KANSAS GAS SERVICE

DIRECT TESTIMONY OF RONALD B. EDELSTEIN

Q. PLEASE STATE YOUR NAME AND BUSINESS ADDRESS.

A. My name is Ronald B. Edelstein. My business address is 655 15th Street, NW, Suite 420, Washington, DC 20005.

I. QUALIFICATIONS

Q. BY WHOM AND IN WHAT CAPACITY ARE YOU EMPLOYED?

A. I am employed by the Gas Technology Institute ("GTI") as Director, Regulatory and Government Relations.

Q. PLEASE DESCRIBE YOUR EDUCATIONAL BACKGROUND AND PROFESSIONAL EXPERIENCE.

A. I graduated from the University of Florida with a BS in Aerospace Engineering (1969), Rensselaer Polytechnic Institute ("RPI") with an MS in Engineering Science: Solid Mechanics (1972), and another MS from RPI in Engineering Science: Environmental Science & Technology (1977). I began my employment with Pratt & Whitney, working as a structural engineer on gas turbines for eight years, then Planning Research Company as an engineering consultant to the U.S. Department of Energy for three years, then the Solar Energy Research Institute as a research and development ("R&D") planner for three years. I joined the Gas Research Institute ("GRI") (now GTI) in 1982 as an R&D planner. I have also held positions (at GRI and GTI) as Director of

Planning, Director of Sales, and Director of State Regulatory Programs. My current position is Director of Regulatory and Government Relations. I have been on the Technical Advisory Board of the California Institute for Energy Efficiency, the California Research, Development, and Demonstration Working Group to define public interest R&D, and the Tennessee Home Energy Conservation Task Force focusing on making natural gas more affordable for low-income consumers. I am serving on the State Energy Efficiency Action Network Industrial Efficiency/Combined Heat and Power ("CHP") Working Group to define barriers to CHP entry into the market. I was also part of the National Petroleum Council's 2010 study on Carbon and End Use Sub-Group. I am participating in the National Energy Action Plan's "Most Energy Efficient Economy" Technology Work Group in conjunction with the U.S. Environmental Protection Agency ("EPA"). I am serving on New York's Regional Greenhouse Gas Initiative ("RGGI") Advisory Group to advise the New York State Energy Research and Development Authority ("NYSERDA") on how best to use proceeds from the sale of allowances consistent with New York State goals and objectives. I also regularly present R&D progress reports on topics of national interest before the National Association of Regulatory Commissioners ("NARUC") Gas Committee and Energy Resources and Environment Committee. I am the facilitator for GTI's Public Interest Advisory Committee.

Q. HAVE YOU PREVIOUSLY FILED TESTIMONY BEFORE ANY REGULATORY COMMISSION?

A. Yes. I have filed testimony before regulatory commissions in the District of Columbia and in the states of Arkansas, Georgia, Kansas, Maryland, Massachusetts, Michigan, Missouri, Ohio, Oklahoma, Tennessee, and Virginia.

II. PURPOSE OF TESTIMONY

Q. WHAT IS THE PURPOSE OF YOUR TESTIMONY?

A. I will support the request of Kansas Gas Service Company ("Kansas Gas" or "Company") to collect a test year operations and maintenance ("O&M") expense adjustment to fund Research and Development (R&D) for the benefit of gas consumers ("Gas Consumer Benefits R&D"). In support of that request I (1) summarize the accomplishments of GTI and its predecessor, GRI; (2) describe the benefits that Kansas Gas's customers would receive from GTI and its Gas Consumer Benefits R&D; and (3) respond to the Commission's discussion of R&D in previous proceedings. That response includes sponsoring a benefit-cost analyses for the program that Kansas Gas is proposing to support: the Operations Technology Development ("OTD") program.

III. IDENTIFICATION OF EXHIBITS

Q. DO YOU SPONSOR ANY EXHIBITS IN SUPPORT OF YOUR TESTIMONY?

A. Yes. I have attached the following exhibits:

Exhibit RBE-1: a list of OTD "Winners";

Exhibit RBE-2: a copy of a letter from the Associate Administrator for Pipeline Safety of the Pipeline and Hazardous Materials Safety Administration ("PHMSA") of the United States Department of Transportation to the Chairman of NARUC supporting approval of R&D.

Exhibit RBE-3: a Kansas-specific benefit-cost analysis relevant to Kansas Gas's proposed OTD projects;

Exhibit RBE-4: a list and description of the OTD projects that Kansas Gas plans to participate in if the Commission approves the requested R&D funding.

Exhibit RBE-5: dues formula for the OTD program; and,

Exhibit RBE-6: the Gas Technology Institute's Public Interest Advisory Committee roster.

IV. GAS CONSUMER BENEFITS R&D

Q. WHAT IS "GAS CONSUMER BENEFITS R&D"?

A. This is a specific type of R&D that seeks to develop technologies that would result in benefits that would accrue almost entirely to gas consumers. These benefits include increased safety, enhanced deliverability, contained costs for distribution O&M, enhanced environmental quality, and greater system integrity.

V. HISTORY OF GTI

Q. WHAT ARE GRI AND GTI?

A. Natural gas local distribution companies ("LDCs") and pipeline companies, in agreement with the Federal Energy Regulatory Commission ("FERC"), formed the Gas Research Institute ("GRI") in 1977 in the midst of natural gas curtailments and a predicted gas supply shortage. At that time, GRI's mission was to plan, manage, and develop financing for a cooperative R&D program addressing improvements in production, transport, storage, distribution, and end use of natural gas for the mutual benefit of the natural gas industry and its present and future customers. Original GRI R&D was on natural gas supply, end-use efficiency, and gas operations. The FERC-approved funding mechanism worked for over twenty-five years, but the restructuring of the natural gas industry and increased competition between gas pipelines led to the dissolving of this funding mechanism and the search for alternative funding.

In 1998 a settlement was reached (among GRI, the gas pipeline companies, gas LDCs, consumer advocates, NARUC, large industrial companies, large and independent gas producers, and FERC staff) to move Gas Consumer Benefits R&D to a non-FERC-approved mechanism, and to shift the R&D approval further downstream, to create a voluntary gas LDC funding approach. FERC-approved funding was to be collected, in decreasing fashion, between 1998 and 2004 to allow time for the creation of a voluntary program, and then discontinued.

Q. WHAT WAS THE NATURE OF THIS VOLUNTARY PROGRAM AS ENVISIONED BY THE FERC?

The 1998 Settlement, in referring to voluntary funding, described a process in which individual interstate pipelines, after 2004 would voluntarily contribute to particular R&D projects and, subject to challenge, such contributions would be recoverable in rates. Additionally, the FERC and the settling parties clearly contemplated in 1998 a system in which the LDCs could "voluntarily contribute" to R&D.

Q. HOW WAS GTI FORMED?

GRI was combined with the Institute of Gas Technology in 2000, and became an R&D laboratory, The Gas Technology Institute ("GTI"). Starting in 1998, funding was collected voluntarily by gas LDCs and with public utility commission approval, state by state and sometimes company by company, to cover gas operations and end-use efficiency R&D. Gas LDC support for gas operations and end-use efficiency R&D are directed through two industry-led consortia: Operations Technology Development ("OTD") and Utilization Technology Development ("UTD"). Applied research was continued under the

Sustaining Membership Program. (Natural gas supply R&D is now covered separately by the United States Department of Energy ("DOE") Fossil Energy Program and others.) Federal funding for gas operations R&D and gas energy-efficiency R&D is funded at a very low level by the federal government. Additionally, DOE and other Federal and state R&D programs require co-funding in order for their funding of R&D projects to be approved.

Q. WHAT WERE THE RESULTS OF THE HISTORICAL GRI/GTI R&D EFFORT?

A. The primary focus of the R&D supplied historically by GRI/GTI was on unconventional gas (e.g., coalbed methane, tight gas sands, and Devonian shale). The current vast supply of gas from shales in the U.S. is, in large part, due to over thirty years of R&D in this area by GRI. GRI also developed the world's first fully condensing natural gas furnace, raising residential furnace energy efficiency to over 96%. A host of other residential, commercial, and industrial energy efficiency technologies were also developed by GRI. Gas operations R&D led to horizontal directional drilling technologies for gas LDCs, optical methane detectors, plastic pipe failure analysis tools, and many other safety and operations technologies. Ultimately, GRI developed and brought over 500 products, processes and techniques to the marketplace providing enormous benefits to U.S. natural gas consumers. I estimate that the national benefits generated by shale technologies alone to be over $50 billion per year.

Q. WHAT IS OTD?

A. OTD is a 501(c)(6) (i.e., not-for-profit) industry-led consortia established in 2003 to provide the nation's natural gas LDCs a way to voluntarily fund Gas Consumer Benefits R&D. Twenty-three gas LDCs are members of OTD. Most, but not all, of the OTD R&D projects are conducted at GTI's research

laboratories. GTI provides program management for research projects funded at other institutions. All of the funding for OTD comes from gas LDCs that have received regulatory approval for cost recovery of R&D funding. OTD funds R&D that would benefit gas consumers, LDCs, and the general public by developing technologies and products that increase the safety, improve the reliability, and reduce the costs of gas transmission and distribution systems. ONE Gas' Oklahoma customers currently contribute to the OTD program.

Q. **WHAT IS YOUR RELATIONSHIP WITH OTD?**

A. I am an employee of GTI which currently manages the OTD program for the gas LDCs. I am not an employee of OTD. I advocate for Gas Consumer Benefits R&D funding that includes OTD funding.

