platform is still in development and is not ready for use yet.

Q31

Does your method require environmental data? If so, what types of data required and how are they collected?

Windspeed, distance, and temperature need to be very accurate so we use an Anemometer to gather this information, as well as a laser rangefinder for distance.

Q32

Can your organization provide results from controlled release testing (CRT) and/or field performance? Please provide information on methods (e.g. Who conducted the testing? Was it performed indoors or outdoors? Under what range of environmental conditions?)If this information will be or has been published in academic papers, please indicate the paper/project. (N/A, unknown, decline to answer)

We have done a test with a client that opened a valve while our drone-based Methane sensor flew overhead to show that the technology works. This did not show a leak rate, but showed that the drone is capable of detecting methane leaks. Since we use the FLIR GFX320 OGI Camera, there is plenty of proven data on that so we did not quantify the leak.

Q33

Has controlled release testing data or performance data on your organization's method been used in modelling or computer simulations? Were the model results used for AltFEMP proposals (N/A, unknown, decline to answer)

N/A

Page 8: Environmental and Operational Constraints

Q34

Under what environmental and operational conditions does your organization not operate in the field (please provide specifics)?

We do not operate in temperatures colder than -20°C, warmer than 50°C, or in flying heavy snow. We can operate in light snow and rain.

Q35

What environmental conditions affect your method's performance (e.g., temperature, precipitation, wind)? For each condition, how is performance impacted?

Falling/Flying rain or snow can affect the OGI Camera, since it is an object with a temperature differential moving across the detection area. Heavy snowfall can give us false readings with the drone-based sensor, but we check every leak point with an OGI camera, so there will not be false leaks showing up on the dashboard.

Q36

Please declare the following (qualifying responses if necessary) (N/A, unknown, decline to answer where necessary):

What is the range of temperatures where the technology is operational (°C, max and min)?	**-20°C to 50°C**
What is the range of wind speed where the technology is operational (kmph, max and min)?	**54km/hr maximum wind resistance on the drone**
How much active rain is tolerated (None, light, medium, heavy)?	**Heavy**
What is the maximum deployment humidity (%)?	**There is no limit**
How much falling snow is tolerated (none, light, medium, heavy)?	**Medium**
How much snow can be tolerated on the ground (none, patchy, thin cover, deep)?	**Deep (just need to clear a take-off/landing area for the drone)**

Q37

How long does it take to deploy at the start of the day (exclude time spent driving to individual sites, if that is a part of the method) in minutes?

5 minutes

Q38

How long is take-down at the end of the day (exclude time spent driving to individual sites, if that is a part of the method) in minutes?

5 minutes

Q39

Is deployment required at each individual site? If so, how long does set-up/take-down take (in minutes)?

No. We can setup the drone at the first site, and leave it unfolded/calibrated for the remainder of the day.

Q40

From the day of measurement, what is the guaranteed reporting timeline (in days)? If multiple reports are generated/provided, please explain what information they contain, and the number of days required for delivery of each report. (if a null response please enter N/A, unknown, decline to answer)

7 days. This includes all the data submitted on the Fugitive Emissions Dashboard. If our crew is staying at a plant camp and has stable internet, they can upload the data each night.

Q41

What is the factor most limiting to safe and efficient field performance leading to high-quality results? (if a null response please enter N/A, unknown, decline to answer)

Heavy snow is the main factor that will limit our ability to fly the drone, and effectively use the OGI Camera.

Page 9: Supply and Scalability of Service Offering

Q42

Using single-well batteries as a baseline, approximately how many facilities can each crew inspect in a typical day, week, month, and/or year? (if a null response please enter N/A, unknown, decline to answer)

Approximately 4-6 single well batteries per day. Depends on the amount of leaks detected and how far apart they are.

Q43

How many independent crews fully equipped with deployment platform, sensor, and trained personnel are currently available for simultaneous deployment? (if a null response please enter N/A, unknown, decline to answer)

3, but have active job postings and candidates being interviewed to expand operations.

Q44

What is your organization’s capacity to scale operations to meet your planned/desired market share of leak detection demand in Alberta? Using single well batteries to normalize site counts, how many do you project your operation to service in 2021, 2022, 2023 at 1 event per year (if this measurement of frequency doesn't apply to your method please explain)? (if a null response please enter N/A, unknown, decline to answer)

Our organization is able to expand and scale as needed. There is no specialized schooling required as we just train each employee as they are hired. This gives them the tools they need to perform the job quickly, safely and efficiently. Our projections for single well batteries are as follows:
2021: 250
2022: 500
2023: 1000

Q45

How many quarters in 2021 or years (if beyond) 2021 do you believe it will take to scale your operation to planned capacity based on projected market conditions?

We are expanding this quarter, and will be continuing to expand throughout the following years.

Q46

Does your organization expect any changes in its overall work capacity (e.g., number of crews, equipment stock, etc.) in the next 5 years? (N/A, unknown, decline to answer)

Yes, we will be growing both our crews and equipment.

Q47

What are your biggest barriers to scaling (e.g. investment, manufacturing of sensors, training of personnel)?

Manufacturing of Sensors and cost of equipment. The OGI Cameras and U10 Methane Sensors are very expensive.

Page 10: Productivity and Cost (Optional):

Q48

What is your method's approximate all-inclusive cost per day (single value or range) in 2021 Canadian dollars (please state assumed currency exchange if Canada is not your host country) under typical operating conditions in areas with facility densities up to 0.5 per square km? (if a null response please enter N/A, unknown, decline to answer)

[redacted]

Q49

How would this cost per day change if your organization is contracted for multiple days, weeks, months, or years? (N/A, unknown, decline to answer

We would need to examine all aspects of the job including site density, # of sites, size of sites, etc. If we were contracted for a large job, we can charge less.

Page 11: Productivity and Cost (Optional):

Q50

Approximately how many sites/day/crew can your technology/method survey for AER Facility Subtype 311/351 (Single well)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

6-10

Q51

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 321/361 (Multi-well group battery)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

1-5

Q52

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 401 (Gas Plant - Sweet)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

1-5

Q53

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 601 (Compressor Station)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

1-5

Q54

If your technology or method is not readily quantified using the 4 questions above, please describe your approach to capturing and conveying leak detection efficiencies to your clients (duty holders) and the indicative performance.

Respondent skipped this question

Page 12: Data Management

Q55

Have LDAR-based data management services been a core requirement of your client/s?

Yes,

If yes/no/varied, are there any key reasons?:
Leak data can be very large and hard to process. That is why we have developed our Fugitive Emissions Dashboard.

Q56

Have your clients set specific requirements regarding data management, quality assessment/control, other requirements? Please explain if possible.

Yes, some clients want just an excel spreadsheet, but some want audit trails, carbon credits, and workflows integrated into the dashboard.

Q57

What LDAR-based data management services does your organization offer?

The Fugitive Emissions Dashboard. This puts all the leak data from the drones and OGI Cameras into a single page where the client can see each leak from a survey and see what equipment is leaking, flow rates, repair status, etc. The dashboard also allows for the data to be exported to a .xls Template for reporting to the AER.

Vendor #18 Response

Collector: [redacted]

[redacted]

Page 2: Introduction

Q1

Contact Information (For Administrative Purposes Only - All Responses Are Anonymized)

Respondent Organization:	[redacted]
Respondent Name:	Vendor 18
Respondent Role:	[redacted]
E-mail:	[redacted]
Phone:	[redacted]
Website:	[redacted]
Response Date (yy/mm/dd):	[redacted]

Q2

Please confirm your understanding that all data collected as a part of this study are anonymous - check "Yes" to confirm.

Yes

Q3

Are you interested in being contacted for future PTAC methane emissions management research including, potential field campaigns?

Yes

Q4

Please indicate if you would like your organization to be publicly listed as a participant in this study. In this scenario, your organization would be identified as a participant that contributed data, but your organization's name is not associated with data you have submitted (data anonymity is preserved).

Yes

Page 3: General Information and Logistics

Q5

Does your organization have commercial LDAR surveying experience? If yes, please describe e.g., types of LDAR services provided, core markets (industry and/or locations), years of corporate experience with LDAR services.

Yes,
If yes, please describe::
OIl & Gas since [redacted]

Q6

Does your organization participate in methane measurement markets outside of Alberta? If you intend to enter new methane measurement markets in 2021 or later please answer - Yes.

Yes,
If yes, which markets? (Optional):
OIl & Gas, Landfill, Composting

Q7

Is your organization able (legally/logistically/etc.) to work in Canada?

Yes

Q8

Is your organization able (legally/logistically/etc.) to work in the United States?

Yes

Q9

Please describe any safety concerns, risks, interruptions or annoyances (for duty holders/operators and/or local residents/communities) possibly introduced by your product/service when completing LDAR surveys (e.g., noise, airspace, road/site congestion).

Respondent skipped this question

Q10

Has the COVID-19 outbreak and/or recent market conditions affected your operations re. LDAR services or is it expected to affect your operations? Please provide a comment if answering yes.

Yes, ongoing,
If Yes, please explain.:
Travel restrictions to sites. Lab testing.

Q11

Has the establishment of equivalency with federal methane regulations in Alberta and Saskatchewan affected your operations? e.g., scale, frequency, jurisdictions? Please comment if yes.

NO

Q12

Have methane-related Canadian provincial and federal programs affected your operations or planned operations? Please comment if yes.

No

Page 4: Leak Detection Service Description

Q13

Is your method or technology compliant with AER Directive 60 leak detection methods (e.g., Method 21) or is it intended to be applied in an AltFEMP?

Respondent skipped this question

Q14

Define your method in detail, including what equipment is used and how it is deployed. Points to address include (but are not limited to):

a. Does your organization offer a technology or a method?	**Technology - Portable, Fixed Continuous and Drone Based Air Quality Monitors**
b. Does your organization offer a product (for sale?), a service, or a combination?	**Product**
c. Is the method mobile or stationary?	**Mobile and Stationary**
d. Does your method require site access or does it measure remotely?	**Both site access and remote measuring**

Q15

What deployment platform(s) is/are used? (for example: hand-held, aerial, truck-mounted, UAV, fixed sensor, portable and temporary on-site mount). If multiple deployment platforms are used, explain them all and how they work together.

hand-held, aerial, truck mounted, UAV, fixed sensor, portable, temporary.
Multiple system varieties for virtually all applications.

Q16

What is the specific work practice associated with your methane leak detection method/technology? Several key elements of the work practice are listed below. Please add and comment on any others you feel are pertinent to your offering.

a. At what distances from source are measurements taken?	**0-? horizontal and vertical distances are applicable**
b. What sensors are employed and how?	**TLDAS and LEL, in hand-held, fixed, UAV**
c. How many people comprise one field crew? What are their roles?	**1 for hand held, 0 for fixed (remote monitoring, 1 for UAV based models**
d. How much time is spent surveying each potential source?	**Short duration for hand held. Indefinite for fixed, up to 8 hours for UAV based.**
e. How much training are field staff required to have?	**15-30 minutes**
f. What output data are generated and reported?	**graphical analysis with included software. CSV format for data only.**

Q17

Has your method or technology been included in a successful AltFEMP proposal or application with a provincial regulator e.g., AER accepted Alternative FEMP Proposal, as described in the AER's Submission Checklist for Directive 060: Alternative FEMP Proposals? If yes, please state the jurisdiction, regulator and scale of adoption by clients/duty-holder.

No,

If no, is your organization planning to be involved in an Alternative FEMP Proposal in 2021 or later? Please provide specifics of your participation but do not reference duty holder(s).:

No active projects at this time

Page 5: Involvement in an LDAR Program

Q18

What scale(s) i.e., component, equipment, facility does your method/technology target? Note that 'component' means inspectors can confirm, diagnose and tag individual leaks.

Component,

Equipment,

Facility

Q19

Is your leak detection method/technology able to distinguish vented from fugitive emissions?

Yes,

If yes, how? If not, how does it account for potential false positives?:

the hand held and UAV systems can be moved to multiple locations to pinpoint vented and/or fugitive emissions.

Q20

Does the work practice lead to diagnosis and tagging of individual leaks?

Yes,

If yes, how? Please describe in detail the process of going from measurement to tagging of leaks. If no, how does the information generated lead to the mitigation of fugitive emissions/leaks?:

Our software will create hotspots that can be measured repeatedly and/or for longer periods to determine if it is a leak or fugitive. WE can then develop a model to determine where the source is originating from

Page 6: Leak Detection Service Description

Q21

For methods that are unable to confirm and tag individual leaks (i.e. "screening" methods), please define any relevant follow-up work practices used. For example, are follow-up OGI crews sent to high-emitting sites to tag leaks? (N/A, unknown, decline to answer)

N/A

Q22

What criteria are used to determine which sites receive follow-up visits? Examples could include:a. Site-level emissions thresholds to trigger follow-ups (in which case, what thresholds are used?)b. Follow-up ratios, such that the top 50% of emitting sites surveyed in a day receive follow-up surveys (if so, what ratios are used?)(N/A, unknown, decline to answer)

N/A

Q23

What are the roles/tasks of follow-up crews when onsite? For example, do they conduct classic facility-wide OGI surveys, looking for all leaks, or do they target large emitters?a. If following a non-standard work practice, what are the details?b. If not immediate, what is the time interval between screening measurement and follow-up tagging of leaks (in days). Please explain how this delay is estimated.(N/A, unknown, decline to answer)

N/A

Page 7: Technical Specifications

Q24

What is the methane sensor that is used? Where applicable, specify brand or type.

TLDAS- Tunable Laser Diode and/or Electrochemical sensors

Q25

Does your surveying result in a quantified flow rate? If no, please skip to next page.

No

Q26

What are the minimum and maximum measurable flow rates of your method (m3/day to align with AER regulations - please note if using another unit of measurement e.g., SCFH)? (N/A, unknown, decline to answer)

Respondent skipped this question

Q27

Please state its median detection limit (i.e. the flow rate corresponding to a 50% detection probability - please specify a corresponding distance and windspeed)? (N/A, unknown, decline to answer)

Respondent skipped this question

Q28

What is the uncertainty/quantification accuracy of flow rate estimates?

Respondent skipped this question

Q29

Are emissions quantified at the component, equipment or facility level? (N/A, unknown, decline to answer)

Respondent skipped this question

Q30

Has your organization developed detection probability curves for your method? (N/A, unknown, decline to answer)

Respondent skipped this question

Q31

Does your method require environmental data? If so, what types of data required and how are they collected?

Respondent skipped this question

Q32

Can your organization provide results from controlled release testing (CRT) and/or field performance? Please provide information on methods (e.g. Who conducted the testing? Was it performed indoors or outdoors? Under what range of environmental conditions?)If this information will be or has been published in academic papers, please indicate the paper/project. (N/A, unknown, decline to answer)

Respondent skipped this question

Q33

Has controlled release testing data or performance data on your organization’s method been used in modelling or computer simulations? Were the model results used for AltFEMP proposals (N/A, unknown, decline to answer)

Respondent skipped this question

Page 8: Environmental and Operational Constraints

Q34

Under what environmental and operational conditions does your organization not operate in the field (please provide specifics)?

We are manufacturers and generally do not operate in the filed

Q35

What environmental conditions affect your method’s performance (e.g., temperature, precipitation, wind)? For each condition, how is performance impacted?

Respondent skipped this question

Q36

Please declare the following (qualifying responses if necessary) (N/A, unknown, decline to answer where necessary):

What is the range of temperatures where the technology is operational (°C, max and min)?	**-40 to +40 C**
What is the range of wind speed where the technology is operational (kmph, max and min)?	**N/A**
How much active rain is tolerated (None, light, medium, heavy)?	**hand-held and UAV none-light, Fixed heavy**
What is the maximum deployment humidity (%)?	**90%**
How much falling snow is tolerated (none, light, medium, heavy)?	**hand-held and UAV none-light, Fixed heavy**
How much snow can be tolerated on the ground (none, patchy, thin cover, deep)?	**N/A**

Q37

How long does it take to deploy at the start of the day (exclude time spent driving to individual sites, if that is a part of the method) in minutes?