VI. R&D FOR GAS TRANSMISSION AND DISTRIBUTION SYSTEMS

Q. WHAT HAVE BEEN THE RESULTS OF THE GRI/GTI R&D TO INCREASE THE SAFETY AND REDUCE O&M COSTS FOR GAS TRANSMISSION AND DISTRIBUTION SYSTEMS EITHER THROUGH OTD OR SIMILAR R&D PROJECTS THAT PREDATE OTD?

A. GRI/GTI research focused on the fundamentals of polyethylene ("PE") pipe, especially fracture mechanics, failure analysis, and joining integrity, in an effort to lower the technical risks and increase the confidence in PE pipe. When GRI was created, plastic pipe comprised about 20% of all new distribution mains; today, non-corroding PE pipe, with a cost of about half that of coated steel pipe, comprises over 90% of all new main and service installations.

Q. ARE YOU SAYING THAT GRI/GTI RESEARCH WAS RESPONSIBLE FOR THE GROWTH IN PLASTIC PIPE USE?

A. No. Plastic pipe may have made it to the market place anyway due to cost. What I am saying is that without timely and directed research, the industry might have installed whole systems made of PVC (as did Cairo, Egypt) or other plastics that may have been subject to failure. In the early 1980s no one knew how long plastic pipe materials would last. Industry questioned whether the material would unfold in long lengths under stress (rapid crack propagation), evaporate, turn to powder, or be affected by bacteria, insects, or worms. GRI developed accelerated testing using tanks of water mixed with detergent and warmer temperatures, and then verified that failures in the accelerated test specimens duplicated the microscopic topography of failures in the field, mainly rapid crack propagation or slow crack growth. We determined the life of medium and high density PE pipes was 50 years plus. Based on that research, the majority of plastic pipe that went into the ground after the mid-1980s was medium and high-density PE. Right now, under OTD, GTI is working on a new generation of even higher strength plastic pipe. The introduction of new plastic materials will allow utilities to use plastic pipe at higher pressures and temperatures than possible with current plastic materials. OTD has investigated the use of Polyamide 11 (“PA11”) and Polyamide 12 (“PA12”) pipe for high-pressure gas-distribution applications. PA11 and PA12 are both impervious to corrosion found in steel-based pipe. PE is, of course, resistant to corrosion but cannot be used at higher pressures. GTI has also performed R&D to determine which versions of pre-1980 vintage plastic may be at risk.

Q. ARE THERE OTHER EXAMPLES OF R&D RELATED TO TRANSMISSION AND DISTRIBUTION SYSTEMS?

A. Yes. Most gas mains and services installed in the 1970s used trenching tools

that tore up the surface and subsurface, increasing restoration costs and risked penetrating near-surface utility lines. Six years of GRI/GTI research yielded the first set of guided horizontal boring tools that since then have been in use throughout the gas industry, providing substantial cost savings. When the horizontal boring tools were found to sometimes lead to cross-boring with sewer lines, GTI developed crossbore guidelines for utilities and sewer line cleanout services to identify and ameliorate this problem. And GTI is working on "look ahead" technology so that the boring tool can "see" and be guided around underground obstacles.

Q. HAS GTI R&D IMPROVED OPERATIONAL SAFETY?

A. Yes. For instance, GTI developed the optical methane detector ("OMD"). This device works by directing a laser beam from a vehicle to quickly and reliably scan streets for methane leakage. Many LDCs conduct required leak inspections by a walking survey; the OMD allows LDCs to convert to driving surveys with a significant reduction in response time and reduction in labor cost with the same or better accuracy. That technology was followed by the portable methane detector ("PMD") to speed up walking surveys and for use on non-drivable areas like service line locations. For OTD, enhanced safety of the general public, customers, and utility personnel is of primary concern. Identification, and reduction of methane leaks, reduction of corrosion, prevention of failures, and identification and amelioration of potential areas of risk, all are focal points for OTD. Reduction of third party damage, the primary cause of gas distribution system incidents, is also of high interest.

Q. WHAT RESULTS HAVE BEEN ACHIEVED BY OTD PROJECTS?

A. As indicated in the OTD/UTD "winners" list, Exhibit RBE-1, GTI's OTD-funded

efforts have developed and brought to the marketplace a main inspection camera, a Metallic Joint Locator ("MJL"), a portable methane detector (just discussed), a flash fire suppression system for shoring operations, a lift assist device for use with jackhammers and other pavement breaking tools, an innovative utility crew truck to increase speed of operations and enhance safety, a soil compaction measurement device, a micro-excavation system, first responders' training tools, a comparative evaluation of technologies used to locate underground pipes and facilities, long-life pipeline repair coatings, meter/riser corrosion reduction guidelines, flaw acceptance criteria for low-stress pipelines and mains, evaluation of the impact of reworked (remolded) plastic, and best practices (mentioned) to prevent crossboring of gas systems and sewer lines. The development and commercialization of a breakthrough plastic pipe locator has also occurred, critically needed by the gas industry. These products and information pieces have increased distribution system and public safety, lowered O&M costs, enhanced system deliverability, and enhanced system integrity.

Q. TO FOCUS ON JUST TWO OF THESE MANY PROJECTS, PLEASE DESCRIBE THE OTD-SPONSORED PROJECTS INVOLVING MAIN INSPECTION CAMERAS AND MJL.

A. Developed by GTI under OTD sponsorship, the PRX250K keyhole camera is small and flexible, making it easily maneuverable through tight bends, allowing utilities to examine pipe segments without the need to drill additional access holes for hard-to-reach locations. Moreover, a crew can insert the camera into the underground pipe via an 18" diameter keyhole drilled out at the surface, reducing the impact on the right of way.

The MJL provides an easy way to locate cast-iron joints, chill rings in welded steel pipe, metallic tapping tees, metallic flanges, and metal repair clamps. In field tests, the MJL was also able to detect bell and spigot joints for an eight-inch-diameter pipe buried at a depth of six feet. This technology, developed by GTI under OTD sponsorship is now available commercially.

Q. PLEASE DESCRIBE SOME OF THE ONGOING OTD R&D THAT PROMISES TO REDUCE COSTS AND INCREASE SAFETY FOR LDCS IN THE FUTURE.

A. OTD-sponsored projects that hold particular promise for LDCs, including Kansas Gas, include a robotic system to clean older natural gas mains, lining technologies for older mains, and improved laser leak detection systems.

Q. WHAT TECHNOLOGY IS UNDER DEVELOPMENT FOR THE LIVE CLEANING OF GAS MAINS?

A. Research is under way with OTD support to develop a robotic system for cleaning gas mains under “live” conditions. The introduction of a commercially available live mains cleaning system will allow gas distribution system operators, such as Kansas Gas, to conduct thorough cleaning operations without having to disrupt gas service. A more efficient cleaning system is important because utility operators sometimes find pipes containing debris and dust that can hinder inspection, rehabilitation, or repair activities. Debris and dust in the lines can also reduce gas flow and block orifices, filters, and tubing.

Q. CAN YOU DESCRIBE THE LEAK VS. RUPTURE AND YIELD STRENGTH DETERMINATION PROJECTS

A. The Leak vs. Rupture project has as its objective the determination of whether or not a steel pipe will leak or rupture, based on critical parameters such as

yield strength and hardness. The yield strength determination project has as its objective the development of a methodology to assist operators in backfilling missing yield strength records of undocumented pipe for the purposes of determining maximum allowable operating pressure (MAOP) and classifying segments as distribution or transmission. It will allow the use of small samples of pipe, rather than entire pipe segments for testing to determine yield strength.

Q. WHAT WORK IS BEING DONE ON LINING TECHNOLOGIES?

A. With OTD funding, GTI is performing burst testing on candidate structural slip liner materials. A structural liner that has the ability to rehabilitate long sections of deteriorating distribution mains will provide operators with a cost-effective alternative to open trench replacement when access is limited or excavation is too expensive. The structural properties of the liner will allow operators to use this rehabilitation technique in sections of pipe where the integrity of the host pipe cannot be maintained – for example, bare steel or steel with insufficient cathodic protection.

Q. WHAT R&D ISSUES AND CHALLENGES REMAIN FOR THE GAS DISTRIBUTION INDUSTRY?

A. There are substantial technological challenges remaining for delivery of natural gas that, if met, could benefit gas consumers and the environment, and which could improve the reliability, integrity and safety of transmission and distribution facilities, such as those operated by Kansas Gas. There are many vital reasons for continuing the work GTI has begun and PHMSA has urged regulators to approve R&D programs at the state level to promote pipeline safety. See Exhibit RBE-2.

Q. CAN YOU DESCRIBE SOME OF THE CHALLENGES THAT YOU SEE AHEAD

OF US?

A. Yes. Federal pipeline and distribution integrity requirements will enhance the safety of the natural gas system, but technologies and tools for inspecting and operating transmission and distribution pipelines can also be enhanced. For example, R&D is needed on both "pigging" technology, that is, nondestructive evaluation ("NDE") techniques, and on direct assessment approaches (as an alternative to "pigging" or hydrostatic testing). Research is also needed to enhance the confidence in current NDE techniques used to inspect natural gas pipelines. A substantial portion of the national pipeline system is not "piggable;" that is, valves, bends, turns, reduced-diameter pipe sections, or other obstructions prohibit internal inspection by a "pig." A "pig" is a mechanical device that is moved through the interior of the pipe to measure various characteristics of the pipeline material, e.g., deformations, wall thickness, etc. Further, current NDE tools and technologies can detect pipe-wall thinning and circumferential flaws, but other types of flaws, such as stress corrosion cracking and axial flaws, are very difficult to detect. Only additional R&D can ameliorate these and other issues such as determining the life of pipeline coatings and better understanding microbiologically influenced corrosion. One such tool, the Electromagnetic Acoustic Transducer ("EMAT"), uses an electromagnetic field to generate an ultrasonic signal to detect stress corrosion cracks and other smaller flaws in metal pipe. The EMAT tool, under development by OTD, can move upstream or downstream, and is available in smaller pipe sizes than the traditional interstate pipeline pigs, for use in formerly unpiggable, distribution-system-size metallic pipes. In terms of distribution system integrity, third-party damage is the major cause of "hits" on the gas distribution system. While new

one-call systems and more rigorous enforcement have helped with this issue, there are technology needs in this area.

The guided horizontal boring tools described earlier are guidable from point to point as well as steerable; however, they still cannot “see” in front of their path underground, so a “look ahead” device for use underground is under development. The GPS excavation encroachment prevention project, when completed, can also significantly reduce third party damage. The ability to locate sewer pipes, utilities and other obstacles is still an important and unresolved safety issue. And the plastic pipe locator, discussed earlier, will aid in locating plastic pipe and sewer lines. These issues are being addressed by OTD. And, as an OTD member, Kansas Gas has access to all OTD results.

After third-party damage, another area of concern in distribution systems involves the issue of corrosion of steel pipe, especially bare steel and aging cast iron gas mains. Projects relevant to addressing aging cast iron mains include the cast iron joint locator, robotic tools to clean older gas mains, and enhanced leak detection technologies.

Keyhole and micro-excavation technology is beginning to reduce the time and cost of excavations and gas system repair and replacement, but additional R&D is needed to develop and standardize advanced tools.

Infrastructure security is at the forefront of national attention following the events of 9/11. R&D in this area is being conducted; the “cyber” and physical security of our natural gas infrastructure is critical to gas consumers, the general public, and the national interest.

As new sources of methane enter the interstate natural gas grid, either through shale gas, renewable resources like biogas, issues of

interchangeability and its impact on gas system integrity need to be examined.

The impact on the U.S. natural gas industry of potential global climate change initiatives has not yet been determined. While the combustion of methane ("CH_4") produces much less carbon dioxide ("CO_2") per MMBtu than either coal or oil, CH_4 has a high global warming potential, estimated at 25 times the impact of a CO_2 molecule, so initiatives to further reduce leaks in natural gas systems have been called for. Additional R&D also will be needed to reduce methane leakage for safety considerations and to keep the costs of meeting leak-reduction goals reasonable. GTI is performing R&D to detect, quantify, and ameliorate methane leakage consistent with safety and other requirements.

Q. WHAT IS GTI DOING IN THE AREA OF CYBERSECURITY?

A. GTI has established, as part of OTD, a cybersecurity collaborative. The objective is to address high-priority cybersecurity issues through the use of a multiyear collaborative between OTD and the Department of Homeland Security (DHS) focused on the development of an outreach and education process and a technology evaluation and transfer initiative. The Collaborative will work to transfer applicable technologies to the gas industry members from the DHS Transition to Practice (TTP) Program. As part of OTD, the Company will have access to these technologies.

Q. WHAT WILL OTD DO TO ADDRESS ALL OF THESE CONTINUING TECHNICAL CHALLENGES?

A. OTD has projects to address all these areas of concern. The Company, as a member of OTD will have the ability to access data on all these projects. With funding from Kansas customers, the projects can then be field tested, if

applicable, in this service territory, with its unique soil, climate, historical pipe materials, and other conditions. And, as an OTD member, the Company can call upon GTI to get specific technical advice on new operations challenges if and when they arise.

VII. BENEFIT-COST ANALSYSIS OF R&D PROJECTS SELECTED FOR KANSAS

Q. WHAT WERE THE RESULTS OF YOUR BENEFIT/COST ANALYSIS?

A. I performed a benefit-cost analysis for the OTD projects that Kansas Gas is planning to support with funding from Kansas customers. This Kansas-specific analysis shows a benefit-cost ratio of 4.5:1 for OTD (Exhibit RBE-3).

For OTD projects, the benefits include avoided costs of utility operations, increased system safety, increased deliverability, and enhanced system integrity.

Q**. PLEASE DESCRIBE YOUR EXHIBIT NO. RBE-3.**

A. Exhibit RBE-3 quantifies the net benefits that customers in Kansas could receive from an R&D investment in OTD. My studies estimate the expected benefits that may be realized but they are not an attempt to predict the future. My OTD analysis does not attempt to quantify the net benefits that could arise from one safety-related R&D investment because the benefits of safety projects are difficult to quantify, yet they are of major importance. However, the costs of this safety-related project is included in my overall analysis. I looked specifically at the benefits and costs of projects that the Company expects to fund in 2017 and 2018, but I included five years of R&D costs in the overall benefit/cost ratios.

Q. BRIEFLY DESCRIBE YOUR ANALYSIS.

A. Starting with the projects that Kansas Gas has determined are likely to be

funded coincident with the effective date of the proposed rates, I estimated the benefits that the Company may realize based on the facilities in service and actual operating experience and data in Kansas. For example, I used DOT/PHMSA Form 7100 data as the basis for many of the OTD calculations, in terms of miles of pipe of various types, number and type of leak, and other pertinent data. I also relied on data from reports published by the Company. For each project I also estimated the costs the Company would incur to implement the new technology or process. Additionally, for the OTD projects, I assigned a probability of success parameter for each project, based on its R&D "stage" or milestone. The use of probabilities is appropriate because of the challenge of developing and commercializing advanced technologies.

Q. HAVE OTHER REGULATORS ACCEPTED GTI'S BENEFIT-COST ANALYSIS?

A. The analyses have been used before the FERC and the states of California, Massachusetts, Illinois, and the District of Columbia. No negative comments were received on the analyses, and the FERC used them to validate that the projects were likely to benefit consumers in a reasonable period of time.

Q. PLEASE DESCRIBE THE STAGE/GATE PROCESS.

A. The R&D stage/gate process used by OTD allows companies to fund R&D in phases or stages. The project will continue to be funded only if technical and projected cost goals are met. This allows companies to make an annual funding commitment to a particular project at each gate (or milestone) based on the progress in that effort in previous research stage. A company does not have to agree to fund an entire R&D project, only that particular stage. (Of course, the Company dollars are leveraged by the other companies that fund

the project, so total project costs are not borne by just one company.) So the R&D stage/gate process can be viewed as a funnel, with many concepts introduced in Stage 1 and each Stage followed by a decision gate where unsuccessful projects are winnowed out. Only those projects that continue to meet technical and economic feasibility criteria are allowed to continue. That is why use of R&D stages as a surrogate for probability of success is appropriate. DOE uses a similar process, called Technology Readiness Level, to evaluate the stages of its R&D projects, and the California Energy Commission has a stage/gate process modeled after GTI's.

VIII. QUESTIONS RAISED IN PREVIOUS RATE CASE

Q. HOW DO FUNDING THESE PROJECTS BENEFIT KANSAS CUSTOMERS?

A. The benefits to Kansas customers of the OTD program are enhanced safety, higher deliverability, increased integrity, and avoided O&M costs. The safety, deliverability, and integrity benefits are very difficult to monetize, yet can result in a safer system, with fewer incidents, early detection of problems, and ability to deliver gas in Kansas in the worst of winter weather conditions. Clear benefits to gas consumers in Kansas and to Kansas' general public. On the issue of avoided O&M costs, these are adjusted by the Commission at each rate case. And, while avoided cost result in real savings, in most cases the Company can use the funds to expand operations to fix the next class of leaks and other problems.

Q. SO, GIVEN THAT PUBLIC FUNDING IS REQUIRED, WHY CAN'T WE SIMPLY ALLOW THE FEDERAL GOVERNMENT (AND TAXPAYERS) TO CARRY THE BURDEN, AND NOT THE CUSTOMERS?

A. Sadly, DOE funding for energy efficiency and fossil energy related to natural gas has been severely reduced over the years. In the 1990's, DOE funding of gas related R&D was over $250 million per year. Now, it is under $50 million per year. (GRI/GTI funding over the same period has been reduced from $212 million per year to $60-$70 million per year.) Further, DOE will only fund basic and applied R&D, leaving later stage R&D to GTI, EPRI, and other entities. Even in the technology development stage DOE requires co-funding from the performing entity in order to proceed. Thus, even with DOE funding, both GTI and EPRI need customer funding in order to provide the requisite co-funding required by DOE. And PHMSA funding for pipeline safety, running at about $5-10 million per year, is woefully inadequate. In fact, PHMSA, see Exhibit RBE-2, has asked that its funding be supplemented by customer funding R&D.

Q. WHAT ABOUT MANUFACTURERS FUNDING OTD OPERATIONS SAFETY R&D?

A. Sadly, the situation is a real challenge with operations safety technology. Take the example of the plastic pipe locator. It took thirty years of R&D, and about $15 million (through five different technical approaches) to successfully develop a plastic pipe locator that could find 90% of buried plastic pipe 90% of the time. The market for this technology is the approximately 300 gas companies in this country. Selling even 300 units a year, the manufacturer would not be able to recover his cost of R&D even after decades of sales. Yet this technology was critical for the accurate locating of plastic pipe once the tracer wire was no longer operable. The market for operations safety technology is too small to provide for breakthrough R&D by manufacturers.