Hand-held/UAV less than 15 minutes. Fixed always on

Q38

How long is take-down at the end of the day (exclude time spent driving to individual sites, if that is a part of the method) in minutes?

Hand-held/UAV less than 15 minutes. Fixed always on

Q39

Is deployment required at each individual site? If so, how long does set-up/take-down take (in minutes)?

Hand-held/UAV less than 15 minutes. Fixed always on

Q40

From the day of measurement, what is the guaranteed reporting timeline (in days)? If multiple reports are generated/provided, please explain what information they contain, and the number of days required for delivery of each report. (if a null response please enter N/A, unknown, decline to answer)

Live data reporting

Q41

What is the factor most limiting to safe and efficient field performance leading to high-quality results? (if a null response please enter N/A, unknown, decline to answer)

N/A

Page 9: Supply and Scalability of Service Offering

Q42

Using single-well batteries as a baseline, approximately how many facilities can each crew inspect in a typical day, week, month, and/or year? (if a null response please enter N/A, unknown, decline to answer)

N/A

Q43

How many independent crews fully equipped with deployment platform, sensor, and trained personnel are currently available for simultaneous deployment? (if a null response please enter N/A, unknown, decline to answer)

n?A

Q44

What is your organization’s capacity to scale operations to meet your planned/desired market share of leak detection demand in Alberta? Using single well batteries to normalize site counts, how many do you project your operation to service in 2021, 2022, 2023 at 1 event per year (if this measurement of frequency doesn't apply to your method please explain)? (if a null response please enter N/A, unknown, decline to answer)

N/A

Q45

How many quarters in 2021 or years (if beyond) 2021 do you believe it will take to scale your operation to planned capacity based on projected market conditions?

N/A

Q46

Does your organization expect any changes in its overall work capacity (e.g., number of crews, equipment stock, etc.) in the next 5 years? (N/A, unknown, decline to answer)

N/A

Q47

What are your biggest barriers to scaling (e.g. investment, manufacturing of sensors, training of personnel)?

N/A

Page 10: Productivity and Cost (Optional):

Q48

What is your method’s approximate all-inclusive cost per day (single value or range) in 2021 Canadian dollars (please state assumed currency exchange if Canada is not your host country) under typical operating conditions in areas with facility densities up to 0.5 per square km? (if a null response please enter N/A, unknown, decline to answer)

N/A

Q49

How would this cost per day change if your organization is contracted for multiple days, weeks, months, or years? (N/A, unknown, decline to answer

N/A

Page 11: Productivity and Cost (Optional):

Q50

Approximately how many sites/day/crew can your technology/method survey for AER Facility Subtype 311/351 (Single well)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

Survey time per site, cost per site (optional), and additional comments::
N/A

Q51

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 321/361 (Multi-well group battery)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

Survey time per site, cost per site (optional), and additional comments::
N/A

Q52

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 401 (Gas Plant - Sweet)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

Survey time per site, cost per site (optional), and additional comments::
N/A

Q53

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 601 (Compressor Station)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

Survey time per site, cost per site (optional), and additional comments::
N/A

Q54

If your technology or method is not readily quantified using the 4 questions above, please describe your approach to capturing and conveying leak detection efficiencies to your clients (duty holders) and the indicative performance.

WE are a manufacturer not a service organization

Page 12: Data Management

Q55

Have LDAR-based data management services been a core requirement of your client/s?

N/A

Q56

Have your clients set specific requirements regarding data management, quality assessment/control, other requirements? Please explain if possible.

Respondent skipped this question

Q57

What LDAR-based data management services does your organization offer?

Respondent skipped this question

Vendor #19 Response

Collector: [redacted]

[redacted]

Page 2: Introduction

Q1

Contact Information (For Administrative Purposes Only - All Responses Are Anonymized)

Respondent Organization:	[redacted]
Respondent Name:	Vendor 19
Respondent Role:	[redacted]
E-mail:	[redacted]
Phone:	[redacted]
Website:	[redacted]
Response Date (yy/mm/dd):	[redacted]

Q2

Please confirm your understanding that all data collected as a part of this study are anonymous - check "Yes" to confirm.

Yes

Q3

Are you interested in being contacted for future PTAC methane emissions management research including, potential field campaigns?

Yes

Q4

Please indicate if you would like your organization to be publicly listed as a participant in this study. In this scenario, your organization would be identified as a participant that contributed data, but your organization's name is not associated with data you have submitted (data anonymity is preserved).

Yes

Page 3: General Information and Logistics

Q5

Does your organization have commercial LDAR surveying experience? If yes, please describe e.g., types of LDAR services provided, core markets (industry and/or locations), years of corporate experience with LDAR services.

Yes,

If yes, please describe::

(Yes, with heavy caveats). [redacted] is a startup offering a new type of emissions visualisation and quantification solution, based around quantum dingle photon detection technology. The first commercial units are shipping within the month, and we are actively seeking field trials for the equipment in the second half of 2021 and onwards. [redacted] has had solid support from Innovate UK and has been working closely with the UK National Physical Laboratory to prove we can do what we claim. We have demonstrated our cameras in multiple industrial trials and shown they work in bright sunlight, snow, rain, fog and the dark. We have also carried out industrial trials at the [redacted]

We are working with industrial partners [redacted]

Q6

Does your organization participate in methane measurement markets outside of Alberta? If you intend to enter new methane measurement markets in 2021 or later please answer - Yes.

Yes,

If yes, which markets? (Optional):

Global

Q7

Is your organization able (legally/logistically/etc.) to work in Canada?

Yes

Q8

Is your organization able (legally/logistically/etc.) to work in the United States?

Yes

Q9

Please describe any safety concerns, risks, interruptions or annoyances (for duty holders/operators and/or local residents/communities) possibly introduced by your product/service when completing LDAR surveys (e.g., noise, airspace, road/site congestion).

None - the technology has a small form factor (similar to a security camera) and uses an entirely eye safe tunable diode Lidar to gather gas concentration data. The greatest safety concern is the preference to be installed at height. The equipment is small and light enough to be attached to existing infrastructure, a MEWP or a tripod/mast.

Q10

Has the COVID-19 outbreak and/or recent market conditions affected your operations re. LDAR services or is it expected to affect your operations? Please provide a comment if answering yes.

Yes, ongoing,

If Yes, please explain.:

The Covid-19 pandemic has limited access to the development laboratory to only a porportion of staff, at only a proportion of the time. This has slowed down the delivery of the first camera units for sale, and will continue to slow delivery of new units for field trial over the course of 2021. [redacted] is expecting to be carrying out field trials by Q4 2021.

Q11

Has the establishment of equivalency with federal methane regulations in Alberta and Saskatchewan affected your operations? e.g., scale, frequency, jurisdictions? Please comment if yes.

No. [redacted] has had no exposure to the Canadian market so far.

Q12

Have methane-related Canadian provincial and federal programs affected your operations or planned operations? Please comment if yes.

No. [redacted] has had no exposure to the Canadian market so far.

Page 4: Leak Detection Service Description

Q13

Is your method or technology compliant with AER Directive 60 leak detection methods (e.g., Method 21) or is it intended to be applied in an AltFEMP?

AltFEMP

Q14

Define your method in detail, including what equipment is used and how it is deployed. Points to address include (but are not limited to):

a. Does your organization offer a technology or a method?	**[redacted] offers a gas measurement camera utilising unique quantum single photon technology based on Tunable Diode Lidar (TDLidar).**
b. Does your organization offer a product (for sale?), a service, or a combination?	**[redacted] offers both the quantum gas camera, operational software, and interprative and consultative expertise.**
c. Is the method mobile or stationary?	**The cameras are currently fixed emplacments, sat on a pan-tilt mechanism. Future versions of the camera (Q3 2022) will be mountable on UAVs.**
d. Does your method require site access or does it measure remotely?	**The camera can monitor methane emissions at a range of up to 200m. While site access is beneficial (as the equipment can be set up to view more infrastructure), surveys can take place from outside the fenceline if necessary.**

Q15

What deployment platform(s) is/are used? (for example: hand-held, aerial, truck-mounted, UAV, fixed sensor, portable and temporary on-site mount). If multiple deployment platforms are used, explain them all and how they work together.

The cameras are currently fixed emplacments, sat on a pan-tilt mechanism. Future versions of the camera (Q3 2022) will be mountable on UAVs.

Q16

What is the specific work practice associated with your methane leak detection method/technology? Several key elements of the work practice are listed below. Please add and comment on any others you feel are pertinent to your offering.

a. At what distances from source are measurements taken?	**Up to 200 metres.**
b. What sensors are employed and how?	**Quantum single photon detection using single photon avalance detector (SPAD) technology coupled with a tunable diode Lidar (TDLidar) at the absorption wavelength of the target gas.**
c. How many people comprise one field crew? What are their roles?	**The quantum gas camera can be operated by a lone worker.**
d. How much time is spent surveying each potential source?	**A single area can be surveyed for anywhere between 60 and 180 seconds, and individual methane sources identified from that. In practice, when searching for sources, the camera will 'tile' the area with scans, building up a picture of the surrounding area over time (dependent on scan duration for each 'tile).**
e. How much training are field staff required to have?	**At present, cameras are operated solely by [redacted] staff. Future operators would receive at least one day of training in the operation of the camera.**
f. What output data are generated and reported?	**Output data include calculated leak rate as a function of time for each individual leak that is located, and a concentration isobar map overlaid on a visual image of the area being surveyed. All data is metadata tagged so datapoints and images can easily be associated with each other.**
Additional work practice details	**N/A**

Q17

Has your method or technology been included in a successful AltFEMP proposal or application with a provincial regulator e.g., AER accepted Alternative FEMP Proposal, as described in the AER's Submission Checklist for Directive 060: Alternative FEMP Proposals? If yes, please state the jurisdiction, regulator and scale of adoption by clients/duty-holder.

No,

If no, is your organization planning to be involved in an Alternative FEMP Proposal in 2021 or later? Please provide specifics of your participation but do not reference duty holder(s).:

[redacted] is eager to participate in an Alternative FEMP Proposal in 2021 or 2022. At this stage, we are making explorative enquiries and searching for parter operations in Canada.

Page 5: Involvement in an LDAR Program

Q18

What scale(s) i.e., component, equipment, facility does your method/technology target? Note that ‘component’ means inspectors can confirm, diagnose and tag individual leaks.

Component,

Equipment,

Facility

Q19

Is your leak detection method/technology able to distinguish vented from fugitive emissions?

Yes,

If yes, how? If not, how does it account for potential false positives?:

The initial offering of the software (Q2 2021) will not distinguish between vents and fugitive emissions. Future versions of the software (Q4 2021 onwards) are expected to be able to monitor regular emissions over time (for regularity, intermittency and intensity) and designate these as 'vents' (visualising and quantifying for emissions budgets but not necessarily reporting an alarm). Any further emissions detected over the top of expected vents (distinguishable by their persistence and lower intensity than vents) will be designated as 'leaks' (visualising, quantifying, and reporting an alarm).

Q20

Does the work practice lead to diagnosis and tagging of individual leaks?

Yes,

If yes, how? Please describe in detail the process of going from measurement to tagging of leaks. If no, how does the information generated lead to the mitigation of fugitive emissions/leaks?:

As methane is detected, the camera can be made to zoom in on the individual source, recording datapoints tagged with metadata including date, time and relative location of the focus (and therefore, the individual leak).

Page 6: Leak Detection Service Description

Q21

For methods that are unable to confirm and tag individual leaks (i.e. “screening” methods), please define any relevant follow-up work practices used. For example, are follow-up OGI crews sent to high-emitting sites to tag leaks? (N/A, unknown, decline to answer)

N/A. [redacted] quantum gas camera can confirm and tag individual leaks.

Q22

What criteria are used to determine which sites receive follow-up visits? Examples could include:a. Site-level emissions thresholds to trigger follow-ups (in which case, what thresholds are used?)b. Follow-up ratios, such that the top 50% of emitting sites surveyed in a day receive follow-up surveys (if so, what ratios are used?)(N/A, unknown, decline to answer)

N/A

Q23

What are the roles/tasks of follow-up crews when onsite? For example, do they conduct classic facility-wide OGI surveys, looking for all leaks, or do they target large emitters?a. If following a non-standard work practice, what are the details?b. If not immediate, what is the time interval between screening measurement and follow-up tagging of leaks (in days). Please explain how this delay is estimated.(N/A, unknown, decline to answer)

N/A

Page 7: Technical Specifications

Q24

What is the methane sensor that is used? Where applicable, specify brand or type.

Uncooled single photon avalanche detector, employing time-correlated single photon counting technology. White paper available on request.

Q25

Does your surveying result in a quantified flow rate? If no, please skip to next page.

Yes

Q26

What are the minimum and maximum measurable flow rates of your method (m3/day to align with AER regulations - please note if using another unit of measurement e.g., SCFH)? (N/A, unknown, decline to answer)

Minimum detection ~ 1.6 cubic metres of methane per day. Upper limit less well-known - very roughly 1000 times greater than minimum.

Q27

Please state its median detection limit (i.e. the flow rate corresponding to a 50% detection probability - please specify a corresponding distance and windspeed)? (N/A, unknown, decline to answer)

Unknown.

Q28

What is the uncertainty/quantification accuracy of flow rate estimates?

Accuracy and uncertainty are two different measures. Field trials have esitmated leak flow rates with ~30% inaccuracy. Intrinsic uncertainty is still pending traceable measurement.

Q29

Are emissions quantified at the component, equipment or facility level? (N/A, unknown, decline to answer)

The quantum gas camera quantifies emissions at the component level, allowing for quantification at the equipment or facility level by combining leak measurements.

Q30

Has your organization developed detection probability curves for your method? (N/A, unknown, decline to answer)

Unknown

Q31

Does your method require environmental data? If so, what types of data required and how are they collected?

To calculate leak flow rate, the system needs to receive wind speed and direction data from an anemometer.

Q32

Can your organization provide results from controlled release testing (CRT) and/or field performance? Please provide information on methods (e.g. Who conducted the testing? Was it performed indoors or outdoors? Under what range of environmental conditions?)If this information will be or has been published in academic papers, please indicate the paper/project. (N/A, unknown, decline to answer)

Data from controlled release studies in the UK and France can be provided on request. A white paper containing results is currently in pre-print with the Applied Energy Journal (and is also available on request).

Q33

Has controlled release testing data or performance data on your organization's method been used in modelling or computer simulations? Were the model results used for AltFEMP proposals (N/A, unknown, decline to answer)

N/A

Page 8: Environmental and Operational Constraints

Q34

Under what environmental and operational conditions does your organization not operate in the field (please provide specifics)?

The camera is compliant with IP64 requirements (certification pending), and can operate between 0 and 40 deg C. Performance is not guaranteed outside of these temperatures, nor in the presence of zero wind, which affects the leak flow rate calculation.

Q35

What environmental conditions affect your method's performance (e.g., temperature, precipitation, wind)? For each condition, how is performance impacted?

The camera is compliant with IP64 requirements (certification pending), and can operate between 0 and 40 deg C. While the equipment is not known to stop working outside of these temperaturtes, performance is not guaranteed. In the presence of zero wind, the leak flow rate calculation will be negatively impacted (to the point where measurement uncertainty will become unreasonably high).
The system has been observed to perform with no appreciaable loss of performance in persistent rain.

Q36

Please declare the following (qualifying responses if necessary) (N/A, unknown, decline to answer where necessary):

What is the range of temperatures where the technology is operational (°C, max and min)?	**40 and 0.**
What is the range of wind speed where the technology is operational (kmph, max and min)?	**100(?) and 7.2**
How much active rain is tolerated (None, light, medium, heavy)?	**At least medium.**
What is the maximum deployment humidity (%)?	**Unknown**
How much falling snow is tolerated (none, light, medium, heavy)?	**Unknown, expected to tolerate at least medium**
How much snow can be tolerated on the ground (none, patchy, thin cover, deep)?	**Deep**

Q37

How long does it take to deploy at the start of the day (exclude time spent driving to individual sites, if that is a part of the method) in minutes?

Setup time expected to be less than one day, depending on the facility, and perhaps considerably less.

Q38

How long is take-down at the end of the day (exclude time spent driving to individual sites, if that is a part of the method) in minutes?

Similar in time to setup, and highly dependent on the installation (fixed emplacement, tripod mount, installation position etc).

Q39

Is deployment required at each individual site? If so, how long does set-up/take-down take (in minutes)?

The fixed emplacement camera is deployed on a pan-tilt, allowing it to survey up to 200m in any direction within line of sight. It does not need to be set up at each individual leak point.

Q40

From the day of measurement, what is the guaranteed reporting timeline (in days)? If multiple reports are generated/provided, please explain what information they contain, and the number of days required for delivery of each report. (if a null response please enter N/A, unknown, decline to answer)

Unknown. On the order of days for a full report on top of real-time alerts.

Q41

What is the factor most limiting to safe and efficient field performance leading to high-quality results? (if a null response please enter N/A, unknown, decline to answer)

Unknown, likely wind.

Page 9: Supply and Scalability of Service Offering

Q42

Using single-well batteries as a baseline, approximately how many facilities can each crew inspect in a typical day, week, month, and/or year? (if a null response please enter N/A, unknown, decline to answer)

This is entirely dependent on how close the wells are to each other and whether they can surveyed more than one well at a time. It is impossible to answer this question quantitatively. [redacted] cameras are designed to continuously monitor a facility on a 24/7/265 basis, normally powered from mains power. Current operation off 24V batteries enables the camera to run for approximately 8 hours.

Q43

How many independent crews fully equipped with deployment platform, sensor, and trained personnel are currently available for simultaneous deployment? (if a null response please enter N/A, unknown, decline to answer)

One or two cameras will be available for field trial in Q4 2021, quickly expanding to approximately ten times this in 2022.

Q44

What is your organization's capacity to scale operations to meet your planned/desired market share of leak detection demand in Alberta? Using single well batteries to normalize site counts, how many do you project your operation to service in 2021, 2022, 2023 at 1 event per year (if this measurement of frequency doesn't apply to your method please explain)? (if a null response please enter N/A, unknown, decline to answer)

N/A. [redacted] produces a continuous monitoring solution rather than an intermittent survey monitoring solution.

Q45

How many quarters in 2021 or years (if beyond) 2021 do you believe it will take to scale your operation to planned capacity based on projected market conditions?

Methane is the gas we are focusing on first because it causes about one quarter of manmade global warming and leaks are valued at >$30B a year (Rhodium Group 2015). Methane is such a potent GHG it only takes a 3% leak rate to make natural gas as bad for climate change as burning coal. The global natural gas leak detection market is US$1.5B+ with a CAGR of >7% (Research and Markets 2018) driven by gas becoming the dominant fossil fuel, slowly increasing government regulations, and expanding investor pressure to improve industry standards.
Current detection technologies are complex, expensive and need trained experts to operate so regulations only enforce occasional inspections. The gas industry is searching for ways to catch these leaks and reinstate natural gas as a transition fossil fuel and gas suppliers as environmentally responsible and worthy investment.
Methane production and supply are not the only markets we are pursuing. Our next largest target is the petrochemical industry which consumes natural gas to manufacture a wide range of industrial materials. The gas leak detection market for the 2,000 chemical plants worldwide is US$0.5B and is expanding rapidly with product diversification in major industries such as construction and transport and increasing safety regulation. This market also has a strong use for methane detection but demand detection of other gases as well, notably carbon dioxide and ethylene. Another market we are addressing is environmental monitoring for landfill and Landfill-Gas-To-Energy plants that need improved GHG leak detection.
We believe the customers we can reach already service at least 60% or >US$1B of the total global revenue, and as major equipment suppliers to them we can obtain 20% of this and more than $200M revenue per year ourselves.

Q46

Does your organization expect any changes in its overall work capacity (e.g., number of crews, equipment stock, etc.) in the next 5 years? (N/A, unknown, decline to answer)

Yes. [redacted] expects to expand rapidly over the next five years from its current state as an 8-employee SME.

[redacted] was founded [redacted] years ago and has to date received around [redacted] industry contracts. We have [redacted] more in contracts and another [redacted] of grants awarded and still to be claimed.

In FY2022 our strong Innovate [redacted] in grants, commercial contract activity will grow to more than [redacted] total. In FY2023 we will continue to grow and close a Series A investment round for around £4m.
[redacted] uses an extensive network of expert contractors and advisors for technology and business development and has a hiring plan to expand the internal teams for these functions as well as business operations and administration as our revenue expands.
FY2023 sales will be more than 50 units and then in FY2024 more than 200 units for [redacted] In FY2025 we will sell more than 1000 units and start to generate cash.
In 5 years [redacted] will have a world leading high-value gas measurement platform deployed globally and growing rapidly. Our expanded engineering, business development, operations and administration staff will be close to 100 people, mostly in the UK. Sales of around 2,000 cameras per year will generate more than [redacted] in revenue and service and development contracts will add another [redacted] We will have a gross margin around 50% and an EBITDA of more than 20%. Several of our major customers will be discussing with us how they might acquire us.
We expect to be a strategic acquisition by one of our large customers for [redacted] in <7 years, in line with the following table of comparable acquisitions and the recent acquisition of Rebellion Photonics by Honeywell.

Q47

What are your biggest barriers to scaling (e.g. investment, manufacturing of sensors, training of personnel)?

The oil and gas industry is at a strategic crossroads, where a path needs to be defined into a lower-carbon future dictated by the need to achieve Net Zero by the middle of the century. However, the industry is also driven by regulation, safety and compliance, as well as the needs of investors. More and more, investors are asking ethical and environmental questions of their beneficiaries where previously only financial output was a concern. What the industry is currently struggling with is the lack of standards and regulatory policy time lag with respect to current innovation. The industry is reluctant to fully commit to a solution that may become anathema under new regulations, or that will hit a target that is seen as less valuable than what a different solution will enable.
Regulatory policy is, therefore, the major rate determining step of widespread uptake of continuous monitoring technology. Various approaches (of which [redacted] offering stands pre-eminent) are ready and waiting to deliver on the the requirement, and the current march of climate change policy is tipping the balance increasingly towards needing to make a commitment and define how it will be achieved.

Page 10: Productivity and Cost (Optional):

Q48

What is your method's approximate all-inclusive cost per day (single value or range) in 2021 Canadian dollars (please state assumed currency exchange if Canada is not your host country) under typical operating conditions in areas with facility densities up to 0.5 per square km? (if a null response please enter N/A, unknown, decline to answer)

Unknown.

Q49

How would this cost per day change if your organization is contracted for multiple days, weeks, months, or years? (N/A, unknown, decline to answer

Unknown.

Page 11: Productivity and Cost (Optional):

Q50

Approximately how many sites/day/crew can your technology/method survey for AER Facility Subtype 311/351 (Single well)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

Survey time per site, cost per site (optional), and additional comments::
Unknown. [redacted] technology is new, and designed for 24/7 continuous monitoring rather than intermittent site surveys.

Q51

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 321/361 (Multi-well group battery)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

Survey time per site, cost per site (optional), and additional comments::
Unknown. [redacted] technology is new, and designed for 24/7 continuous monitoring rather than intermittent site surveys.

Q52

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 401 (Gas Plant - Sweet)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

Survey time per site, cost per site (optional), and additional comments::
Unknown. [redacted] technology is new, and designed for 24/7 continuous monitoring rather than intermittent site surveys.

Q53

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 601 (Compressor Station)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

Survey time per site, cost per site (optional), and additional comments::
Unknown. [redacted] technology is new, and designed for 24/7 continuous monitoring rather than intermittent site surveys.

Q54

If your technology or method is not readily quantified using the 4 questions above, please describe your approach to capturing and conveying leak detection efficiencies to your clients (duty holders) and the indicative performance.

[redacted] technology offers multiple benefits over the current state of the art. The ability to simultaneously visualise and quantify releases of methane is a step forward, as is the ability to provide this on a 24/7/365 basis, offering faster responses than intermittent studies. The user emits less methane, for a lower overall investment.

The industry is looking for disruptive sensors that combine selectivity, sensitivity, high rejection of spurious results, long lifetime and low cost of operation so they can be widely deployed and operated in continuous automatic monitoring systems from which data can be integrated into comprehensive and automated safety, environmental and maintenance response systems. Other technologies can offer a portion of this benefit, but only [redacted] combination of accuracy, sensitivity, long range, robustness, and low-cost scalability addresses all the requirements for tackling the market.

Page 12: Data Management

Q55

Have LDAR-based data management services been a core requirement of your client/s?

Varied

Q56

Have your clients set specific requirements regarding data management, quality assessment/control, other requirements? Please explain if possible.

These arrangements are subject to corporate confidentiality.

Q57

What LDAR-based data management services does your organization offer?

[redacted] is still producing its first units. At present, data management is on a case by case basis.

Vendor #20 Response

Collector: [redacted]

[redacted]

Page 2: Introduction

Q1

Contact Information (For Administrative Purposes Only - All Responses Are Anonymized)

Respondent Organization: [redacted]

Respondent Name: [redacted]

Respondent Role: [redacted]

E-mail: [redacted]

Phone: [redacted]

Response Date (yy/mm/dd): [redacted]

Q2

Please confirm your understanding that all data collected as a part of this study are anonymous - check "Yes" to confirm.

Yes

Q3

Are you interested in being contacted for future PTAC methane emissions management research including, potential field campaigns?

Yes

Q4

Please indicate if you would like your organization to be publicly listed as a participant in this study. In this scenario, your organization would be identified as a participant that contributed data, but your organization’s name is not associated with data you have submitted (data anonymity is preserved).

Yes

Page 3: General Information and Logistics

Q5

Does your organization have commercial LDAR surveying experience? If yes, please describe e.g., types of LDAR services provided, core markets (industry and/or locations), years of corporate experience with LDAR services.

Yes,
If yes, please describe::
We provide technological solutions for finding and quantifying natural gas leak emissions.

Q6

Does your organization participate in methane measurement markets outside of Alberta? If you intend to enter new methane measurement markets in 2021 or later please answer - Yes.

Yes,
If yes, which markets? (Optional):
worldwide

Q7

Is your organization able (legally/logistically/etc.) to work in Canada?

Yes

Q8

Is your organization able (legally/logistically/etc.) to work in the United States?

Yes

Q9

Please describe any safety concerns, risks, interruptions or annoyances (for duty holders/operators and/or local residents/communities) possibly introduced by your product/service when completing LDAR surveys (e.g., noise, airspace, road/site congestion).

none

Q10

Has the COVID-19 outbreak and/or recent market conditions affected your operations re. LDAR services or is it expected to affect your operations? Please provide a comment if answering yes.

No

Q11

Has the establishment of equivalency with federal methane regulations in Alberta and Saskatchewan affected your operations? e.g., scale, frequency, jurisdictions? Please comment if yes.

yes, current regulations may specify other technologies that are less effective but legacy and thus make it more difficult to introduce to the market despite offering superior performance.

Q12

Have methane-related Canadian provincial and federal programs affected your operations or planned operations? Please comment if yes.

no

Page 4: Leak Detection Service Description

Q13

Is your method or technology compliant with AER Directive 60 leak detection methods (e.g., Method 21) or is it intended to be applied in an AltFEMP?

Respondent skipped this question

Q14

Define your method in detail, including what equipment is used and how it is deployed. Points to address include (but are not limited to):

a. Does your organization offer a technology or a method?	**technology**
b. Does your organization offer a product (for sale?), a service, or a combination?	**we offer both products as well as services, whichever the customer prefers.**
c. Is the method mobile or stationary?	**we offer products that are mobile and products that are stationary.**
d. Does your method require site access or does it measure remotely?	**Generally, we require site access but we can detect and quantify emissions from 100meters from the source while driving, flying or walking.**

Q15

What deployment platform(s) is/are used? (for example: hand-held, aerial, truck-mounted, UAV, fixed sensor, portable and temporary on-site mount). If multiple deployment platforms are used, explain them all and how they work together.

1. hand-held
2. UAV
3. vehicle mounted
4. fixed location

all solutions (which are independent) utilize a common, patented laser absorption-based technology that extractively samples local air and measures local wind velocity. These methods detect leaks and provide measurements of leak location and size (emissions rate) and send comprehensive digital reports to the Cloud that summarize measurements and results.

Q16

What is the specific work practice associated with your methane leak detection method/technology? Several key elements of the work practice are listed below. Please add and comment on any others you feel are pertinent to your offering.

a. At what distances from source are measurements taken?	**distances range from less than 1 meter to 100 meters (or farther) from sources**
b. What sensors are employed and how?	**laser absorption analyzers are employed to measure methane and ethane, and combined with sensors recording wind velocity and GPS, as appropriate.**
c. How many people comprise one field crew? What are their roles?	**1 person can operate any one of our solutions.**
d. How much time is spent surveying each potential source?	**depends on the size/extent of the source but typically a source can be surveyed in a few minutes.**
e. How much training are field staff required to have?	**2-4 hours of training is sufficient**
f. What output data are generated and reported?	**output data that describes the leak location, source attribute and size of each recorded leak are available in digital reports digitally and on displayed on Google Earth maps**

Q17

Has your method or technology been included in a successful AltFEMP proposal or application with a provincial regulator e.g., AER accepted Alternative FEMP Proposal, as described in the AER's Submission Checklist for Directive 060: Alternative FEMP Proposals? If yes, please state the jurisdiction, regulator and scale of adoption by clients/duty-holder.

Decline to Answer

Page 5: Involvement in an LDAR Program

Q18

What scale(s) i.e., component, equipment, facility does your method/technology target? Note that 'component' means inspectors can confirm, diagnose and tag individual leaks.

Component,

Equipment,

Facility

Q19

Is your leak detection method/technology able to distinguish vented from fugitive emissions?

No

Q20

Does the work practice lead to diagnosis and tagging of individual leaks?

Yes,

If yes, how? Please describe in detail the process of going from measurement to tagging of leaks. If no, how does the information generated lead to the mitigation of fugitive emissions/leaks?:
our hand-held solution can pinpoint leak locations. our driving and UAV based solutions can estimate leak locations and thus save considerable time finding the precise locations of leaks.

Page 6: Leak Detection Service Description

Q21

For methods that are unable to confirm and tag individual leaks (i.e. “screening” methods), please define any relevant follow-up work practices used. For example, are follow-up OGI crews sent to high-emitting sites to tag leaks? (N/A, unknown, decline to answer)

for leaks estimated while using our flying or driving solutions, followup practices may include crews using our handheld solutions, not necessarily OGI, to pinpoint leaks.

Q22

What criteria are used to determine which sites receive follow-up visits? Examples could include:a. Site-level emissions thresholds to trigger follow-ups (in which case, what thresholds are used?)b. Follow-up ratios, such that the top 50% of emitting sites surveyed in a day receive follow-up surveys (if so, what ratios are used?)(N/A, unknown, decline to answer)

users of our solutions can determine whether to follow up or not based on the reported quantitative leak rates and geospatial locations provided.

Q23

What are the roles/tasks of follow-up crews when onsite? For example, do they conduct classic facility-wide OGI surveys, looking for all leaks, or do they target large emitters?a. If following a non-standard work practice, what are the details?b. If not immediate, what is the time interval between screening measurement and follow-up tagging of leaks (in days). Please explain how this delay is estimated.(N/A, unknown, decline to answer)

see above

Page 7: Technical Specifications

Q24

What is the methane sensor that is used? Where applicable, specify brand or type.

ABB LGR-ICOS laser-absorption based analyzer

Q25

Does your surveying result in a quantified flow rate? If no, please skip to next page.