Q. HAVE YOU BEEN ABLE TO QUANTIFY THE LIKELY BENEFITS THAT KANSAS CUSTOMERS WOULD RECEIVE BY PARTICIPATING IN R&E PROJECTS?

A. Yes. As I indicated earlier in my testimony, I have provided benefit-cost analyses as exhibits to this testimony. The benefit-cost ratio for OTD projects for the Kansas ratepayers is 4.5:1. See Exhibit RBE-3. The OTD analyses -- performed specifically for Kansas gas customers – responds directly to the Commission's staff comments "that it does not appear that ratepayer savings have been quantified" and that, "Staff believes that a quantification of expected savings is important in order for the Commission to evaluate the costs and benefits of the proposal."

Q. WHAT OF STAFF COMMENTS THAT GTI HAS NOT OUTLINED THE ROLE OF THE COMMISSION IN PARTICIPATING IN, REVIEWING, AND SELECTING FUTURE PROJECTS.

A. The Company has indicated to me that it is willing to submit a list of future OTD projects to the Commission staff, so that staff has a chance to review and comment on the projects.

Q. WHAT OF THE ISSUE OF "MANDATORY" VERSUS "VOLUNTARY" FUNDING OF GTI?

A As discussed previously, the FERC Settlement of 1998 envisioned a voluntary R&D program that would be moved downstream, from natural gas pipeline approval under FERC, to LDC approval of R&D under the State Commissions. The OTD program does just that. The program is a "customer choice" program, with every dollar allocated by the individual LDC to projects specific to its customers and service territory. If an LDC has cast iron, it can sponsor cast

iron R&D. If not, then it can choose not to. This election process is incorporated into each project. And, of course, the decision to join OTD in the first place by the LDC (and ultimately, the Commission) is voluntary, not mandatory.

IX. KANSAS GAS'S PROPOSED FUNDING OF R&D

Q. WHAT SPECIFIC TYPES OF RESEARCH PROJECTS IS GTI EXPECTING TO RESEARCH ON BEHALF OF KANSAS GAS AND ITS CUSTOMERS?

A. The Company has identified 11 R&D projects for OTD as being projects that would be of particular interest to Kansas Gas and its customers. Assuming the Commission approves funding as part of this proceeding, and these projects remain active, Kansas Gas could participate in these projects beginning in 2017. I have provided a brief description of each of the OTD projects in my Exhibit RBE-5.

Q. BECAUSE ONE GAS IS ALREADY A MEMBER OF OTD, WHAT ADDITIONAL BENEFITS WOULD BE PROVIDED TO KANSAS CUSTOMERS IF THEY FUNDED OTD?

A. As I stated above, the R&D can be field tested in Kansas to evaluate the development of new techniques and assess the R&D under conditions unique to Kansas and Kansas Gas. The additional funding would allow Kansas Gas to increase the overall funding level of these projects and to fund additional projects that, due to financial limits, ONE Gas is currently unable to fund.

Q. IF FUNDING IS APPROVED IN THIS PROCEEDING, HOW WILL KANSAS GAS CHOOSE PROJECTS IN THE FUTURE?

A. Kansas Gas will choose where its research dollars are applied from the list of candidate projects that GTI will provide the Company each year. In future years, the already-selected projects will be funded to their conclusion. Kansas Gas will also have the option to fund new projects based on additional needs and new proposals. As indicated, the Company is willing to submit lists of such projects to Commission Staff for their review.

Q. WHAT LEVEL OF FUNDING IS KANSAS GAS PROPOSING?

A. Kansas Gas is proposing to fund OTD at the amount necessary to become a full participating member in that organization. The basic annual cost for that membership is 50 cents per customer for OTD. There is also a minimum requirement designed for smaller companies and jurisdictions. These funding requirements were approved by the Board of Directors of OTD as described in my Exhibit RBE-5. Kansas Gas is requesting $300,000 per year for OTD.

Q. WHAT OTHER STATES ARE ALREADY PARTICIPATING IN OTD FUNDING PROGRAMS?

A. There are 29 states currently authorizing research funding for Gas-Consumer Benefits R&D for one or more of the LDCs in their state. These are Alabama, Arizona, California, Delaware, Florida, Idaho, Illinois, Kentucky, Louisiana, Maryland, Mississippi, Minnesota, Nevada, New York, New Hampshire, New Jersey, New Mexico, North Carolina, Ohio, Oklahoma, Oregon, Pennsylvania, South Carolina, Tennessee, Texas, Utah, Virginia, Washington, and Wyoming. Thirty-two and a half million gas customers nationwide are now funding OTD, half the meters in the country.

Q. DOES ANYONE OVERSEE THE RESEARCH AND DEVELOPMENT ACTIVITIES UNDERTAKEN BY GTI?

A. Yes. In addition to the protections afforded the public by virtue of UTD and OTD being 501(c)(6) organizations, and GTI being a 501(c)(3) organization, GRI/GTI activities have been reviewed by the National Academy of Sciences, the GTI Public Interest Advisory Committee (made up of representatives from NARUC, the National Association of State Utility Consumer Advocates ("NASUCA"), as well as environmental and scientific representatives), and by the NARUC Gas Committee and Energy Resource and Environment Committee. A list of the members of the GTI Public Interest Advisory Committee ("PIAC") is attached as Exhibit RBE-6. The Commission and the Citizens' Utility Ratepayer Board ("CURB") will be invited to join GTI's Public Interest Advisory Committee upon the Commission approving R&D cost recovery for Kansas Gas. That will provide customers added protection that R&D dollars are being productively spent. Further, if Commission members are part of the NARUC Gas or Energy Resources and Environment (ERE) Committee, GTI reports regularly to those Committees.

Q. HAVE KANSAS CUSTOMERS BENEFITED FROM THE R&D PERFOMED AT GRI/GTI?

A. Yes. I summarized the benefits earlier in my testimony. One of these deserves to be highlighted because it may have produced the most direct consumer benefit. It is the research that produced the fully condensing natural gas furnace that vastly improved the energy efficiency of furnaces. As I noted above there are numerous other projects that produced direct and indirect benefits also.

X. CONCLUSION

Q. IN CONCLUSION, HOW WILL KANSAS GAS' CUSTOMERS BENEFIT FROM R&D FUNDING, PARTICULARLY THE FUNDING OF OTD?

A. Kansas-based gas consumer benefit-to-cost ratio for the proposed R&D is projected to be 4.5 to 1 for OTD. Maintaining Gas Consumer-Benefits R&D programs is absolutely critical for the continued safe transportation and affordable use of natural gas as a current and future environmentally benign, domestically produced energy source for Kansas and for the United States. Kansas Gas's participation in this program will provide direct benefits to its customers and contribute to the needed funding of these critical R&D projects. Therefore, I urge the Commission to approve KGS's request for funding of the GTI R&D projects.

Q. DOES THIS CONCLUDE YOUR PREFILED DIRECT TESTIMONY?

A. Yes it does.

VERIFICATION

STATE OF MARYLAND RBE
~~DISTRICT OF COLUMBIA~~)
) ss:
COUNTY OF MONTGOMERY)

Ronald B. Edelstein, being duly sworn upon his oath, deposes and states that he is an Independent Consultant for Kansas Gas Service, a Division of ONE Gas, Inc.; that he has read and is familiar with the foregoing Testimony filed herewith; and that the statements made therein are true to the best of his knowledge, information, and belief.

Ronald B. Edelstein

SUBSCRIBED AND SWORN to before me this 22ND day of May, 2016.

Notary Public

Commission/Appointment Expires: 10/20/2019

PAOLO MARTINEZ
Notary Public
Montgomery County
Maryland
My Commission Expires Oct. 20, 2019

OTD Operations Technology Development

Results in Use

OTD's mission is to identify, select, fund, and oversee research projects resulting in innovative solutions and the improved safety, reliability, and operational efficiency of natural gas systems.

Since 2003, the OTD program has provided utilities, pipeline companies, service providers, and others in the natural-gas-delivery business with innovative tools, enhanced processes, and advanced equipment for improving gas system operations.

These products represent the results of OTD efforts to build a stronger industry infrastructure , enhance system integrity, and improve the efficiency of a wide range of operations activities.

Selected OTD-Developed Products in the Marketplace

> Large-Diameter, Medium-Pressure Inflatable Stoppers

Mainline Control Systems

Marketed as the Kleiss MCS Flow Stopping System, this new system is used to stop the flow of gas in polyethylene, steel, cast-iron, and PVC pipes at diameters up to 18 inches and pressures up to 60 psig. The system, which is manufactured in Europe, was investigated through OTD to validate its operation and potential savings in the U.S. gas industry.

Contact: Wade Farr | 812-459-3936 | wfarr@mainlinecs.com | www.mainlinecontrolsystems.com

> IRED Infrared Portable Ethane Detector

SENSIT Technologies

This easy-to-use handheld detector was developed for use in the field to discriminate natural gas leaks from other sources of methane (e.g., swamp gas, landfill gas, and engine exhaust) and detect trace levels of ethane. The detection of ethane can be used as a fingerprint for natural gas in situations where the origin of a methane leak signal is questioned.

Contact: Scott Kleppe | 219-465-2700 | jScottK@gasleaksensors.com | info@gasleaksensors.com

> Acoustic Pipe Locator (APL)

SENSIT Technologies

SENSIT's ULTRA-TRAC® APL acoustic-based pipe locator provides the ability to locate plastic pipes before excavations and construction. Now commercially available, in tests the system was shown to be capable of detecting multiple buried plastic pipes at depths up to five feet.