Yes

Q26

What are the minimum and maximum measurable flow rates of your method (m3/day to align with AER regulations - please note if using another unit of measurement e.g., SCFH)? (N/A, unknown, decline to answer)

minimum measurable flow rate: 0.3 m3/day

Q27

Please state its median detection limit (i.e. the flow rate corresponding to a 50% detection probability - please specify a corresponding distance and windspeed)? (N/A, unknown, decline to answer)

40meters from the source, we can detect 0.6 m3/day with 50% probability.

Q28

What is the uncertainty/quantification accuracy of flow rate estimates?

Respondent skipped this question

Q29

Are emissions quantified at the component, equipment or facility level? (N/A, unknown, decline to answer)

Respondent skipped this question

Q30

Has your organization developed detection probability curves for your method? (N/A, unknown, decline to answer)

Yes

Q31

Does your method require environmental data? If so, what types of data required and how are they collected?

our methods record all environmental data necessary to yield results.

Q32

Can your organization provide results from controlled release testing (CRT) and/or field performance? Please provide information on methods (e.g. Who conducted the testing? Was it performed indoors or outdoors? Under what range of environmental conditions?)If this information will be or has been published in academic papers, please indicate the paper/project. (N/A, unknown, decline to answer)

Respondent skipped this question

Q33

Has controlled release testing data or performance data on your organization's method been used in modelling or computer simulations? Were the model results used for AltFEMP proposals (N/A, unknown, decline to answer)

Respondent skipped this question

Page 8: Environmental and Operational Constraints

Q34

Under what environmental and operational conditions does your organization not operate in the field (please provide specifics)?

heavy rain poses difficulties (>0.1"/hour)

Q35

What environmental conditions affect your method's performance (e.g., temperature, precipitation, wind)? For each condition, how is performance impacted?

Respondent skipped this question

Q36

Please declare the following (qualifying responses if necessary) (N/A, unknown, decline to answer where necessary):

What is the range of temperatures where the technology is operational (°C, max and min)?	**<50C**
What is the range of wind speed where the technology is operational (kmph, max and min)?	**<40kmph**
How much active rain is tolerated (None, light, medium, heavy)?	**<0.1"/hour**
What is the maximum deployment humidity (%)?	**N/A**

Q37

How long does it take to deploy at the start of the day (exclude time spent driving to individual sites, if that is a part of the method) in minutes?

<2 minutes to start recording data after power on

Q38

How long is take-down at the end of the day (exclude time spent driving to individual sites, if that is a part of the method) in minutes?

negligible

Q39

Is deployment required at each individual site? If so, how long does set-up/take-down take (in minutes)?

negligible

Q40

From the day of measurement, what is the guaranteed reporting timeline (in days)? If multiple reports are generated/provided, please explain what information they contain, and the number of days required for delivery of each report. (if a null response please enter N/A, unknown, decline to answer)

reports may be obtained after survey completion automatically and in a few minutes.

Q41

What is the factor most limiting to safe and efficient field performance leading to high-quality results? (if a null response please enter N/A, unknown, decline to answer)

Respondent skipped this question

Page 9: Supply and Scalability of Service Offering

Q42

Using single-well batteries as a baseline, approximately how many facilities can each crew inspect in a typical day, week, month, and/or year? (if a null response please enter N/A, unknown, decline to answer)

Respondent skipped this question

Q43

How many independent crews fully equipped with deployment platform, sensor, and trained personnel are currently available for simultaneous deployment? (if a null response please enter N/A, unknown, decline to answer)

Respondent skipped this question

Q44

What is your organization’s capacity to scale operations to meet your planned/desired market share of leak detection demand in Alberta? Using single well batteries to normalize site counts, how many do you project your operation to service in 2021, 2022, 2023 at 1 event per year (if this measurement of frequency doesn't apply to your method please explain)? (if a null response please enter N/A, unknown, decline to answer)

Respondent skipped this question

Q45

How many quarters in 2021 or years (if beyond) 2021 do you believe it will take to scale your operation to planned capacity based on projected market conditions?

Respondent skipped this question

Q46

Does your organization expect any changes in its overall work capacity (e.g., number of crews, equipment stock, etc.) in the next 5 years? (N/A, unknown, decline to answer)

Respondent skipped this question

Q47

What are your biggest barriers to scaling (e.g. investment, manufacturing of sensors, training of personnel)?

Respondent skipped this question

Page 10: Productivity and Cost (Optional):

Q48

What is your method’s approximate all-inclusive cost per day (single value or range) in 2021 Canadian dollars (please state assumed currency exchange if Canada is not your host country) under typical operating conditions in areas with facility densities up to 0.5 per square km? (if a null response please enter N/A, unknown, decline to answer)

Respondent skipped this question

Q49

How would this cost per day change if your organization is contracted for multiple days, weeks, months, or years? (N/A, unknown, decline to answer

Respondent skipped this question

Page 11: Productivity and Cost (Optional):

Q50

Approximately how many sites/day/crew can your technology/method survey for AER Facility Subtype 311/351 (Single well)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

Respondent skipped this question

Q51

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 321/361 (Multi-well group battery)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

Respondent skipped this question

Q52

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 401 (Gas Plant - Sweet)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

Respondent skipped this question

Q53

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 601 (Compressor Station)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

Respondent skipped this question

Q54

If your technology or method is not readily quantified using the 4 questions above, please describe your approach to capturing and conveying leak detection efficiencies to your clients (duty holders) and the indicative performance.

Respondent skipped this question

Page 12: Data Management

Q55

Have LDAR-based data management services been a core requirement of your client/s?

Respondent skipped this question

Q56

Have your clients set specific requirements regarding data management, quality assessment/control, other requirements? Please explain if possible.

Respondent skipped this question

Q57

What LDAR-based data management services does your organization offer?

Respondent skipped this question

Vendor #21 Response

Collector: [redacted]

[redacted]

Page 2: Introduction

Q1

Contact Information (For Administrative Purposes Only - All Responses Are Anonymized)

Respondent Organization:	[redacted]
Respondent Name:	Vendor 21
Respondent Role:	[redacted]
E-mail:	[redacted]
Website:	[redacted]
Response Date (yy/mm/dd):	[redacted]

Q2

Please confirm your understanding that all data collected as a part of this study are anonymous - check "Yes" to confirm.

Yes

Q3

Are you interested in being contacted for future PTAC methane emissions management research including, potential field campaigns?

Yes

Q4

Please indicate if you would like your organization to be publicly listed as a participant in this study. In this scenario, your organization would be identified as a participant that contributed data, but your organization's name is not associated with data you have submitted (data anonymity is preserved).

Yes

Page 3: General Information and Logistics

Q5

Does your organization have commercial LDAR surveying experience? If yes, please describe e.g., types of LDAR services provided, core markets (industry and/or locations), years of corporate experience with LDAR services.

Yes,

If yes, please describe::

Yes, we provide monitoring services at over 200 upstream well sites, primarily in the United States.

Q6

Does your organization participate in methane measurement markets outside of Alberta? If you intend to enter new methane measurement markets in 2021 or later please answer - Yes.

Yes

Q7

Is your organization able (legally/logistically/etc.) to work in Canada?

Yes

Q8

Is your organization able (legally/logistically/etc.) to work in the United States?

Yes

Q9

Please describe any safety concerns, risks, interruptions or annoyances (for duty holders/operators and/or local residents/communities) possibly introduced by your product/service when completing LDAR surveys (e.g., noise, airspace, road/site congestion).

We offer stationary monitoring services. While installing the monitors does not interrupt operations, we do request that operators install t-posts ahead of time to mount our monitors.

Q10

Has the COVID-19 outbreak and/or recent market conditions affected your operations re. LDAR services or is it expected to affect your operations? Please provide a comment if answering yes.

No

Q11

Has the establishment of equivalency with federal methane regulations in Alberta and Saskatchewan affected your operations? e.g., scale, frequency, jurisdictions? Please comment if yes.

No, though we are saying this as a primarily [redacted]

Q12

Have methane-related Canadian provincial and federal programs affected your operations or planned operations? Please comment if yes.

Respondent skipped this question

Page 4: Leak Detection Service Description

Q13

Is your method or technology compliant with AER Directive 60 leak detection methods (e.g., Method 21) or is it intended to be applied in an AltFEMP?

AltFEMP

Q14

Define your method in detail, including what equipment is used and how it is deployed. Points to address include (but are not limited to):

a. Does your organization offer a technology or a method?	**We offer a continuous monitoring and certification service**
b. Does your organization offer a product (for sale?), a service, or a combination?	**Service**
c. Is the method mobile or stationary?	**Stationary**
d. Does your method require site access or does it measure remotely?	**We require site access initially to install**

Q15

What deployment platform(s) is/are used? (for example: hand-held, aerial, truck-mounted, UAV, fixed sensor, portable and temporary on-site mount). If multiple deployment platforms are used, explain them all and how they work together.

Stationary sensor that is installed on site.

Q16

What is the specific work practice associated with your methane leak detection method/technology? Several key elements of the work practice are listed below. Please add and comment on any others you feel are pertinent to your offering.

a. At what distances from source are measurements taken?	**Variable- 10-100 meters**
b. What sensors are employed and how?	**Methane (TLDAS), TVOC (PID), in a stationary package**
c. How many people comprise one field crew? What are their roles?	**We send out one trained field technician**
d. How much time is spent surveying each potential source?	**Sensors sample every second**
e. How much training are field staff required to have?	**None; we provide a training session on our dashboard as part of the service**

Q17

Has your method or technology been included in a successful AltFEMP proposal or application with a provincial regulator e.g., AER accepted Alternative FEMP Proposal, as described in the AER's Submission Checklist for Directive 060: Alternative FEMP Proposals? If yes, please state the jurisdiction, regulator and scale of adoption by clients/duty-holder.

No,

If no, is your organization planning to be involved in an Alternative FEMP Proposal in 2021 or later? Please provide specifics of your participation but do not reference duty holder(s).:

We are beginning to engage [redacted] we may

Page 5: Involvement in an LDAR Program

Q18

What scale(s) i.e., component, equipment, facility does your method/technology target? Note that 'component' means inspectors can confirm, diagnose and tag individual leaks.

Equipment,

Facility

Q19

Is your leak detection method/technology able to distinguish vented from fugitive emissions?

Unknown

Q20

Does the work practice lead to diagnosis and tagging of individual leaks?

Yes

Page 6: Leak Detection Service Description

Q21

For methods that are unable to confirm and tag individual leaks (i.e. "screening" methods), please define any relevant follow-up work practices used. For example, are follow-up OGI crews sent to high-emitting sites to tag leaks? (N/A, unknown, decline to answer)

Typically, customers pair our stationary monitoring with a follow-up OGI crew when leaks are detected. However, for many leaks we detect that are operational in nature- for example, a leaking thief hatch, or contractors who don't use vapor recovery lines-no OGI camera is needed to resolve the emission.

Q22

What criteria are used to determine which sites receive follow-up visits? Examples could include:a. Site-level emissions thresholds to trigger follow-ups (in which case, what thresholds are used?)b. Follow-up ratios, such that the top 50% of emitting sites surveyed in a day receive follow-up surveys (if so, what ratios are used?)(N/A, unknown, decline to answer)

We develop and set criteria with producers. For example, one of our operators in Colorado is concerned with VOC emissions due to community air pollution concerns, and so we set a 5 minute alarm when tVOC levels exceed a certain threshold.

Q23

What are the roles/tasks of follow-up crews when onsite? For example, do they conduct classic facility-wide OGI surveys, looking for all leaks, or do they target large emitters?a. If following a non-standard work practice, what are the details?b. If not immediate, what is the time interval between screening measurement and follow-up tagging of leaks (in days). Please explain how this delay is estimated.(N/A, unknown, decline to answer)

Again, this varies by the emissions source. While traditional LDAR only addresses certain components, much our follow-up addresses operational emission sources and the time interval between identifying and remediating varies heavily- we've had remediation action taken as soon as 10 minutes after an alarm being isssued.

Page 7: Technical Specifications

Q24

What is the methane sensor that is used? Where applicable, specify brand or type.

Our [redacted] methane sensor uses a tunable laser diode absorption spectroscopy technique.

Q25

Does your surveying result in a quantified flow rate? If no, please skip to next page.

Yes

Q26

What are the minimum and maximum measurable flow rates of your method (m3/day to align with AER regulations - please note if using another unit of measurement e.g., SCFH)? (N/A, unknown, decline to answer)

A minimum of .1 g/s in most wind conditions. We've never calculated the maximum flow rate; our maximum detection of 10,000 ppm.

Q27

Please state its median detection limit (i.e. the flow rate corresponding to a 50% detection probability - please specify a corresponding distance and windspeed)? (N/A, unknown, decline to answer)

Respondent skipped this question

Q28

What is the uncertainty/quantification accuracy of flow rate estimates?

+/- 30%

Q29

Are emissions quantified at the component, equipment or facility level? (N/A, unknown, decline to answer)

Equipment group level

Q30

Has your organization developed detection probability curves for your method? (N/A, unknown, decline to answer)

Yes

Q31

Does your method require environmental data? If so, what types of data required and how are they collected?

Yes, we collect wind speed and direction.

Q32

Can your organization provide results from controlled release testing (CRT) and/or field performance? Please provide information on methods (e.g. Who conducted the testing? Was it performed indoors or outdoors? Under what range of environmental conditions?)If this information will be or has been published in academic papers, please indicate the paper/project. (N/A, unknown, decline to answer)

Yes, we've conducted testing at Colorado State University's METEC facility.

Q33

Has controlled release testing data or performance data on your organization’s method been used in modelling or computer simulations? Were the model results used for AltFEMP proposals (N/A, unknown, decline to answer)

Yes, our performance data has been using in FEAST model simulations.

Page 8: Environmental and Operational Constraints

Q34

Under what environmental and operational conditions does your organization not operate in the field (please provide specifics)?

Respondent skipped this question

Q35

What environmental conditions affect your method’s performance (e.g., temperature, precipitation, wind)? For each condition, how is performance impacted?

We have approximately one week of battery backup, so there are certain field conditions where performance could be impacted by low temperatures and cloudy conditions. For such locations, we recommend an extra set of batteries and solar panels.

Q36

Please declare the following (qualifying responses if necessary) (N/A, unknown, decline to answer where necessary):

What is the range of temperatures where the technology is operational (°C, max and min)?	**-40 to 40 C**
What is the range of wind speed where the technology is operational (kmph, max and min)?	**0 - 120**
How much active rain is tolerated (None, light, medium, heavy)?	**Heavy**
What is the maximum deployment humidity (%)?	**100%**
How much falling snow is tolerated (none, light, medium, heavy)?	**Heavy**
How much snow can be tolerated on the ground (none, patchy, thin cover, deep)?	**Heavy**

Q37

How long does it take to deploy at the start of the day (exclude time spent driving to individual sites, if that is a part of the method) in minutes?

20-30 minutes per sensor, including the initial post installation (typically happens before our technician)

Q38

How long is take-down at the end of the day (exclude time spent driving to individual sites, if that is a part of the method) in minutes?

0

Q39

Is deployment required at each individual site? If so, how long does set-up/take-down take (in minutes)?

Yes, 20-30 minutes/sensor

Q40

From the day of measurement, what is the guaranteed reporting timeline (in days)? If multiple reports are generated/provided, please explain what information they contain, and the number of days required for delivery of each report. (if a null response please enter N/A, unknown, decline to answer)

Sensors sample every second and report to the cloud every minute in regions with cellular connection. For satellite or other connectivity, reporting frequency may be lower

Q41

What is the factor most limiting to safe and efficient field performance leading to high-quality results? (if a null response please enter N/A, unknown, decline to answer)

N/A

Page 9: Supply and Scalability of Service Offering

Q42

Using single-well batteries as a baseline, approximately how many facilities can each crew inspect in a typical day, week, month, and/or year? (if a null response please enter N/A, unknown, decline to answer)

N/A

Q43

How many independent crews fully equipped with deployment platform, sensor, and trained personnel are currently available for simultaneous deployment? (if a null response please enter N/A, unknown, decline to answer)

N/A

Q44

What is your organization’s capacity to scale operations to meet your planned/desired market share of leak detection demand in Alberta? Using single well batteries to normalize site counts, how many do you project your operation to service in 2021, 2022, 2023 at 1 event per year (if this measurement of frequency doesn't apply to your method please explain)? (if a null response please enter N/A, unknown, decline to answer)

Our capacity is high- while we haven't entered this market yet, as a venture backed company we have the operational capacity to scale both production and deployment staff to meet these needs

Q45

How many quarters in 2021 or years (if beyond) 2021 do you believe it will take to scale your operation to planned capacity based on projected market conditions?