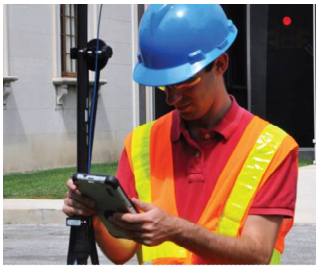
Contact: Scott Kleppe | 219-465-2700 | jScottK@gasleaksensors.com | info@gasleaksensors.com

> LocusMap Mobile GIS Solution

LocusView

This system maps new installations with comprehensive tracking and traceability data, creating GIS features in a format that allows field-collected data to be directly integrated into the enterprise GIS. Barcode scanning and high-accuracy GPS automate the system and help create high-accuracy maps.

Contact: Alicia Farag | 847-387-9412 | alicia@locusview.com | www.locusview.com



> LocusSurvey for Tracking Leak-Survey Routes

LocusView

LocusSurvey uses tablet computers and GPS to track leak-survey routes. The GPS breadcrumb trail is overlaid in a GIS to track pipe segments that are surveyed to provide real-time reporting and monitoring. LocusSurvey eliminates paper maps and records, automating the process of documenting surveys and leak locations.

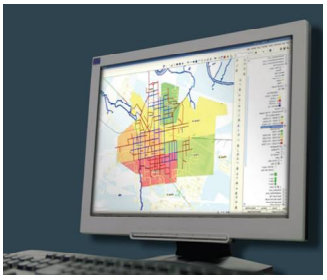
Contact: Alicia Farag | 847-387-9412 | alicia@locusview.com | www.locusview.com

> Uptime® 3.0 Distribution Integrity Management Risk Model

GL Noble Denton

Uptime® 3.0 provides an integrated environment for the integrity management of gas distribution and transmission pipeline assets. Uptime provides core support for all the key elements of distribution integrity management program regulations.

Contact: Michael Moore | 717-724-1900 | michael.moore@gl-group.com | www.gl-group.com



> NO-BLO® DBS System

Mueller Co.

Directional Bag Stopper (DBS) technology allows for routine maintenance without interruption of gas service to the customer. A portable system, it allows field technicians to perform many tasks related to the gas service line, including meter replacement and work on any part of the meter set, such as risers and regulators.

Contact: Bryan Kortte | 217-425-7516 | bkortte@muellercompany.com | www.muellergas.com

> Portable Methane Detector (PMD)

SENSIT Technologies

The handheld SENSIT® PMD uses optical-detection technology to provide sensitivity and cost advantages over conventional techniques employing flame ionization detectors. The PMD improves the efficiency of leak surveys, is less costly to maintain than other technologies, and can detect leaks from low ppm to 100% gas.

Contact: Scott Kleppe | 219-465-2700 | jScottK@gasleaksensors.com | info@gasleaksensors.com

> Lift Assists for Pavement Breakers and Rock Drills

Integrated Tool Solutions, LLC

These devices assist workers in lifting pavement breaker and rock drills after the bits break through surface pavements and rocks and need to be repositioned for the next penetration. By eliminating the need to manually lift and re-position the heavy tools, the lift assists make breaking easier and less physically demanding.

Contact: Ryan Purczynski | 951-929-4808 | rpurczynski@integratedtoolsolutions.com | www.integratedtoolsolutions.com

> Keyhole Pipeline Inspection Camera System

ULC Robotics

The PRX250K keyhole camera is an internal inspection system designed for visual assessment of live mains through conventional pits or small keyholes. The system is easily maneuverable through tight bends, allowing utilities to examine pipe segments without the need to drill additional access holes.

Contact: Greg Penza | 631-667-9200 | gpenza@ulcrobotics.com | www.ulcrobotics.com

> Metallic Joint Locator (MJL)

SENSIT Technologies

The SENSIT Ultra-Trac® MJL accurately locates bell joints, repair clamps, and service connections on metallic piping systems, significantly reducing excavation areas and pavement restoration costs. In field tests, the MJL was also able to detect bell and spigot joints for an eight-inch-diameter water main buried at a depth of six feet.

Contact: Scott Kleppe | 219-465-2700 | jScottK@gasleaksensors.com | info@gasleaksensors.com

Information on additional available products can be found at the OTD website: www.otd-co.org

Informational Products

In addition to the development of new tools, processes, and products, OTD supports research that results in useful information on various aspects related to gas delivery and operations. Listed here are some of the key reports developed under OTD sponsorship.

Selected OTD-Developed Technical Reports

PIPE & LEAK LOCATION

> Cross Bores Best Practices Guide & Videos

Significant research was conducted to investigate gas line/sewer line cross bores. The Guide and "how-to" videos (available through the OTD website) provide recommendations and procedures for preventing and detecting cross bores. (OTD-12/0003)

> Residential Methane Gas Detector Program

This reports provides results of a project initiated to determine whether commercially available combustible gas detectors are susceptible to giving false positive responses to an assortment of typical household chemicals, including ammonia, ethanol, acetone, toluene, isobutane, ethyl acetate, isopropanol, heptane, and hydrogen. (OTD-13/0003)

> Underground Facility Pinpointing

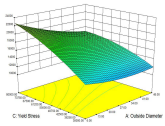
Reports from this project present the results of research conducted on several technologies used by utilities to locate underground pipes and facilities. Researchers investigated standard electromagnetic locators, ground-penetrating radar, and alternative imaging tools. The reports provide a comparative, technical evaluation of tools that are currently available. (OTD-6/0001)

EXCAVATION & SITE RESTORATION

> Evaluation of Flowable Fill Around Buried Pipes

Flowable fill is required by some agencies for use as backfill material for pipe repairs, rehabilitations, and other operations. Presented in this report are the results of performance tests of flowable fill, including the effects of flowable fill on pipeline corrosion and on the detection of gas flow and leaks through the backfill. (OTD-07/0004)

PIPELINE INTEGRITY MANAGEMENT & AUTOMATION



> Leak-Rupture Boundary Report and Calculator

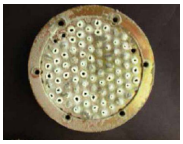
This report and associated software allows operators to determine the leak-rupture boundary for a pipe segment based on properties such as the diameter, toughness, and yield strength. Operators can use the calculator for risk modeling and consequence analysis. (OTD-13/0002 and OTD 13/0004)

> Evaluation of Guided Wave Technology as a Hydrotest Equivalent

This report details an evaluation conducted to demonstrate and validate the use of Guided Wave Ultrasonic Testing as an equivalent to a hydrotest. A standard was developed and incorporated by the National Association of Corrosion Engineers (NACE) into the NACE TG410 committee standard. (OTD-11/0001)

> "Black Powder" Contamination in the Gas Industry: Survey and Best Practice Manual

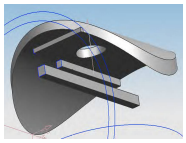
Black powder – a substance composed mainly of iron sulfides and iron oxides – can cause corrosion and create wear on pipelines. This report provides information on issues, cleanup techniques, and management methods related to "black powder" contaminants. Results were compiled into a "best practices" industry manual. (OTD-07/0002)



> Literature Review for Elemental Sulfur Deposits in Natural Gas Transmission Pipelines

Deposits of "elemental sulfur" – which can block natural gas pipes and equipment – are becoming an increasing concern in the natural gas industry. This report summarizes a literature review to develop a better understanding of the sources, causes, and mitigation possibilities for sulfur deposits found in gas pipelines. (OTD-09/0001)

> Establishment of Yield Strength Using Sub-Size Samples Without Gas-Line Shutdown



This report presents the results of a multi-phase project is to develop, validate, and obtain regulatory acceptance for a method to establish pipeline yield strength that allows for a less expensive sampling procedure that does not require the line to be taken out of service. (OTD-13/0005)

OPERATIONS INFRASTRUCTURE SUPPORT

> Ignition Testing of Electronic Devices

In this project, handheld electronic devices were tested to determine if ignition occurs in the presence of a flammable methane/air mixture. Laboratory tests demonstrated a large margin of safety under the scenarios investigated. (OTD-12/0001)

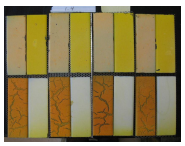
> Intelligent Utility Installation Process

This report provides a methodology, field process, and a data model for capturing data during new utility installations. The process is used to capture information regarding the location, materials, installation process, environmental considerations, and other factors. (OTD-12/0002)

> Tracer Wire for HDD Applications

Extensive research and testing culminated in the release of a report that provides valuable information on the properties and performance of various tracer-wire products for use in horizontal directional drilling (HDD) operations. (OTD-13/0001)

> Study of Low-Impact Markings



A variety of paints, materials, and techniques were tested and characterized in an effort to identify products and methods that can be used for temporary utility marking. Information developed in this study allows users to identify the most appropriate marker type for a given environment to achieve the desired marking duration. (OTD-11/0002)

> DVDs for Training First Responders

DVD training products help gas companies better educate first-responding personnel about natural gas emergencies. Learning modules with realistic scenarios cover a variety of issues to enhance public and worker safety. The product also serves to improve emergency-response effectiveness and coordination. (OTD-07/0005)

ENVIRONMENTAL, RENEWABLES & GAS QUALITY

> Field Measurement Program to Improve Uncertainties for Key Greenhouse Gas Emission Factors for Distribution Sources

This report summarizes the results of field surveys conducted at six natural gas utilities. With the support of the American Gas Association, research updated emissions factors for metering stations, regulating stations, and customer meters. (OTD-10/0002)