N/A

Q46

Does your organization expect any changes in its overall work capacity (e.g., number of crews, equipment stock, etc.) in the next 5 years? (N/A, unknown, decline to answer)

Yes

Q47

Respondent skipped this question

What are your biggest barriers to scaling (e.g. investment, manufacturing of sensors, training of personnel)?

Page 10: Productivity and Cost (Optional):

Q48

What is your method's approximate all-inclusive cost per day (single value or range) in 2021 Canadian dollars (please state assumed currency exchange if Canada is not your host country) under typical operating conditions in areas with facility densities up to 0.5 per square km? (if a null response please enter N/A, unknown, decline to answer)

Variable

Q49

How would this cost per day change if your organization is contracted for multiple days, weeks, months, or years? (N/A, unknown, decline to answer

Costs reduce with scale

Page 11: Productivity and Cost (Optional):

Q50

Approximately how many sites/day/crew can your technology/method survey for AER Facility Subtype 311/351 (Single well)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

Respondent skipped this question

Q51

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 321/361 (Multi-well group battery)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

Respondent skipped this question

Q52

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 401 (Gas Plant - Sweet)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

Respondent skipped this question

Q53

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 601 (Compressor Station)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

Respondent skipped this question

Q54

If your technology or method is not readily quantified using the 4 questions above, please describe your approach to capturing and conveying leak detection efficiencies to your clients (duty holders) and the indicative performance.

Our customers are interested in overall leak reductions rather than efficiencies. We communicate the advantages of our approach as lowering emissions and being able to independently verify those reductions.

Page 12: Data Management

Q55

Have LDAR-based data management services been a core requirement of your client/s?

Yes

Q56

Have your clients set specific requirements regarding data management, quality assessment/control, other requirements? Please explain if possible.

[redacted] our data management, QA/QC and reporting procedures have been developed to meet Regulation 7 (new continuous monitoring requirement for 6 months before and after drilling)

Q57

What LDAR-based data management services does your organization offer?

We offer our clients a dashboard where they can explore and visualize data, as well as automated reporting to state/provincial agencies.

Vendor #22 Response

Collector: [redacted]

[redacted]

Page 2: Introduction

Q1

Contact Information (For Administrative Purposes Only - All Responses Are Anonymized)

Respondent Organization:	[redacted]
Respondent Name:	Vendor 22
Respondent Role:	[redacted]
E-mail:	[redacted]
Phone:	[redacted]
Response Date (yy/mm/dd):	[redacted]

Q2

Please confirm your understanding that all data collected as a part of this study are anonymous - check "Yes" to confirm.

Yes

Q3

Are you interested in being contacted for future PTAC methane emissions management research including, potential field campaigns?

Yes

Q4

Please indicate if you would like your organization to be publicly listed as a participant in this study. In this scenario, your organization would be identified as a participant that contributed data, but your organization's name is not associated with data you have submitted (data anonymity is preserved).

Yes

Page 3: General Information and Logistics

Q5

Does your organization have commercial LDAR surveying experience? If yes, please describe e.g., types of LDAR services provided, core markets (industry and/or locations), years of corporate experience with LDAR services.

Decline to answer

Q6

Does your organization participate in methane measurement markets outside of Alberta? If you intend to enter new methane measurement markets in 2021 or later please answer - Yes.

Yes,
If yes, which markets? (Optional):
British Columbia

Q7

Is your organization able (legally/logistically/etc.) to work in Canada?

Yes

Q8

Is your organization able (legally/logistically/etc.) to work in the United States?

No

Q9

Please describe any safety concerns, risks, interruptions or annoyances (for duty holders/operators and/or local residents/communities) possibly introduced by your product/service when completing LDAR surveys (e.g., noise, airspace, road/site congestion).

We created our service to have a low impact to our clients resulting in little to no impact on day to day operations

Q10

Has the COVID-19 outbreak and/or recent market conditions affected your operations re. LDAR services or is it expected to affect your operations? Please provide a comment if answering yes.

Yes, but resolved by year-end 2020,
If Yes, please explain.:
Delays due to new methods of permitting, was quickly resolved in partnership with [redacted] and our clients.

Q11

Has the establishment of equivalency with federal methane regulations in Alberta and Saskatchewan affected your operations? e.g., scale, frequency, jurisdictions? Please comment if yes.

We're primarily a BC based company, the regulations have had a significant impact on reducing emissions

Q12

Have methane-related Canadian provincial and federal programs affected your operations or planned operations? Please comment if yes.

Respondent skipped this question

Page 4: Leak Detection Service Description

Q13

Is your method or technology compliant with AER Directive 60 leak detection methods (e.g., Method 21) or is it intended to be applied in an AltFEMP?

AER Directive 60 Compliant / Method 21

Q14

Define your method in detail, including what equipment is used and how it is deployed. Points to address include (but are not limited to):

a. Does your organization offer a technology or a method?	**Method**
b. Does your organization offer a product (for sale?), a service, or a combination?	**a service**
c. Is the method mobile or stationary?	**mobile**
d. Does your method require site access or does it measure remotely?	**site access**

Q15

What deployment platform(s) is/are used? (for example: hand-held, aerial, truck-mounted, UAV, fixed sensor, portable and temporary on-site mount). If multiple deployment platforms are used, explain them all and how they work together.

We use the GF320 camera

Q16

What is the specific work practice associated with your methane leak detection method/technology? Several key elements of the work practice are listed below. Please add and comment on any others you feel are pertinent to your offering.

a. At what distances from source are measurements taken?	**between 1.5m and 16m**
c. How many people comprise one field crew? What are their roles?	**1-2 technician and an assistant**
d. How much time is spent surveying each potential source?	**varies depending on component**
e. How much training are field staff required to have?	**3+ months before they can work independantly**
f. What output data are generated and reported?	**rates, location, description, history, physical tags, and digital records**

Q17

Has your method or technology been included in a successful AltFEMP proposal or application with a provincial regulator e.g., AER accepted Alternative FEMP Proposal, as described in the AER's Submission Checklist for Directive 060: Alternative FEMP Proposals? If yes, please state the jurisdiction, regulator and scale of adoption by clients/duty-holder.

No,
If no, is your organization planning to be involved in an Alternative FEMP Proposal in 2021 or later? Please provide specifics of your participation but do not reference duty holder(s).:
We have looked at options, however in the BC regulations giving detailed surveys isn't really possible with the top alt femp methods.

Page 5: Involvement in an LDAR Program

Q18

What scale(s) i.e., component, equipment, facility does your method/technology target? Note that 'component' means inspectors can confirm, diagnose and tag individual leaks.

Component,

Equipment,

Facility

Q19

Is your leak detection method/technology able to distinguish vented from fugitive emissions?

Yes,
If yes, how? If not, how does it account for potential false positives?:
Technician training to distinguish what is fugitive and what is normal operational venting

Q20

Does the work practice lead to diagnosis and tagging of individual leaks?

Yes,
If yes, how? Please describe in detail the process of going from measurement to tagging of leaks. If no, how does the information generated lead to the mitigation of fugitive emissions/leaks?:
We tag and document every leak and vent directly.

Page 6: Leak Detection Service Description

Q21

For methods that are unable to confirm and tag individual leaks (i.e. "screening" methods), please define any relevant follow-up work practices used. For example, are follow-up OGI crews sent to high-emitting sites to tag leaks? (N/A, unknown, decline to answer)

N/A

Q22

What criteria are used to determine which sites receive follow-up visits? Examples could include:a. Site-level emissions thresholds to trigger follow-ups (in which case, what thresholds are used?)b. Follow-up ratios, such that the top 50% of emitting sites surveyed in a day receive follow-up surveys (if so, what ratios are used?)(N/A, unknown, decline to answer)

N/A

Q23

What are the roles/tasks of follow-up crews when onsite? For example, do they conduct classic facility-wide OGI surveys, looking for all leaks, or do they target large emitters?a. If following a non-standard work practice, what are the details?b. If not immediate, what is the time interval between screening measurement and follow-up tagging of leaks (in days). Please explain how this delay is estimated.(N/A, unknown, decline to answer)

We do facility wide OGI

Page 7: Technical Specifications

Q24

What is the methane sensor that is used? Where applicable, specify brand or type.

GF320 Flir camera

Q25

Does your surveying result in a quantified flow rate? If no, please skip to next page.

Yes

Q26

What are the minimum and maximum measurable flow rates of your method (m3/day to align with AER regulations - please note if using another unit of measurement e.g., SCFH)? (N/A, unknown, decline to answer)

M3, and L/min

Q27

Please state its median detection limit (i.e. the flow rate corresponding to a 50% detection probability - please specify a corresponding distance and windspeed)? (N/A, unknown, decline to answer)

unknown

Q28

What is the uncertainty/quantification accuracy of flow rate estimates?

GF320 has a 20% error margin

Q29

Are emissions quantified at the component, equipment or facility level? (N/A, unknown, decline to answer)

Component, and facilitiy.

Q30

Has your organization developed detection probability curves for your method? (N/A, unknown, decline to answer)

Unknown

Q31

Does your method require environmental data? If so, what types of data required and how are they collected?

We build CO2e totals per client, total number of leaks/vents, their repair rate and initial emission rate and end of year repair rate.

Q32

Can your organization provide results from controlled release testing (CRT) and/or field performance? Please provide information on methods (e.g. Who conducted the testing? Was it performed indoors or outdoors? Under what range of environmental conditions?)If this information will be or has been published in academic papers, please indicate the paper/project. (N/A, unknown, decline to answer)

N/A

Q33

Has controlled release testing data or performance data on your organization’s method been used in modelling or computer simulations? Were the model results used for AltFEMP proposals (N/A, unknown, decline to answer)

N/A

Page 8: Environmental and Operational Constraints

Q34

Under what environmental and operational conditions does your organization not operate in the field (please provide specifics)?

During shut downs, and temperatures below -30C

Q35

What environmental conditions affect your method’s performance (e.g., temperature, precipitation, wind)? For each condition, how is performance impacted?

All of the examples can have an impact. The extent of which is determined at the field level on if a reschedule is needed.

Q36

Please declare the following (qualifying responses if necessary) (N/A, unknown, decline to answer where necessary):

What is the range of temperatures where the technology is operational (°C, max and min)?	**30C to -20C**
What is the range of wind speed where the technology is operational (kmph, max and min)?	**Below 20km/h**
How much active rain is tolerated (None, light, medium, heavy)?	**Medium**
What is the maximum deployment humidity (%)?	**N/A**
How much falling snow is tolerated (none, light, medium, heavy)?	**Medium**
How much snow can be tolerated on the ground (none, patchy, thin cover, deep)?	**moderate coverage, depends on the site**

Q37

How long does it take to deploy at the start of the day (exclude time spent driving to individual sites, if that is a part of the method) in minutes?

10 minutes

Q38

How long is take-down at the end of the day (exclude time spent driving to individual sites, if that is a part of the method) in minutes?

10 minutes

Q39

Is deployment required at each individual site? If so, how long does set-up/take-down take (in minutes)?

5 minutes cool down time

Q40

Respondent skipped this question

From the day of measurement, what is the guaranteed reporting timeline (in days)? If multiple reports are generated/provided, please explain what information they contain, and the number of days required for delivery of each report. (if a null response please enter N/A, unknown, decline to answer)

Q41

What is the factor most limiting to safe and efficient field performance leading to high-quality results? (if a null response please enter N/A, unknown, decline to answer)

Very cold or very hot temps, but it's more personnel comfort than equipment.

Page 9: Supply and Scalability of Service Offering

Q42

Using single-well batteries as a baseline, approximately how many facilities can each crew inspect in a typical day, week, month, and/or year? (if a null response please enter N/A, unknown, decline to answer)

depending on distance between 20 single well sites on average

---

Q43

How many independent crews fully equipped with deployment platform, sensor, and trained personnel are currently available for simultaneous deployment? (if a null response please enter N/A, unknown, decline to answer)

2 complete crews, with a 3rd if additional equipment can be acquired.

Q44

What is your organization's capacity to scale operations to meet your planned/desired market share of leak detection demand in Alberta? Using single well batteries to normalize site counts, how many do you project your operation to service in 2021, 2022, 2023 at 1 event per year (if this measurement of frequency doesn't apply to your method please explain)? (if a null response please enter N/A, unknown, decline to answer)

We are capable of performing [redacted], but can increase that easily.

Q45

How many quarters in 2021 or years (if beyond) 2021 do you believe it will take to scale your operation to planned capacity based on projected market conditions?

1 quarter, depending on equipment availability and if current market demand justifies purchase

---

Q46

Does your organization expect any changes in its overall work capacity (e.g., number of crews, equipment stock, etc.) in the next 5 years? (N/A, unknown, decline to answer)

We do expect growth in the future

Q47

What are your biggest barriers to scaling (e.g. investment, manufacturing of sensors, training of personnel)?

growth trend justifying purchase of new equipment

Page 10: Productivity and Cost (Optional):

Q48

What is your method's approximate all-inclusive cost per day (single value or range) in 2021 Canadian dollars (please state assumed currency exchange if Canada is not your host country) under typical operating conditions in areas with facility densities up to 0.5 per square km? (if a null response please enter N/A, unknown, decline to answer)

Respondent skipped this question

Q49

How would this cost per day change if your organization is contracted for multiple days, weeks, months, or years? (N/A, unknown, decline to answer

Respondent skipped this question

Page 11: Productivity and Cost (Optional):

Q50

Approximately how many sites/day/crew can your technology/method survey for AER Facility Subtype 311/351 (Single well)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

Respondent skipped this question

Q51

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 321/361 (Multi-well group battery)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

Respondent skipped this question

Q52

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 401 (Gas Plant - Sweet)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

Respondent skipped this question

Q53

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 601 (Compressor Station)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

Respondent skipped this question

Q54

If your technology or method is not readily quantified using the 4 questions above, please describe your approach to capturing and conveying leak detection efficiencies to your clients (duty holders) and the indicative performance.

Respondent skipped this question

Page 12: Data Management

Q55

Have LDAR-based data management services been a core requirement of your client/s?

Yes,

If yes/no/varied, are there any key reasons?:
Providing comprehensive access to our clients

Q56

Have your clients set specific requirements regarding data management, quality assessment/control, other requirements? Please explain if possible.

Yes they've all got individual needs that we try to accommodate

Q57

What LDAR-based data management services does your organization offer?

An online database with statistics and leaking components list by site

Vendor #23 Response

Collector: [redacted]

[redacted]

Page 2: Introduction

Q1

Contact Information (For Administrative Purposes Only - All Responses Are Anonymized)

Respondent Organization:	[redacted]
Respondent Name:	Vendor 23
Respondent Role:	[redacted]
E-mail:	[redacted]
Phone:	[redacted]
Website:	[redacted]
Response Date (yy/mm/dd):	[redacted]

Q2

Please confirm your understanding that all data collected as a part of this study are anonymous - check "Yes" to confirm.

Yes

Q3

Are you interested in being contacted for future PTAC methane emissions management research including, potential field campaigns?

Yes

Q4

Please indicate if you would like your organization to be publicly listed as a participant in this study. In this scenario, your organization would be identified as a participant that contributed data, but your organization's name is not associated with data you have submitted (data anonymity is preserved).

Yes

Page 3: General Information and Logistics

Q5

Does your organization have commercial LDAR surveying experience? If yes, please describe e.g., types of LDAR services provided, core markets (industry and/or locations), years of corporate experience with LDAR services.

Yes,
If yes, please describe::
[redacted] Services include: Fugitive Emission Inspections, Nitrogen and Air Leak Detection, Infrared Flare Stack Inspections, Electrical Inspections, Process Inspections, and Motion Amplification. [redacted] core markets currently include: Oil and Gas and Wood Product sectors. [redacted] has been providing Infrared and Gas Detection Services for over [redacted]

Q6

Does your organization participate in methane measurement markets outside of Alberta? If you intend to enter new methane measurement markets in 2021 or later please answer - Yes.

Yes,
If yes, which markets? (Optional):
British Columbia, Saskatchewan

Q7

Is your organization able (legally/logistically/etc.) to work in Canada?

Yes

Q8

Is your organization able (legally/logistically/etc.) to work in the United States?

Unknown

Q9

Please describe any safety concerns, risks, interruptions or annoyances (for duty holders/operators and/or local residents/communities) possibly introduced by your product/service when completing LDAR surveys (e.g., noise, airspace, road/site congestion).

None.

Q10

Has the COVID-19 outbreak and/or recent market conditions affected your operations re. LDAR services or is it expected to affect your operations? Please provide a comment if answering yes.

Yes, ongoing,
If Yes, please explain.:
The COVID-19 outbreak had reduced typical work loads in 2020 and has affected usual work procedures, but has been manageable.

Q11

Has the establishment of equivalency with federal methane regulations in Alberta and Saskatchewan affected your operations? e.g., scale, frequency, jurisdictions? Please comment if yes.

No

Q12

Have methane-related Canadian provincial and federal programs affected your operations or planned operations? Please comment if yes.

No

Page 4: Leak Detection Service Description

Q13

Is your method or technology compliant with AER Directive 60 leak detection methods (e.g., Method 21) or is it intended to be applied in an AltFEMP?

AER Directive 60 Compliant / Method 21

Q14

Define your method in detail, including what equipment is used and how it is deployed. Points to address include (but are not limited to):

a. Does your organization offer a technology or a method?

[redacted] provides Inspection and Reporting Services.

b. Does your organization offer a product (for sale?), a service, or a combination?

[redacted] provides Inspection and Reporting Services.

c. Is the method mobile or stationary?

[redacted] services are mobile.

d. Does your method require site access or does it measure remotely?

[redacted] provides on-site inspection services

Q15

What deployment platform(s) is/are used? (for example: hand-held, aerial, truck-mounted, UAV, fixed sensor, portable and temporary on-site mount). If multiple deployment platforms are used, explain them all and how they work together.

Fugitive Emission Inspections are performed with Infrared Cameras (hand-held) and a High Flow Sampler (Backpack).
Nitrogen and Air Leak Detection is performed with Ultrasonic Detectors and Infrared Cameras (both hand-held).
Infrared Flare Stack Inspections are performed via UAV Drone equipped with Infrared Camera (portable).
Electrical Inspections are performed with non-contact Ultrasonic Detectors.
Process Inspections are customized and can use all of the above equipment.
Motion Amplification utilizes video camera technology in conjunction with software and processing algorithms. Motion Amplification is typically used on rotating equipment but can be used to detect any subtle movement.

Q16

What is the specific work practice associated with your methane leak detection method/technology? Several key elements of the work practice are listed below. Please add and comment on any others you feel are pertinent to your offering.

a. At what distances from source are measurements taken?

Typically measurements are taken from 1 to 3 meters away. Depending on required safe distance

b. What sensors are employed and how?

Infrared Sensors are employed in the Infrared Camera and Combustible Sensors are used in the Hi-Flow Sampler.

c. How many people comprise one field crew? What are their roles?

One person can be deployed for an inspection but in some cases two inspectors are sent to cut down the inspection time.

d. How much time is spent surveying each potential source?

Depend on the leak anywhere from 15-20 minutes

e. How much training are field staff required to have?

Employees are trained for all required Safety Training and go through in-house training via equipment manuals and testing. Vendor Certification is also available after probationary periods

f. What output data are generated and reported?

[redacted] **Reports include video data of gas leaks and lost emission data is provided with Hi-Flow Sampler software.**

Q17

Has your method or technology been included in a successful AltFEMP proposal or application with a provincial regulator e.g., AER accepted Alternative FEMP Proposal, as described in the AER's Submission Checklist for Directive 060: Alternative FEMP Proposals? If yes, please state the jurisdiction, regulator and scale of adoption by clients/duty-holder.

No,

If no, is your organization planning to be involved in an Alternative FEMP Proposal in 2021 or later? Please provide specifics of your participation but do not reference duty holder(s).:

[redacted] may consider being involved in an Alternative FEMP Program, but to date have not seen a cost effective / viable AltFEMP that we'd like to be involved with. Digital IR always considers the best solutions for our customers.

Page 5: Involvement in an LDAR Program

Q18

What scale(s) i.e., component, equipment, facility does your method/technology target? Note that 'component' means inspectors can confirm, diagnose and tag individual leaks.

Component

Q19

Is your leak detection method/technology able to distinguish vented from fugitive emissions?

Yes,

If yes, how? If not, how does it account for potential false positives?:

[redacted] equipment may not be able to distinguish vented from fugitive emissions, but we only hire well experienced Red Seal Journeyman Instrumentation Technicians that have extensive knowledge of normal venting.

Q20

Does the work practice lead to diagnosis and tagging of individual leaks?

Yes,

If yes, how? Please describe in detail the process of going from measurement to tagging of leaks. If no, how does the information generated lead to the mitigation of fugitive emissions/leaks?:

[redacted] well experienced Red Seal Journeyman Instrumentation Technicians have extensive knowledge of equipment and typical venting. Repair solutions are provided in our reports and any serious leaks are reported to site operations as soon as possible.

Page 6: Leak Detection Service Description

Q21

For methods that are unable to confirm and tag individual leaks (i.e. "screening" methods), please define any relevant follow-up work practices used. For example, are follow-up OGI crews sent to high-emitting sites to tag leaks? (N/A, unknown, decline to answer)

[redacted] always performs a building pre-scan for safe entry. If the leak is serious and poses a safety hazard, [redacted] notifies site operations immediately.

Q22

What criteria are used to determine which sites receive follow-up visits? Examples could include:a. Site-level emissions thresholds to trigger follow-ups (in which case, what thresholds are used?)b. Follow-up ratios, such that the top 50% of emitting sites surveyed in a day receive follow-up surveys (if so, what ratios are used?)(N/A, unknown, decline to answer)

[redacted] leaves the site follow-ups in the hands of our clients, but we do pass on the regulation requirements.

Q23

What are the roles/tasks of follow-up crews when onsite? For example, do they conduct classic facility-wide OGI surveys, looking for all leaks, or do they target large emitters?a. If following a non-standard work practice, what are the details?b. If not immediate, what is the time interval between screening measurement and follow-up tagging of leaks (in days). Please explain how this delay is estimated.(N/A, unknown, decline to answer)

Unknown

Page 7: Technical Specifications

Q24

What is the methane sensor that is used? Where applicable, specify brand or type.

FLIR Infrared Sensors in the Camera and Bacharach Combustible Sensors in the Hi-Flow Sampler.

Q25

Does your surveying result in a quantified flow rate? If no, please skip to next page.

Yes

Q26

What are the minimum and maximum measurable flow rates of your method (m3/day to align with AER regulations - please note if using another unit of measurement e.g., SCFH)? (N/A, unknown, decline to answer)

Cubic feet per minute and litres per minute.

Q27

Please state its median detection limit (i.e. the flow rate corresponding to a 50% detection probability - please specify a corresponding distance and windspeed)? (N/A, unknown, decline to answer)

Median detection limit is 1.5 - 3 meters for the OGI.

Q28

What is the uncertainty/quantification accuracy of flow rate estimates?

Uncertainty of the Hi-Flow sampler is +/- 4%.

Q29

Are emissions quantified at the component, equipment or facility level? (N/A, unknown, decline to answer)

Component

Q30

Has your organization developed detection probability curves for your method? (N/A, unknown, decline to answer)

No

Q31

Does your method require environmental data? If so, what types of data required and how are they collected?

Atmospheric conditions are recorded for all of our inspections.

Q32

Can your organization provide results from controlled release testing (CRT) and/or field performance? Please provide information on methods (e.g. Who conducted the testing? Was it performed indoors or outdoors? Under what range of environmental conditions?)If this information will be or has been published in academic papers, please indicate the paper/project. (N/A, unknown, decline to answer)

Decline to answer.

Q33

Has controlled release testing data or performance data on your organization's method been used in modelling or computer simulations? Were the model results used for AltFEMP proposals (N/A, unknown, decline to answer)

Unknown

Page 8: Environmental and Operational Constraints

Q34

Under what environmental and operational conditions does your organization not operate in the field (please provide specifics)?

[redacted] OGI cameras accuracy are effected at -20 Deg.C so we don't use this equipment below this temperature. We also do not work if conditions are deemed unsafe.

Q35

What environmental conditions affect your method's performance (e.g., temperature, precipitation, wind)? For each condition, how is performance impacted?

[redacted] OGI cameras accuracy are effected at -20 Deg.C so we don't use this equipment below this temperature. Extreme rain, snow, and wind are also avoided for our outdoor inspections, but correction factor calculations can be provided for mild conditions.

Q36

Please declare the following (qualifying responses if necessary) (N/A, unknown, decline to answer where necessary):

What is the range of temperatures where the technology is operational (°C, max and min)?	**–40°C to +350°C (Note: Digital IR works in –20°C to +35°C)**
What is the range of wind speed where the technology is operational (kmph, max and min)?	**OGI Cameras are operational with wind of 0 - 28 km/hr.**
How much active rain is tolerated (None, light, medium, heavy)?	**Light rain or snow is tolerated.**
What is the maximum deployment humidity (%)?	**95% relative humidity +25°C to +40°C**
How much falling snow is tolerated (none, light, medium, heavy)?	**Light snow is tolerated**
How much snow can be tolerated on the ground (none, patchy, thin cover, deep)?	**Deep snow is tolerated**

Q37

How long does it take to deploy at the start of the day (exclude time spent driving to individual sites, if that is a part of the method) in minutes?

Deployment times vary widely. [redacted] works with client requirements.

Q38

How long is take-down at the end of the day (exclude time spent driving to individual sites, if that is a part of the method) in minutes?

Take-down times vary widely. [redacted] works with client requirements.

Q39

Is deployment required at each individual site? If so, how long does set-up/take-down take (in minutes)?

Deployment time after site check-in and safety is completed is approximately 10 - 15 minutes.

Q40

From the day of measurement, what is the guaranteed reporting timeline (in days)? If multiple reports are generated/provided, please explain what information they contain, and the number of days required for delivery of each report. (if a null response please enter N/A, unknown, decline to answer)

Initial reports are provided immediately after inspection (same day). Final reports are provided after data has been fully processed.

Q41

What is the factor most limiting to safe and efficient field performance leading to high-quality results? (if a null response please enter N/A, unknown, decline to answer)

The most limiting factors to field inspections are weather and inspector experience.

Page 9: Supply and Scalability of Service Offering

Q42

Using single-well batteries as a baseline, approximately how many facilities can each crew inspect in a typical day, week, month, and/or year? (if a null response please enter N/A, unknown, decline to answer)

[redacted] crews can inspect a maximum of 10 single-well batteries per day if they're in close proximity.

Q43

How many independent crews fully equipped with deployment platform, sensor, and trained personnel are currently available for simultaneous deployment? (if a null response please enter N/A, unknown, decline to answer)

[redacted] has one fully equipped deployment platform for fugitive emissions surveys. We have more equipment to perform other types of inspections, but only one Hi-Flow Sampler.

Q44

What is your organization's capacity to scale operations to meet your planned/desired market share of leak detection demand in Alberta? Using single well batteries to normalize site counts, how many do you project your operation to service in 2021, 2022, 2023 at 1 event per year (if this measurement of frequency doesn't apply to your method please explain)? (if a null response please enter N/A, unknown, decline to answer)

Unknown

Q45

How many quarters in 2021 or years (if beyond) 2021 do you believe it will take to scale your operation to planned capacity based on projected market conditions?

Unknown

Q46

Does your organization expect any changes in its overall work capacity (e.g., number of crews, equipment stock, etc.) in the next 5 years? (N/A, unknown, decline to answer)

Unknown

Q47

What are your biggest barriers to scaling (e.g. investment, manufacturing of sensors, training of personnel)?

[redacted] has found that price undercutting competing businesses have made Fugitive Emission Surveys more fiscally unviable as [redacted] only hires well experienced Journeymen Inspectors that can confidently identify issues, this requires a higher wage. [redacted] has taken notice that competitors have been hiring inspectors with low experience levels at low wages.

Page 10: Productivity and Cost (Optional):

Q48

What is your method's approximate all-inclusive cost per day (single value or range) in 2021 Canadian dollars (please state assumed currency exchange if Canada is not your host country) under typical operating conditions in areas with facility densities up to 0.5 per square km? (if a null response please enter N/A, unknown, decline to answer)

[redacted] for a 12 hour day.

Q49

How would this cost per day change if your organization is contracted for multiple days, weeks, months, or years? (N/A, unknown, decline to answer

[redacted] gives discounts for bundled contracts.

Page 11: Productivity and Cost (Optional):

Q50

Approximately how many sites/day/crew can your technology/method survey for AER Facility Subtype 311/351 (Single well)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

11-20,
Survey time per site, cost per site (optional), and additional comments::
[redacted] one-man-crew can survey 11 - 20 inspections per 12 hour day.

Q51

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 321/361 (Multi-well group battery)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

6-10,
Survey time per site, cost per site (optional), and additional comments::
[redacted] one-man-crew can survey 6 - 10 inspections per 12 hour day.

Q52

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 401 (Gas Plant - Sweet)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

1-5,
Survey time per site, cost per site (optional), and additional comments::
[redacted] one-man-crew can survey 1 - 5 inspections per 12 hour day.

Q53

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 601 (Compressor Station)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

1-5,
Survey time per site, cost per site (optional), and additional comments::
[redacted] one-man-crew can survey 1 - 5 inspections per 12 hour day.

Q54

If your technology or method is not readily quantified using the 4 questions above, please describe your approach to capturing and conveying leak detection efficiencies to your clients (duty holders) and the indicative performance.

N/A

Page 12: Data Management

Q55

Have LDAR-based data management services been a core requirement of your client/s?

Varied,
If yes/no/varied, are there any key reasons?:
[redacted] provides many inspection services including predictive maintenance. Fugitive Emission Surveys are one one part of our company.

Q56

Have your clients set specific requirements regarding data management, quality assessment/control, other requirements? Please explain if possible.

Yes, [redacted] multiple systems depending on client requirements.

Q57

What LDAR-based data management services does your organization offer?

[redacted] only provides Gas Leak Detection / Data.
Clients handle their own OGC and AER submissions.

Vendor #24 Response

Collector: [redacted]

[redacted] [redacted]

Page 2: Introduction

Q1

Contact Information (For Administrative Purposes Only - All Responses Are Anonymized)

Respondent Organization:	[redacted]
Respondent Name:	Vendor 24
Respondent Role:	[redacted]
E-mail:	[redacted]
Phone:	[redacted]
Website:	[redacted]
Response Date (yy/mm/dd):	[redacted]

Q2

Please confirm your understanding that all data collected as a part of this study are anonymous - check "Yes" to confirm.

Yes

Q3

Are you interested in being contacted for future PTAC methane emissions management research including, potential field campaigns?

Yes

Q4

Please indicate if you would like your organization to be publicly listed as a participant in this study. In this scenario, your organization would be identified as a participant that contributed data, but your organization's name is not associated with data you have submitted (data anonymity is preserved).

Yes

Page 3: General Information and Logistics

Q5

Does your organization have commercial LDAR surveying experience? If yes, please describe e.g., types of LDAR services provided, core markets (industry and/or locations), years of corporate experience with LDAR services.