> Improving Methane Emission Estimates for Natural Gas Distribution Companies

This report details Phase 2 of a four-phase field-testing program to evaluate gas leak rates from belowground pipelines, provide a simplified procedure that can be used to monitor pipeline leaks from surface measurements, and update the methane emission estimates for the main lines in a distribution system. (OTD-14/0001)

> Pipeline-Quality Methane: North American Guidance Document for Introduction of Dairy-Waste-Derived Biomethane into Existing Natural Gas Networks

The guidance document provides reference and recommendations for the consideration of biomethane from dairy-waste digestion for introduction into gas pipeline networks. Four reports and an executive summary detail results of a biogas/biomethane Gas Technology Institute research program. (OTD-09/0011; OTD-09/0012; OTD-09/0013; OTD-09/0014). A similar guidance report on landfill-derived gas is also available. (OTD-12/0007)

Contact: Maureen Droessler
847-768-0608
maureen.droessler@otd-co.org
www.otd-co.org

U.S. Department of Transportation
Pipeline and Hazardous Materials
Safety Administration

1200 New Jersey Ave, S.E.
Washington, D.C. 20590

April 10, 2013

The Honorable Philip B. Jones
Chairman of the Board and President
National Association of Regulatory Utility Commissioners
1101 Vermont Avenue, NW, Suite 200
Washington D.C. 20005

Dear Chairman Jones:

I am writing to urge you to strongly consider allowing ratepayer recovered funding for gas distribution research and development (R&D) programs and technologies. While together we have made great strides in assessing and ensuring the integrity of the Nation's pipeline infrastructure, it is not possible to greatly reduce high consequence pipeline incidents without reducing the likelihood of their occurrence. The tragedies at San Bruno, California, and Allentown, Pennsylvania, have shown that there is an increased need for technical safety solutions for both natural gas transmission and distribution lines.

By developing and deploying improved defect assessment technologies and methods as a part of a balanced mitigation strategy, we can aggressively manage pipeline safety and stop solely relying on pipeline replacement programs that can be significantly expensive and disruptive to ratepayers. Current research road mapping has identified several priorities within the gas distribution sector that new research projects could address. However, given the limitations of the Federal budget, and given the fact that rate cases for distribution pipelines do not include rate recovery for integrity management or research endeavors, there is a considerable need for additional funding at the State level for gas distribution pipeline integrity management R&D.

We know that the balance between rate recovery and safety is a delicate issue. Managing rates is an important part of what State public utility commissioners do, and it can be a difficult task in a recovering economy. However, an investment in ensuring the integrity of State pipelines will be increasingly important and will pay both safety and economic dividends as time goes on. We should not wait for the next tragic incident to occur to the people of our communities before we act—with the price of gas at historic lows, there is no better time to strike than now.

Sincerely,

Jeffrey D. Wiese
Associate Administrator
for Pipeline Safety

cc: Mr. Charles Gray
Executive Director
National Association of Regulatory Utility Commissioners
1101 Vermont Avenue, NW, Suite 200
Washington, D.C. 20005

Mr. Barry T. Smitherman
Chairman of the Committee on Gas
National Association of Regulatory Utility Commissioners
1101 Vermont Avenue, NW, Suite 200
Washington, D.C. 20005

Mr. Paul Roberti
Chairman of the Task Force on Pipeline Safety
National Association of Regulatory Utility Commissioners
1101 Vermont Avenue, NW, Suite 200
Washington, D.C. 20005

Surface Indentation for Material Characterization RBE

4.14.c 42353.0

5

Project	Project Number	NPV Probability Weighted Benefits	NPV R&D Costs	B/C Ratio	Notes	R&D Costs:	2017	2018	R&D Stage
Residential Methane Detectors	1.14.g	$448,266	$70,231	6.4			$40,000	$40,000	5
Triple Plus Shut Off Valve	1.15.e	$182,456	$61,452	3.0			$35,000	$35,000	4
EMAT Sensor for Unipiggable Pipe	4.13.c	$3,790,953	$175,578	21.6			$100,000	$100,000	4
Surface Indentation for Material Characterization	4.14.c	$111,030	$35,116	3.2			$20,000	$20,000	5
GPS GIS-Based Conflation System	5.13.b	$455,534	$70,231	6.5			$40,000	$40,000	4
Cybersecurity Collaborative	5.15.a	$73,183	$35,116	2.1			$20,000	$20,000	5
Remote Gas Sensing Monitor	7.15.b	$12,156	$5,267	2.3			$3,000	$3,000	4
Remote Gas Sensing for First Responders	7.16.b		$17,558		Benefits are safety related and difficult to quantify		$10,000	$10,000	4
Secure Communications for Networked Gas Sensors	7.16.c	$20,642	$8,779	2.4			$5,000	$5,000	3
Remote Field QA/QC	8.16.b	$27,575	$17,558	1.6			$10,000	$10,000	5
Operator Qualifications Management System	8.16.c	$58,492	$29,848	2.0			$17,000	$17,000	5
							$300,000	$300,000	
Outyear R&D Dollars (2019-2021)			$635,941						
OTD Totals		**$5,180,286**	**$1,162,675**	**4.5**					

Surface Indentation for Material Characterization

4.14.c

Parameter	5	Reference
Nominal Discount Rate	10.00%	Weighted pre-tax ROI
Annual GDP Deflator (U.S. 2011-2015)	1.5%	http://data.worldbank.org/indicator/NY.GDP.DEFL.KD.ZG
Real Discount Rate	8.37%	

2017	2018	2019	2020	2021
0.916	0.840	0.769	0.705	0.646

Annual Loaded Salary, Average utility worker	$99,025	
Average hourly salary	$47.61	
Average cost to repair main leak	$2,900	Based on industry data
Average cost to repair service leak	$1,400	Based on industry data
KS Specific Data		PMSA Form 7100, 2014 data
Miles of unprotected, bare steel pipe	265	
Miles of Steel pipe, other	1,831	CP, uncoated; not CP, coated
Miles of steel pipe, coated cathodically protected	3,844	
Miles of plastic mains	5,351	Total miles of main
Miles of cast iron mains	70	11361
Bare steel services, #	60,365	
Cathodically protected, coated steel services, other steel	30,097	
Plastic services	539,359	Total services
Services, other	4	629825
Average service length, feet	68	
Corrosion Leaks, Mains	336	
Corrosion Leaks, Services	652	
Leaks, Natural Forces, Mains	235	
Leaks, Natural Forces, Services	188	
Leaks, Materials or welds, mains	207	
Leaks, Materials or welds, services	57	
Excavation Leaks, Mains	189	
Excavation Leaks, Services	649	
Total Leaks, Equipment, mains	167	
Total Leaks, Equipment, services	162	
Excavation Tickets	326,328	

R&D Stages and Probabilities of Success

Stage	Name	Probability of Success
1	Idea Generation	10%
2	Technical/ market analysis	20%
3	Research Implementa-tion	30%
4	Technology Development	50%
5	Product Development	70%
6	Deployment	90%
7	Commercial-ization	95%
8	Implementa-tion	100%

Residential Methane Detector

1.14.g

R&D Stage 5

	2017	2108	2019	2020	2021	Totals
Benefits	$0	-$367,494	$52,294	$472,081	$891,869	
NPV Benefits	$0	-$308,520	$40,225	$332,724	$575,951	$640,380
Probability of Success	70%					
NPV Probability Weighted Benefits	$0	-$215,964	$28,158	$232,907	$403,166	$448,266
R&D Costs	$40,000	$40,000	$0	$0	$0	
NPV R&D Costs	$36,650	$33,581	$0	$0	$0	$70,231
Benefit/Cost Ratio						**6.4**

Parameter	**Value**					
Total Service lines	629,825	629825	629825	629825	629825	
Percent penetration	0%	5%	10%	15%	20%	
Impacted Customers	0	31,491	62,983	94,474	125,965	
Cost of Advanced equpment, per unit	$75	$75	$75	$75	$75	
Added units per year	0	31,491	31,491	31,491	31,491	
Total Installed Costs of advanced equipment	$0	$2,361,844	$2,361,844	$2,361,844	$2,361,844	
Cost of conventional technology	$50	$50	$50	$50	$50	
Installed cost of conventional tech.	$0	$1,574,563	$1,574,563	$1,574,563	$1,574,563	
Net installed costs	$0	$787,281	$787,281	$787,281	$787,281	
False alarm rates of conventional technology	7%	7%	7%	7%	7%	Based on GTI testing
Number of false alarms per year	0	2,204	4,409	6,613	8,818	
Manpower wasted due to false alarms (hrs/alarm)	4	4	4	4	4	
Cost of wasted manpower	$0	$419,787	$839,575	$1,259,362	$1,679,150	
Net Benefits	$0	-$367,494	$52,294	$472,081	$891,869	

Triple Plus Shutoff Valve

1.15.e

R&D Stage 4

	2017	2108	2019	2020	2021	Totals
Benefits	$0	$0	-$675,018	$224,527	$1,124,071	
NPV Benefits	$0	$0	-$519,238	$158,247	$725,903	$364,912
Probability of Success	50%					
NPV Probability Weighted Benefits	$0	$0	-$259,619	$79,123	$362,951	$182,456
R&D Costs	$35,000	$35,000				
NPV R&D Costs	$32,069	$29,383				$61,452
Benefit/Cost Ratio						**3.0**

Parameter	**Value**					
Number of services	629,825	629,825	629,825	629,825	629,825	
Percent Penetration	0%	0%	5%	10%	15%	
Units installed per year	0	0	31,491	31,491	31,491	
Total installations	0	0	31,491	62,983	94,474	
Cost per installation Advanced technology	$250	$250	$250	$250	$250	
Cost per installation of conventional technology	$200	$200	$200	$200	$200	
Incremental Installation cost all units	$0	$0	$1,574,563	$1,574,563	$1,574,563	
False alarm rate of conventional technology	10%	10%	10%	10%	10%	
False alarms per year	0	0	3,149	6,298	9,447	
Manpower wasted per false alarm, hrs	6	6	6	6	6	
Labor savings per year	$0	$0	$899,545	$1,799,089	$2,698,634	
Net Savings	$0	$0	-$675,018	$224,527	$1,124,071	

EMAT Sensor for Unpiggable Pipe

4.13.c

R&D Stage 4

	2017	2108	2019	2020	2021	Totals
Benefits	$0	$0	$1,788,351	$1,788,351	$1,788,351	$5,365,054
NPV Benefits	$0	$0	$1,375,636	$1,260,435	$1,154,881	$3,790,953
Probability of Success	50%					
NPV Probability Weighted Benefits	$0	$0	$687,818	$630,218	$577,441	$1,895,476
R&D Costs	$100,000	$100,000	$0	$0	$0	
NPV R&D Costs	$91,626	$83,953				$175,578
Benefit/Cost Ratio						**21.6**

Parameter	**Value**					
Bare steel and steel pipe other, mains	2,096					
Unpiggable miles	524					
Percent inspected per year (7-year cycle)	14.29%	14.29%	14.29%	14.29%	14.29%	
Cost to hydrostatically test unpiggable lines/yr	$0	$0	$516,662	$516,662	$516,662	
Cost for EMAT testing (for unpiggable and extensive mod miles)	$0	$0	$566,036	$566,036	$566,036	
Extensive Modification Miles	419.2					
Cost to pig with extensive modifications	$0	$0	$1,837,725	$1,837,725	$1,837,725	
Net Benefits	$0	$0	$1,788,351	$1,788,351	$1,788,351	

General Assumptions:	2001$	2015$	
Costs of making lines piggable (1)	$3,480	$4,554	$/mile
Permanent pig traps (1)	$8,572	$11,218	$/mile
Extensive Modification of pipeline to accommodate pigs and add permanent pig traps (1)	$23,449	$30,687	$/mile
Direct Assessment (1)	$7,000	$9,161	$/mile
Hydrostatic testing (1)	$5,274	$6,902	$/mile
Smart pigging (EMAT)	$3,210	$4,201	$/mile

Pigging statistics: (2)	
Easily piggable	50%
easily made piggable	5%
Piggable with extensive retrofits	20%
Not piggable	25%
	100%

(1) OPS report, 2001$

(2) AGA estimate for OPS

(3) Ref: http://www.multpl.com/gdp-deflator/table

Surface Indentation for Material Characterization

4.14.c

R&D Stage	5					
	2017	**2108**	**2019**	**2020**	**2021**	**Totals**
Benefits	$0	$37,519	$37,519	$37,519	$37,519	
NPV Benefits	$0	$31,498	$28,860	$26,443	$24,229	$111,030
Probability of Success	70%					
NPV Probability Weighted Benefits	$0	$22,049	$20,202	$18,510	$16,960	$77,721
R&D Costs	$20,000	$20,000	$0	$0	$0	
NPV R&D Costs	$18,325	$16,791				$35,116
Benefit/Cost Ratio						**2.2**

Parameter	**Value**				
Leaks due to material problems	207				
Percent attributable to material failures	25%				
Percent preventable by surface indent test	25%				
Avoided costs, Mains per leak	$2,900				
Avoided costs per year	$0	$37,519	$37,519	$37,519	$37,519

GPS-Based GIS Conflation System

5.13.b

R&D Stage 4

	2017	2108	2019	2020	2021	Totals
Benefits	$0	$0	$366,076	$466,076	$466,076	
NPV Benefits	$0	$0	$281,593	$328,492	$300,983	$911,068
Probability of Success	50%					
NPV Probability Weighted Benefits	$0	$0	$140,797	$164,246	$150,491	$455,534
R&D Costs	$40,000	$40,000	$0	$0	$0	
NPV R&D Costs	$36,650	$33,581				$70,231

Benefit/Cost Ratio **6.5**

Parameter	Value					
Excavation tickets per year	326,328					
Percent improperly located due to inaccurate maps	1%					
Improper locates requiring service visits	3,263	3,263	3,263	3,263	3,263	
Time spent for hand locates per job, hrs	3	3	3	3	3	
Avoided costs of hand locates	$0	$0	$466,076	$466,076	$466,076	
Costs of implementation	$0	$0	$100,000	$0	$0	
Net Savings	$0	$0	$366,076	$466,076	$466,076	

Cybersecurity Collaborative

5.15.a

R&D Stage	5					
	2017	**2108**	**2019**	**2020**	**2021**	**Totals**
Benefits	$0	-$488	$49,513	$49,513	$49,513	
NPV Benefits	$0	-$409	$38,086	$34,897	$31,974	$104,547
Probability of Success	70%					
NPV Probability Weighted Benefits	$0	-$286	$26,660	$24,428	$22,382	$73,183
R&D Costs	$20,000	$20,000	$0	$0	$0	
NPV R&D Costs	$18,325	$16,791				$35,116
Benefit/Cost Ratio						**2.1**

Parameter	**Value**					
IT cost savings, hrs per year	0	1040	1040	1040	1040	Assumes 1/2 manyr/yr labor savings
Labor savings per year	$0	$49,513	$49,513	$49,513	$49,513	
Cost to implement	$0	$50,000	$0	$0	$0	
Net savings	$0	-$488	$49,513	$49,513	$49,513	

Remote Gas Sensing Monitor

7.15.b

R&D Stage 4

	2017	2108	2019	2020	2021	Totals
Benefits	$0	$0	$11,469	$11,469	$11,469	
NPV Benefits	$0	$0	$8,822	$8,083	$7,406	$24,311
Probability of Success	50%					
NPV Probability Weighted Benefits	$0	$0	$4,411	$4,042	$3,703	$12,156
R&D Costs	$3,000	$3,000	$0	$0	$0	
NPV R&D Costs	$2,749	$2,519				$5,267
Benefit/Cost Ratio						**2.3**

Parameter	**Value**				
Excavation Leaks per yr, mains & services	838	838	838	838	838
Percent requiring revisits	0%	0%	10%	10%	10%
Revists avoided per year	0	0	84	84	84
Hours per revisit	3	3	3	3	3
Avoided costs	$0	$0	$11,969	$11,969	$11,969
Sensor costs per year			$500	$500	$500
Net Savings	$0	$0	$11,469	$11,469	$11,469

Secure Communication for Networked Gas Sensors

7.16.c

R&D Stage	3					
	2017	**2108**	**2019**	**2020**	**2021**	**Totals**
Benefits	$0	$0	-$31,254	$68,746	$68,746	
NPV Benefits	$0	$0	-$24,041	$48,453	$44,395	$68,806
Probability of Success	30%					
NPV Probability Weighted Benefits	$0	$0	-$7,212	$14,536	$13,318	$20,642
R&D Costs	$5,000	$5,000	$0	$0	$0	
NPV R&D Costs	$4,581	$4,198				$8,779

Benefit/Cost Ratio **2.4**

Parameter	**Value**				
Miles of Mains, bare and other, CI	2,166				
Leak surveys saved per year	0	0	2	2	2
Avoided Walking survey time, 3 miles per hr, hrs	0	0	1,444	1,444	1,444
Savings for avoided surveys	$0	$0	$68,746	$68,746	$68,746
Cost of implementation	$0	$0	$100,000	$0	$0
Net savings	$0	$0	-$31,254	$68,746	$68,746

Remote QA/QC

8.16.b

R&D Stage 5

	2017	2108	2019	2020	2021	Totals
Benefits	$0	$0	$1,900	$19,000	$38,000	
NPV Benefits	$0	$0	$1,462	$13,391	$24,540	$39,392
Probability of Success	70%					
NPV Probability Weighted Benefits	$0	$0	$1,023	$9,374	$17,178	$27,575
R&D Costs	$10,000	$10,000	$0	$0	$0	
NPV R&D Costs	$9,163	$8,395				$17,558

Benefit/Cost Ratio **1.6**

Parameter	Value				
Plastic pipe components audited per year	0	0	1,000	10,000	20,000
Failure rate	0.1%	0.1%	0.1%	0.1%	0.1%
Component Failures	0	0	1	10	20
False digs to locate failed items, one per failure	0	0	1	10	20
Cost per false dig	$2,900	$2,900	$2,900	$2,900	$2,900
Savings per year	$0	$0	$2,900	$29,000	$58,000
Cost of audit per item	$1	$1	$1	$1	$1
Cost of auditing	$0	$0	$1,000	$10,000	$20,000
Net savings	$0	$0	$1,900	$19,000	$38,000

Operator Qualifications Management System

8.16.c

R&D Stage	5					
	2017	**2108**	**2019**	**2020**	**2021**	**Totals**
Benefits	$0	-$25,488	$49,513	$49,513	$49,513	
NPV Benefits	$0	-$21,397	$38,086	$34,897	$31,974	$83,559
Probability of Success	70%					
NPV Probability Weighted Benefits	$0	-$14,978	$26,660	$24,428	$22,382	$58,492
R&D Costs	$17,000	$17,000	$0	$0	$0	
NPV R&D Costs	$15,576	$14,272				$29,848
Benefit/Cost Ratio						**2.0**

Parameter	**Value**					
Mgmt cost savings, hrs per year	0	1040	1040	1040	1040	Assumes 1/2 manyr/yr labor savings
Labor savings per year	$0	$49,513	$49,513	$49,513	$49,513	
Cost to implement	$0	$75,000	$0	$0	$0	
Net savings	$0	-$25,488	$49,513	$49,513	$49,513	

Exhibit

Proposed KGS OTD Projects

Residential Methane Detectors Program 1.14.g

Create a comprehensive program for achieving full customer adoption of cost effective, reliable, accurate and readily available residential methane detectors. Phase 2, will include technology development and evaluation, codes and standards development, stakeholder engagement and economic and market analysis. In phase 2, under this multiyear program, several discreet initiatives are being proposed as tasks with the initial work being a consumer behavior study to better understand how customers react to potential leaks and the development of a "Fit for Purpose" standard for residential methane detectors. This phase also includes a comprehensive pilot program to evaluate the commercially available detectors that performed well during laboratory evaluations conducted in phase 1. Phase 3 may include follow-up work providing technical information to the standards organizations and regulators for implementation.