Yes,
If yes, please describe::
Pipeline leak inspection, compressor station surveys, building surveys, distribution / fabrication of OGI cameras, hi flow sampler, mobile leak detection solutions, and portable gas detection instrumentation.

Q6

Does your organization participate in methane measurement markets outside of Alberta? If you intend to enter new methane measurement markets in 2021 or later please answer - Yes.

Yes,
If yes, which markets? (Optional):
Across Canada

Q7

Is your organization able (legally/logistically/etc.) to work in Canada?

Yes

Q8

Is your organization able (legally/logistically/etc.) to work in the United States?

No

Q9

Please describe any safety concerns, risks, interruptions or annoyances (for duty holders/operators and/or local residents/communities) possibly introduced by your product/service when completing LDAR surveys (e.g., noise, airspace, road/site congestion).

N/A

Q10

Has the COVID-19 outbreak and/or recent market conditions affected your operations re. LDAR services or is it expected to affect your operations? Please provide a comment if answering yes.

No

Q11

Has the establishment of equivalency with federal methane regulations in Alberta and Saskatchewan affected your operations? e.g., scale, frequency, jurisdictions? Please comment if yes.

Yes - greater demand for products / services.

Q12

Have methane-related Canadian provincial and federal programs affected your operations or planned operations? Please comment if yes.

Yes - greater demand for products / services.

Page 4: Leak Detection Service Description

Q13

Is your method or technology compliant with AER Directive 60 leak detection methods (e.g., Method 21) or is it intended to be applied in an AltFEMP?

AER Directive 60 Compliant / Method 21

Q14

Define your method in detail, including what equipment is used and how it is deployed. Points to address include (but are not limited to):

a. Does your organization offer a technology or a method?	**Yes**
b. Does your organization offer a product (for sale?), a service, or a combination?	**Both products and services**
c. Is the method mobile or stationary?	**Both mobile and stationary options are available**
d. Does your method require site access or does it measure remotely?	**Both options are available**

Q15

What deployment platform(s) is/are used? (for example: hand-held, aerial, truck-mounted, UAV, fixed sensor, portable and temporary on-site mount). If multiple deployment platforms are used, explain them all and how they work together.

Manual survey deploying combination of OGI, Hi flow sampler, CGI, and laser instruments.
UAV surveys are available using a laser based sensor mounted to a drone.
Mobile leak detection primarily geared toward pipeline leak inspection in urban areas using a leak survey vehicle.
24/7 monitoring of facilities using either laser based or OGI instrumentation that is permanently mounted and tied into the BMS.
H2S / Odour monitoring using temporary or permanently installed H2S loggers.

Q16

What is the specific work practice associated with your methane leak detection method/technology? Several key elements of the work practice are listed below. Please add and comment on any others you feel are pertinent to your offering.

a. At what distances from source are measurements taken?	**From directly on top of the asset to up to 50 metres**
b. What sensors are employed and how?	**Infrared, Laser, Electrochemical, OGI**
c. How many people comprise one field crew? What are their roles?	**Typically crews of two are deployed.**
d. How much time is spent surveying each potential source?	**For manual surveys using OGI, typically 10 to 30 seconds at each source followed by quantification and pinpointing as required.**
e. How much training are field staff required to have?	**1.5 days of classroom training, 3.5 days of field training, 1 written exam, 1 instrument operator exam, and 1 field exam.**
f. What output data are generated and reported?	**All surveys are geotagged and information collected can be customized based on customer needs. Depending on the type of survey information package might include some or all of the following: walking / driving trails, instrument readings, leak details, temperature, leak flow rate, abnormal operating conditions, date / time of survey, instrument serial #, instrument calibration records, photos, videos.**

Q17

Has your method or technology been included in a successful AltFEMP proposal or application with a provincial regulator e.g., AER accepted Alternative FEMP Proposal, as described in the AER's Submission Checklist for Directive 060: Alternative FEMP Proposals? If yes, please state the jurisdiction, regulator and scale of adoption by clients/duty-holder.

No,

If no, is your organization planning to be involved in an Alternative FEMP Proposal in 2021 or later? Please provide specifics of your participation but do not reference duty holder(s).:

No

Page 5: Involvement in an LDAR Program

Q18

What scale(s) i.e., component, equipment, facility does your method/technology target? Note that 'component' means inspectors can confirm, diagnose and tag individual leaks.

Component,

Equipment,

Facility

Q19

Is your leak detection method/technology able to distinguish vented from fugitive emissions?

Yes

Q20

Does the work practice lead to diagnosis and tagging of individual leaks?

Yes,

If yes, how? Please describe in detail the process of going from measurement to tagging of leaks. If no, how does the information generated lead to the mitigation of fugitive emissions/leaks?:
Typically leaks are initially identified from a distance using OGI or laser based instruments in order to identify areas of interest. Areas of interest are then further investigated using hi flow sampler, infrared instrument, or CGI to pinpoint source of the leak which is then photographed, videoed with verbal annotation, and tagged.

Page 6: Leak Detection Service Description

Q21

For methods that are unable to confirm and tag individual leaks (i.e. “screening” methods), please define any relevant follow-up work practices used. For example, are follow-up OGI crews sent to high-emitting sites to tag leaks? (N/A, unknown, decline to answer)

N/A

Q22

What criteria are used to determine which sites receive follow-up visits? Examples could include:a. Site-level emissions thresholds to trigger follow-ups (in which case, what thresholds are used?)b. Follow-up ratios, such that the top 50% of emitting sites surveyed in a day receive follow-up surveys (if so, what ratios are used?)(N/A, unknown, decline to answer)

N/A

Q23

What are the roles/tasks of follow-up crews when onsite? For example, do they conduct classic facility-wide OGI surveys, looking for all leaks, or do they target large emitters?a. If following a non-standard work practice, what are the details?b. If not immediate, what is the time interval between screening measurement and follow-up tagging of leaks (in days). Please explain how this delay is estimated.(N/A, unknown, decline to answer)

We typically are involved up to the point the leak is pinpointed at which time we report same to our customer for follow up.

Page 7: Technical Specifications

Q24

What is the methane sensor that is used? Where applicable, specify brand or type.

[redacted]

Q25

Does your surveying result in a quantified flow rate? If no, please skip to next page.

Yes

Q26

What are the minimum and maximum measurable flow rates of your method (m3/day to align with AER regulations - please note if using another unit of measurement e.g., SCFH)? (N/A, unknown, decline to answer)

Instrument calculates SCFH and we convert

Q27

Please state its median detection limit (i.e. the flow rate corresponding to a 50% detection probability - please specify a corresponding distance and windspeed)? (N/A, unknown, decline to answer)

Unknown

Q28

What is the uncertainty/quantification accuracy of flow rate estimates?

+/- 10%

Q29

Are emissions quantified at the component, equipment or facility level? (N/A, unknown, decline to answer)

Component

Q30

Has your organization developed detection probability curves for your method? (N/A, unknown, decline to answer)

No

Q31

Does your method require environmental data? If so, what types of data required and how are they collected?

Temperature, barometric pressure

Q32

Can your organization provide results from controlled release testing (CRT) and/or field performance? Please provide information on methods (e.g. Who conducted the testing? Was it performed indoors or outdoors? Under what range of environmental conditions?)If this information will be or has been published in academic papers, please indicate the paper/project. (N/A, unknown, decline to answer)

No

Q33

Has controlled release testing data or performance data on your organization's method been used in modelling or computer simulations? Were the model results used for AltFEMP proposals (N/A, unknown, decline to answer)

No

Page 8: Environmental and Operational Constraints

Q34

Under what environmental and operational conditions does your organization not operate in the field (please provide specifics)?

N/A

Q35

What environmental conditions affect your method's performance (e.g., temperature, precipitation, wind)? For each condition, how is performance impacted?

Wind

Q36

Please declare the following (qualifying responses if necessary) (N/A, unknown, decline to answer where necessary):

What is the range of temperatures where the technology is operational (°C, max and min)?	**-20 to +40 degrees Celsius**
What is the range of wind speed where the technology is operational (kmph, max and min)?	**20 kmph**
How much active rain is tolerated (None, light, medium, heavy)?	**Light**
What is the maximum deployment humidity (%)?	**N/A**
How much falling snow is tolerated (none, light, medium, heavy)?	**Light**
How much snow can be tolerated on the ground (none, patchy, thin cover, deep)?	**Thin Cover**

Q37

How long does it take to deploy at the start of the day (exclude time spent driving to individual sites, if that is a part of the method) in minutes?

<15 minutes

Q38

How long is take-down at the end of the day (exclude time spent driving to individual sites, if that is a part of the method) in minutes?

< 15 minutes

Q39

Is deployment required at each individual site? If so, how long does set-up/take-down take (in minutes)?

Yes - < 15 minutes

Q40

From the day of measurement, what is the guaranteed reporting timeline (in days)? If multiple reports are generated/provided, please explain what information they contain, and the number of days required for delivery of each report. (if a null response please enter N/A, unknown, decline to answer)

Most information is available within 24 hours with final reports within 7 days.

Q41

What is the factor most limiting to safe and efficient field performance leading to high-quality results? (if a null response please enter N/A, unknown, decline to answer)

N/A

Page 9: Supply and Scalability of Service Offering

Q42

Using single-well batteries as a baseline, approximately how many facilities can each crew inspect in a typical day, week, month, and/or year? (if a null response please enter N/A, unknown, decline to answer)

Unknown

Q43

How many independent crews fully equipped with deployment platform, sensor, and trained personnel are currently available for simultaneous deployment? (if a null response please enter N/A, unknown, decline to answer)

3

Q44

What is your organization’s capacity to scale operations to meet your planned/desired market share of leak detection demand in Alberta? Using single well batteries to normalize site counts, how many do you project your operation to service in 2021, 2022, 2023 at 1 event per year (if this measurement of frequency doesn't apply to your method please explain)? (if a null response please enter N/A, unknown, decline to answer)

Operation is easily scalable to meet customer requirements

Q45

How many quarters in 2021 or years (if beyond) 2021 do you believe it will take to scale your operation to planned capacity based on projected market conditions?

1

Q46

Does your organization expect any changes in its overall work capacity (e.g., number of crews, equipment stock, etc.) in the next 5 years? (N/A, unknown, decline to answer)

Yes - expanded operations

Q47

What are your biggest barriers to scaling (e.g. investment, manufacturing of sensors, training of personnel)?

N/A

Page 10: Productivity and Cost (Optional):

Q48

What is your method’s approximate all-inclusive cost per day (single value or range) in 2021 Canadian dollars (please state assumed currency exchange if Canada is not your host country) under typical operating conditions in areas with facility densities up to 0.5 per square km? (if a null response please enter N/A, unknown, decline to answer)

[redacted] for labour and equipment

Q49

How would this cost per day change if your organization is contracted for multiple days, weeks, months, or years? (N/A, unknown, decline to answer

Depending on the geographic location and density of the work may result in economies of scale which could lower price.

Page 11: Productivity and Cost (Optional):

Q50

Approximately how many sites/day/crew can your technology/method survey for AER Facility Subtype 311/351 (Single well)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

11-20

Q51

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 321/361 (Multi-well group battery)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

21+

Q52

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 401 (Gas Plant - Sweet)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

1-5

Q53

Approximately how many sites/day/crew can your technology/method survey for AER Facility subtype 601 (Compressor Station)? Please specify survey time and cost (optional) in comments, as well as clarification on sites/day/crew if needed.

1-5

Q54

If your technology or method is not readily quantified using the 4 questions above, please describe your approach to capturing and conveying leak detection efficiencies to your clients (duty holders) and the indicative performance.

Respondent skipped this question

Page 12: Data Management

Q55

Have LDAR-based data management services been a core requirement of your client/s?

N/A

Q56

Have your clients set specific requirements regarding data management, quality assessment/control, other requirements? Please explain if possible.

Yes. Operator certification, quality assurance audit (desktop and field)

Q57

What LDAR-based data management services does your organization offer?

Respondent skipped this question

Appendix F: Service Provider Data Analysis

Anonymization Key	Commercial LDAR Experience	Areas							Type								Type - Least 'accurate' method considered only for data analysis (Accuracy: OGI>Continuous>Truck>UAV>Satellite), see columns K-P to determine actual offerings per service provider.							People per crew (if applicable)	Time per leak (		
Respondent ID		AB	BC	SK	US	Other	Alt-FEMP or D60/M21	Mobile/Stationary	Handheld	Truck	UAV	Aircraft	Sattelite	Fixed	Total	If Multiple, Together or Separate	Handheld	Truck	UAV	Aircraft	Sattelite	Fixed	If Multiple, Together or Separate		<5min	5-30min	30 min+
2	Yes	Yes			Yes		AltFEMP	Mobile	1	1					2	Together		1					Together	2+		1	
3	No	Yes					AltFEMP	Mobile	1						1		1							N/A?	1		
4	Yes	Yes	Yes	Yes		MB	AltFEMP	Mobile		1					1			1						2	1		
5	No	Yes					AltFEMP	Mobile		1					1			1						1	1		
6	No	Yes					AltFEMP	Mobile					1		1						1			N/A	1		
7	Yes	Yes			Yes	EU									0												
8	Yes	Yes			Yes		AER Directive 60 Compliant / Method 21	Mobile	1	1	1				3	Together		1					Together	1-3	1	1	
9	Yes	Yes	Yes	Yes											0												
10	Yes	Yes			Yes		AltFEMP	Stationary						1	1							1		2	1		
11	Yes	Yes	Yes	Yes	Yes	Global	AltFEMP	Mobile	1						1		1							1-2			
13	Yes	Yes				ON, NWT	AER Directive 60 Compliant / Method 21	Mobile	1						1		1							2-5		1	
14	Yes	Yes	Yes	Yes		Canada	AER Directive 60 Compliant / Method 21	Mobile	1	1					2	Together		1					Together	2			
15	Yes	Yes	Yes	Yes	Yes	Global	AltFEMP	Mobile				1	1		2						1				1		
16	Yes	Yes	Yes	Yes			AER Directive 60 Compliant / Method 21	Mobile	1						1		1							1-2			
17	Yes	Yes				NFL&Lab Offshore	AER Directive 60 Compliant / Method 21	Mobile	1		1				2	Together			1				Together	2		1	
18	Yes	Yes						Both	1	1	1	1		1	5	Together				1			Together	1	1		1
19	Yes	Yes	Yes	Yes	Yes	Global	AltFEMP	Stationary (soon Both)						1	1							1		1	1		
20	Yes	Yes	Yes	Yes	Yes	Global		Both	1	1	1			1	4	Separate		1					Separate	1	1		
22	Decline to ans	Yes	Yes				AER Directive 60 Compliant / Method 21	Mobile	1						1		1							1-2			
23	Yes	Yes	Yes	Yes			AER Directive 60 Compliant / Method 21	Mobile	1		1				2	Together			1				Together	1-2		1	
24	Yes	Yes	Yes	Yes		Canada	AER Directive 60 Compliant / Method 21	Both	1	1	1			1	4	Together		1					Together	2	1		
1	Yes	Yes					AER Directive 60 Compliant / Method 21	Mobile	1						1		1							1-2	1		
12	Yes	Yes		Yes		MB	AER Directive 60 Compliant / Method 21	Mobile	1						1		1							1	1		
21	Yes	Yes			Yes	Canada, US	AltFEMP	Stationary						1	1							1		1			

Appendix F:

Anonymization Key	Est.)		Successful AltFemp?	Plan to be altFEMP?		Detection Scale			Fugitive vs. Vent distinction		Individual Leak Tagging	Methane Sensor	Flow Rate Calculated?	Detection Limits		Max Distance (m)	Detection probability			Te
Respondent ID	Continuous	Variable	Y/N	Y/N		Component	Equipment	Facility					Y/N	Min	Max					min °C
2		1	N			1	1	1	Yes		Yes	Picarro's proprietary closed-path, infrared Cavity Ring Down Spectroscopy sensor.	Yes	0.5 scfh		150	90	5	4	-10
3			N	Y		1			No		Yes	NA	Yes							
4			N	Y				1	No		Yes	Picarro G2201i	Yes	0.2 gCH4/hr				2	3	-40
5			Y				1		No		Yes	Li-Cor LI7700 (with custom configuration)	Yes					4	3	-25
6		1	N	Y		1	1	1	Yes		Yes	NDA Question. It is a super-spectral sensor.								
7																				
8		1	Decline to Answer					1	Decline to answer		Yes	Decline	Yes					3	3	-30
9				Y																
10	1		Y			1	1	1	Yes		Yes	Proprietary	Yes					2	4	-40
11		1	Y			1			Yes		Yes	Multiple	Yes					4	4	-25
13		1	Y			1	1	1	Yes		Yes	FID / THERMO SCIENTIFIC	No					5		-10
14		1	N	N		1	1	1	Yes		Yes	infra red tunable laser, or Pellistor sensor	No					5	3	-15
15			N				1	1	No		No	Wide Angle Fabry-Perot	Yes					1	5	-99
16		1	N			1			Yes		Yes	GMI GT 44/43	Yes					2	3	-45
17		1	N			1	1	1	Yes		Yes	AlphaOne U10. It is a TDLAS (Tunable Diode Laser Absorption Spectroscopy) sensor that integrates with a drone.	Yes					4	4	-20
18	1	1	N	N		1	1	1	Yes		Yes	TLDAS- Tunable Laser Diode and/or Electrochemical sensors	No					2	3	-40
19		1	N	Y		1	1	1	Yes		Yes	Uncooled single photon avalanche detector, employing time-correlated single photon counting technology. White paper available on request.	Yes					2	1	-40
20		1	Decline to Answer			1	1	1	No		Yes	ABB LGR-ICOS laser-absorption based analyzer	Yes					1	4	-99
22		1	N	N		1	1	1	Yes		Yes	GF320 Flir camera	Yes					4	2	-20
23		1	N	Y		1			Yes		Yes	FLIR Infrared Sensors in the Camera and Bacharach Combustible Sensors in the Hi-Flow Sampler.	Yes					2	3	-40
24		1	N	N		1	1	1	Yes		Yes	Heath DP-IR, Heath RMLD-CS, ABB MobileGuard, GMI Gasurveyor, Opgal Eye-C-Gas OGI	Yes					4	1	-20
1			Decline to Answer			1	1	1	Yes		Yes	N/A	No					5	3	-15
12			N	N		1			Yes		Yes	FLIR OGI GFx320	Yes					4	4	-20
21	1		N	Y			1	1			Yes	Proprietary methane sensor	Yes					2	3	-40

Appendix F:

Anonymization Key	mp	Wind		Max Relative Humidity (%)	Rain Level				Snowfall					Snow on ground					Setup Time	Take Down Time		Inspections/ day (SWB)		Current Crews		Potential Future Sites/Year	Approximate Cost Per Day
Respondent ID	max °C	min kmph	max kmph		None (no cloud)	Light	Medium	Heavy	None	Light	Medium	Heavy	N/A	None	Thin	Moderate	Deep	N/A	Min.	Max (min.)	Alt-FEMP or D60/M21	Facilities/d				Facilities/d	$/d
2	45	0	32	99			1				1						1		5	1	AltFEMP	10	10	0		Unknown	Unknown - More info needed
3				N/A									1					1	1	1	AltFEMP	N/A	0	0		Manufacture Limitation	N/A
4	40			No Limit			1				1						1		30	15	AltFEMP	65	65	2	2	Unknown	Decline to Answer
5	40	0	100	100		1				1							1		5	5	AltFEMP		0	5	5	N/A	Unknown - More info needed
6																			N/A	0	AltFEMP		0	0			Decline to Answer
7																							0	0			
8	40	0	30	No Limit		1				1					1		1		10	10	AER Directive 60 Compliant / Method 21		0	6	6		
9																							0	0			
10	50	0	230	100				1				1					1		45	0	AltFEMP	N/A	0	2	2	400	$2000/device, $50/mo/device
11	50	-	-	-															30	30	AltFEMP	9	9	10	10	Decline to answer	Decline to answer
13		0	25	N/A		1			1								1		90		AER Directive 60 Compliant / Method 21	Unknown	0	8	8	N/A	Unknown - More info needed
14	40	0	20	No Limit		1				1					1				15	3	AER Directive 60 Compliant / Method 21	Unknown	0	0	0	Staff Limitation	Decline to answer
15	99	0		No Limit	1							1					1		0	0	AltFEMP	1000	1000	0	N/A	N/A	Decline to answer
16	40			N/A			1						1				1		5	3	AER Directive 60 Compliant / Method 21	20	20	0		3000	$3,000
17	50	0	54	No Limit				1			1						1		5	5	AER Directive 60 Compliant / Method 21	6	6	3	3	1000	$3,500
18	40			90		1		1	1			1						1	15	15		N/A	0	0	N/A	N/A	N/A
19	0			Unknkown			1				1						1				AltFEMP	N/A	0	2	2	N/A	Unknown - More info needed
20	50	0	40	N/A		1													2	0			0	0			
22	30	0	20	N/A			1				1					1			10	10	AER Directive 60 Compliant / Method 21	20	20	2	2	1500+	
23	35	0	28	95		1				1							1			-	AER Directive 60 Compliant / Method 21	10	10	1	1	Unknown	$3,200
24	4	0	20	N/A		1				1					1				15	15	AER Directive 60 Compliant / Method 21	Unknown	0	3	3	Scalable	$750
1	40			80			1				1				1				15	15	AER Directive 60 Compliant / Method 21	3	3	2	2	Unknown	$3,500
12	50	0	40	Unknown				1				1					1		10	2	AER Directive 60 Compliant / Method 21	8	8	3	3	1000	$2,250
21	40	0	120	100				1				1					1		25	0	AltFEMP	N/A	0	0	N/A	Scalable	Unknown - More info needed

Appendix F:

Anonymization Key	Pricing for Larger Projects/Contracts		Current Crews	Facility type 311/351 (Single well)	Facility type 321 361 Multi Group	Facility type 401 - Sweet Gas Plant	Facility type 601 - Compressor station		Data Mangement a base requirement of Clients?
Respondent ID		Alt-FEMP or D60/M21		Facilities/d				Other	
2	Efficiency up costs down	AltFEMP		6-10	6-10	6-10	6-10		No
3	N/A	AltFEMP	N/A					We sell our hardware, application and data management access to our clients and they perform the site activities. With our solution their personnel are able to locate and repair leaks directly, monitor annual surveyed sources to reduce recurrence time and find, report and manage new leaks in the 364 days between annual surveys. This may allow then eventually to eliminate some of their expensive external consultant costs.	Yes
4	Decline to answer	AltFEMP	2	21+	21+	21+	21+		Varied
5	Costs down as time increased	AltFEMP	5	21+	21+	21+	21+	The costs per site are dependent on the work practice that is utilized. Our recommended work practice involves immediate follow-up of detected anomalies. The per site time relates to how the operator chooses to follow up on these anomalies, and the number of anomalies.	Decline to answer
6	Decline to answer	AltFEMP						I think that most questions do not relate to remote sensing via airborne or satellite systems.	N/A
7									
8		AER Directive 60 Compliant / Method 21	6	6-10	1-5	1-5	1-5		Yes
9									
10	Discounts on Mobilization fee	AltFEMP	2						Yes
11	multi year 40% reduction in cost	AltFEMP	10						Varied
13	piece work	AER Directive 60 Compliant / Method 21	8	1-5	6-10	6-10	6-10	We have daily work performance variables that are tracked through daily KPI reporting - we are always on time and on budget	Yes
14	Decline to answer	AER Directive 60 Compliant / Method 21	0					This is impossible to determine without complete knowledge of the site layout and reporting requirements.	N/A
15	Subscriptions lower cost	AltFEMP	N/A	21+	21+	21+	21+	Satellite - We capture 12km x 12km images Aircraft Variant - We fly a linear area with a 750m swath	Yes
16	5-10% reduction	AER Directive 60 Compliant / Method 21		21+	11-20	1-5	6-10		Yes
17	large job - less charge	AER Directive 60 Compliant / Method 21	3	6-10	1-5	1-5	1-5		Yes
18	N/A		N/A					We are a manufacturer not a service organization	N/A
19	Unknown.	AltFEMP	2					Our technology offers multiple benefits over the current state of the art. The ability to simultaneously visualise and quantify releases of methane is a step forward, as is the ability to provide this on a 24/7/365 basis, offering faster responses than intermittent studies. The user emits less methane, for a lower overall investment. The industry is looking for disruptive sensors that combine selectivity, sensitivity, high rejection of spurious results, long lifetime and low cost of operation so they can be widely deployed and operated in continuous automatic monitoring systems from which data can be integrated into comprehensive and automated safety, environmental and maintenance response systems. Other technologies can offer a portion of this benefit, but only QLM's combination of accuracy, sensitivity, long range, robustness, and low-cost scalability addresses all the requirements for tackling the market.	Varied
20									
22		AER Directive 60 Compliant / Method 21	2						Yes
23	Bundled contract discount	AER Directive 60 Compliant / Method 21	1	11-20	6-10	1-5	1-5	N/A	Varied
24	Lower price for economies of scale	AER Directive 60 Compliant / Method 21	3	11-20	21+	1-5	1-5		N/A
1	unknown	AER Directive 60 Compliant / Method 21	2	1-5	1-5	1-5	1-5		No
12	Discounts on large bundle contracts	AER Directive 60 Compliant / Method 21	3	6-10	1-5	1-5	1-5	N/A	Yes
21	Costs reduce with scale	AltFEMP	N/A					Our customers are interested in overall leak reductions rather than efficiencies. We communicate the advantages of our approach as lowering emissions and being able to independently verify those reductions.	Yes

Appendix G Duty Holder and Midstreamer Data Analysis

Anonymization Key	FEMP Budgets			Self Perform LDAR 2020?							Self Perform		
Producer #	2021 FEMP?	2021 Budget?	Influenced by 2020?	SP LD	LD 3rd Party	SP Repair	Repair 3rd Party	Data SP	Data 3rd Party	Comments	Self-perfor	3rd party L	Repair
9	Yes	Yes			1	1	1		1			1	1
13	Yes	No, incorporated into OPEX budget.			1	1			1			1	1
1	Yes	No, this is still under general operation budget. Though there will likely be a distinct budget in the future.			1	1		1	1			1	1
11	Yes	Yes	Yes		1	1		1				1	1
7	Yes	Yes			1	1			1			1	1
12													
5	Yes	Yes		1		1		1					
8	Yes	Yes	Yes		1	1			1			1	1
3	Yes	Yes		1	1	1	1	1	1	Annual Wellsite Screenings - Internal, FEMP/LDAR - 3rd party	1	1	1
6	Yes	Yes.			1	1		1				1	1
2	Yes	Yes			1	1		1	1			1	1

Appendix C

Anonymization Key	LDAR 2021?						
Producer #	Repair 3rd	Data SP	Data 3rd Pa	Comments	Self Perform % 2021	BROA 2020/21	BROA Comments
9	1		1	Operational guideline and Union rules	0		not sure
13			1	Our operations team can perform the majority of leak repairs.	0	Yes	Applied for a subset of our facilities, targeting only MWBs and GSs. Facilities known to have extensive instrument-air systems, like GPs, were omitted due to the cost associated with gathering the inventory of equipment on the I/A systems with no value to us.
1		1		For cost control, data consistency, reporting consistency and ESG strategy, we prefer to have as much data in house as possible. We may use in house resources for the surveys in the future, but so far there has not been the drivers to develop this in house.	0	Yes	We completed company-wide fugitive emissions surveys, as well as a complete new inventory, gathering emitting device data to a very granular level. The results are intended to inform the refinement of our MRRCP, FEMP and our D60 reporting.
11		1			0	No	
7			1		0	No	
12							
5				Third party aerial screening technology, Self perform truck screening, OGI and repair	76+%	No	
8			1		0	No	
3	1	1	1	Annual Wellsite Screenings - Internal, FEMP/LDAR - 3rd party	0	No	
6		1			76+%	No	
2		1	1		0	No	

Appendix (

Anonymization Key	Federal Assets		AER Assets				Method Used			
Producer #	**# of Assets**	**Comments**	**D60**	**D117**	**Unknown**	**Decline to Answer**	**OGI**	**Method 21 (other than OGI)**	**Alternative Methods (alt-FEMP)**	**# of OGI cameras**
9							1	1		
13	0		708		Unknown		1		1	0
1	>100		>100	>100			1			N/A
11	Decline to answer					X	1	1	1	Decline to answer
7	>500				x		1		1	N/A
12										
5							1		1	>1
8	Unknown	With the merger with xxx this is unknown			Not sure		1		1	None
3	Decline to Answer	Please study the publicly available datasets				X (Please study the publicly available datasets)	1	1	1	Unknown
6	Unknown				x		1			0
2						-	1	1		0

Appendix C

Anonymization Key						Self Perform Alt-Femp LDAR?	
Producer #	Make/Model	Number of trained operators:	Train more?	# in 2021 and beyond	Alt-FEMP proposal with AER?	Leak Detection - Yes	Leak Detection - No (Use 3rd party)
9							
13	N/A	0	No		Yes		1
1	N/A	0	Unknown		No		
11		Decline to answer	Decline to answer	100+	No		1
7		N/A	No	N/A	Yes		1
12							
5	FLIR GF x320	>1	Yes		Yes		
8					Yes		1
3	FLIR GH 320/x 320	Unknown	Decline to answer	Unknown	Yes	1	1
6	N/A	0	No	0	No		
2	Unknown	0	No	0	Yes		1

Appendix C

Anonymization Key						If your organization intends to self-perform its AltFEMP efforts in 2021, please provide a high-level overview of the program it intends to implement (e.g., times per year and when, execution method, number of sites, etc.). (N/A, unknown, decline to answer)
Producer #	Data management - Yes	Data management - No (Use 3rd party)	Unknown	Decline to answer	Other/Comments (e.g., combination of self perform and 3rd party):	Open-Ended Response
9						
13		1				N/A
1						NA
11						N/A
7		1				N/A
12						
5					Combination	Combination
8		1				
3	1	1				Not self-performing Alt-FEMP.
6						
2	1	1				n/a

Appendix C

Anonymization Key	What deployment platform(s) will your organization use in 2021? (N/A, Unknown, Decline to Answer)	Are there any FEMP-related labor or equipment limitations your organization is facing, and do you anticipate that they will be resolved? (N/A, Unknown, Decline to Answer)	How many trained alternative-method inspectors does your organization employ? (N/A, Unknown, Decline to Answer)	Does your organization intend to employ more or train more employees in alternative inspection methods in 2021?		Is your organization interested in being contacted to share the research outputs?
Producer #	Open-Ended Response	Open-Ended Response	Open-Ended Response	Response	If yes, how many and by when?	Response
9						
13	Aircraft-mounted, truck-mounted and fixed continuous.	No.	N/A		No	
1	NA	Yes, we don't have the staff to implement any in-house OGI training, leak detection training or detailed data management training.	NA		No	
11	N/A	No	N/A	No		Yes
7	N/A	N/A	N/A	No		No
12						
5		No concerns with OGI or Aerial at this time	8	Yes		Yes
8	OGI and Aerial	None	None	No		Yes
3	Aerial & Ground-based OGI (by exception)	No, the FEMP providers have been able to expand with demand.	Unknown	Unknown		Yes
6				No		No
2	n/a	Decline to answer	0	No		Yes

Appendix C

Anonymization Key	If you or your organization have any further information that you would like to provide in fulfilment of one of these objectives, we welcome any further information you can provide, alongside the reminder that questionnaire data released publicly will be aggregated and anonymized.
Producer #	Open-Ended Response
9	
13	
1	
11	
7	
12	
5	
8	[redacted]
3	
6	
2	