Triple Plus Shut Off Valve – Pilot Program 1.15.e

Support the development of a new system being developed by Triple Plus that combines a residential methane detector with an automatic shut off valve. This project will perform controlled field and pilot evaluations of the Triple Plus Gas+ product which is a gas leak detection and wireless automated shutoff system designed for residential single- and multifamily buildings. The pilot program in this project will provide the information necessary to support implementation of the device, and provide supporting documents to state commissions and internal LDC stakeholders that the system meets their requirements.

EMAT Sensor for Small Diameter and Unpiggable Pipe 4.13.c

Build and test an Electro-Magnetic Acoustic Transducer (EMAT) sensor prototype to detect and quantify wall loss and longitudinal cracks in metallic pipes. The sensor will be used to assess small-diameter and unpiggable pipes containing fittings and other restricting features. The initial target pipe diameter is 8 inches, however the commercial goal is to build tools that can navigate in 6- to 12-inch pipes. These sizes are typically used in unpiggable natural gas transmission and distribution systems. Other sizes will be considered based on industry needs. In phase 1 a laboratory assembly (bench-scale unit) was successfully completed and tested. The work in phase 2 is: build a prototype of the unit with the data management system and a pull-out mechanism for internal testing of pipe sections with controlled and natural cracks and flaws, establish the performance criteria and assess the minimum flaw sizes to be reliably detected by the device and work with the manufacturer to integrate the EMAT sensor into existing platforms for field application. Phase 3 is for testing at utility field sites.

Surface Indentation for Material Characterization Correlation of Surface Properties Based on Vintage 4.14.c

Develop correlation factors to relate surface properties to actual material properties to allow surface indentation techniques to be used for material property validation for pipelines. The correlation factors will be based on pipe vintage by decade. Past research has proven the ability

of surface indentation techniques such as stress-strain microprobes and hardness testing to accurately determine material properties of pipes within a localized area, but variations in material properties through the wall are problematic for local interrogation techniques. Probabilistic confidence intervals will be developed to allow operators to use surface indentation techniques by applying correlation factors to pipe materials that may have through-wall variability. Phase 2 is planned for additional pipe sampling.

GPS-Based GIS Conflation System 5.13.b

Develop and demonstrate a real-time Global Positioning System (GPS)-Based GIS Conflation System to increase the accuracy of a Geographic Information System (GIS) using GPS data collected as part of routine operations. A process called conflation is used to shift the GIS to match the GPS coordinates of assets collected with high accuracy equipment. This project is being performed in two phases. In the recently completed Phase 1, GTI partnered with 3-GIS and RAMTeCH to successfully develop a proof-of-concept system and demonstrated the feasibility of the field data collection system and the server-based GIS conflation process. Phase 2 will be conducted to develop a fully functional prototype system for testing in a pilot project as well as to pursue commercialization of the system. This project builds on the technology being developed in the Intelligent Utility program.

Cybersecurity Collaborative 5.15.a

A multiyear collaborative program between natural gas distribution companies and the Department of Homeland Security (DHS) to address the high priority cybersecurity issues of participating members through a focused outreach and education process and a technology evaluation and transfer initiative.

Remote Gas Sensing & Monitoring for 1st Responders 7.15.b

Phase 2 will develop an unattended methane monitoring device. This monitor would be placed in the vicinity of a suspected (or recently repaired) leak to provide 24 to 48 hours of unattended monitoring. Placement of the device would be at the discretion of the investigator, determined by the hazards at a particular site. The ability to post unattended wireless notifications of hazardous levels back to the utility in real time is the focus of phase 2. The methane sensor from phase 1 will be modified and used for phase 2. Phase 1 developed a system to allow a leak investigator to monitor methane levels at multiple points within a site under investigation. The investigator uses a tablet or phone to see the gas values in real time. Phase 3 is planned for field tests at utility sites and securing a commercializer.

Evaluate Gas Imaging Technologies for First Responders 7.16.b

Evaluate the use of gas imaging technologies for various applications within the gas industry. Specific applications include using these tools for methane emissions quantification (e.g., measuring leak rate) and as a tool for first responders during leak investigation and grading.

Secure Communication for Networked Gas Sensors 7.16.c

Design and build a prototype networked gas detecting device and data aggregation service with communication of the information. Provide the utility (main office) and the field personnel with information about the present and changing nature of methane gas in an area via networked gas detection devices. Any jobsite, ongoing leak or any location deemed necessary by the utility could be monitored with near real-time results. The next phase plans testing of the prototype.

Remote QA/QC: Fusion Inspection and Reporting 8.16.b

Develop a process, visualization, and reporting capability to support the operator and code regulations related to field-based inspections. This system is focused on the capture of plastic pipe fusion related data and required inspections. The project includes the capture of user identity, photos, GPS location and additional data as determined required to support compliance to the changing regulations.

Operator Qualification (OQ) Management System 8.16.c

Develop an OQ management platform based on previous work, allowing for standardized data management of OQ data. This system will enable utilities and contractors to manage qualifications for all employees and make the data readily available in a secure platform. Potential commercialization partners will be identified and a commercialization strategy will be developed.

OTD
Operations
Technology
Development

December 22, 2015

To Who It May Concern

RE: Operations Technology Development, NFP (OTD) – Dues Formula

The dues formula, as ratified by the OTD Board of Directors is as follows:

- $0.50 per natural gas meter per year,
- Minimum annual dues of $150,000,
- Maximum annual dues of $750,000, and
- No maximum annual dues level for pooled members

If you have any questions regarding the dues formula or any OTD-related item, please give me a call at 847-768-0572.

Sincerely,

Ronald N. Snedic
President

OTD is a member-controlled, not-for-profit partnership of natural gas distribution companies formed to conduct near-term applied research resulting in innovative solutions for the improved safety, reliability, and operational efficiency of natural gas systems. For more information, visit www.otd-co.org

1700 South Mount Prospect Road ▾ Des Plaines, IL 60018-1804 ▾ 847-544-3400 ▾ FAX: 847-544-3401 ▾ www.otd-co.org

Public Interest Advisory Committee Membership

Public Utility Commissioner Membership

The Honorable Bob Anthony, Chairman, Oklahoma Corporation Commission

The Honorable Kara Brighton, Commissioner, Wyoming Public Service Commission

The Honorable Julie Brown, Commissioner, Florida Public Service Commission

The Honorable Diane Burman, Commissioner, New York Public Service Commission

The Honorable John Coleman, Jr., Vice Chairman, Pennsylvania Public Utility Commission

The Honorable Lamar Davis, Commissioner, Arkansas Public Service Commission

The Honorable Kristie Fiegen, Vice Chairman, South Dakota Public Utilities Commission

The Honorable James Gardner, Vice Chairman, Kentucky Public Service Commission

The Honorable John Quackenbush, Chairman, Michigan Public Service Commission

The Honorable Paul Roberti, Commissioner, Rhode Island Public Utilities Commission

The Honorable Swain Whitfield, Commissioner, Public Service Commission of South Carolina

Consumer Advocate Membership

Dr. Belinda J. Kolb, Senior Rate Analyst, Office of Consumer Advocate, State of Wyoming

Economist Membership

Dr. Theodore R. Eck, Energy Economics Consultant

Academic/Technical Membership

Dr. Carl Blumstein, Director, California Institute for Energy and Environment

Mr. Gerald Braun, Director, Integrated Resources Network

Mr. Robert Miller, Chairman, National Association of Pipeline Safety Representatives

Mr. Steven Nadel, Executive Director, American Council for an Energy-Efficient Economy

Federal/State R&D Agency Membership

Mr. Joseph Borowiec, Program Manager, Buildings R&D, New York State Energy Research and Development Authority

Mr. Christopher Freitas, Program Manager, Natural Gas R&D, U.S. Department of Energy

Environmental Membership

Mr. Howard A. Learner, Executive Director, Environmental Law and Policy Center

Ms. Elizabeth Noll, Energy Efficiency Advocate, Natural Resources Defense Council

Municipal Membership

Mr. Wade Stinson, Associate General Manager - Operations, City Utilities of Springfield/American Public Gas Association Research Foundation

Mr. Charles S. Warrington, Jr., Managing Director & Executive Officer, Clearwater Gas System / APGARF