Evidence-Based Risk Communication and Pipeline Public Awareness

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Executive Summary

Background

The primary mode of transport for natural gas and hazardous liquids in the United States is through national, regional, and local networks of pipelines, most of which are located below ground. While these pipeline systems provide a means to convey important products across the nation and, in some ways, are safer than other forms of transportation, they also present risks to human health and security, property, and the environment.

Successful risk communication and shared risk management are integral parts of maintaining pipeline safety and allowing for informed decision making on the part of pipeline operators, regulators, excavators, local officials, emergency responders, and other members of the public. Pipeline operators are mandated to develop and implement public awareness programs, and current regulations stipulate that pipeline operators must follow the guidance found in American Petroleum Institute (API) Recommended Practice 1162 (1st Edition) in the design, implementation, and evaluation of these programs. While industry recommended practice has been revised, the revised edition has not been incorporated into regulations by the Pipeline and Hazardous Materials Safety Administration (PHMSA). PHMSA's Public Awareness Program Working Group (PAPWG) recently conducted a review of operators' public awareness programs and found a number of areas that require improvement, many of which touch upon issues that have been studied by risk communication and management researchers.

This report

1) summarizes the science of risk communication and current best practices;
2) examines current pipeline public awareness regulations and guidance; and
3) provides initial recommendations on directions for improving risk communication related to pipeline safety and stakeholder decision-making.

These recommendations focus on three general aspects of risk communication and management: the Stakeholders, the Goals of the risk communication, and the Processes by which the risk communications are developed, implemented, and evaluated.

Findings and Recommendations

The risk communication research emphasizes the following main points:

- Risk communication programs can have different goals, though usually a simple goal of "just sharing information" is not enough. In Care and Consensus-type risk communication the goal is to enable informed decision making on the part of the audience. In Crisis-type communication the goal is to persuade the audience to act in a certain way immediately.

- No matter which type of risk communication goal, the history of risk analysis and perception informs us that assuming the audience shares the same knowledge, perceptions, and values as the sender of risk information is usually incorrect and can cause confusion and animosity. Audience-centered and open approaches are therefore necessary.

- An established audience-centered general process for designing and implementing risk communications involves analyzing the information the audience needs to know to make informed choices, assessing what the audience currently believes, and then focuses on the gaps between the two. Often this comparison is between an "expert" model and a "lay" model. Other times the comparison is between two different stakeholder contexts.

- Assumptions about what successful risk communications look like are wide-spread and unreliable. Communications like other products must be tested. There are a range of options available at different levels of expense for the evaluation of the effectiveness of communications. These strategies are familiar to social and behavioral scientists who should be consulted in such efforts.

- The determination of whether a risk communication strategy is adequate should be based on whether the communication contains the information needed for effective decision making, connects the audience to that information, and is understood by the audience.

- Audience-centered design and testing of risk communications may involve additional resources at the outset, but such processes result in more efficient and effective communications.

Overall it appears that current regulations and guidance incorporate some aspects of the best practices in risk communication research, but there are some areas that are underemphasized, confusing, or missing and could be improved. These areas of improvement are summarized here along with initial recommendations:

Stakeholders and Participation

Neither the development of regulations nor that of API RP 1162 appeared to explicitly involve risk communication and behavioral science specialists. Both the FDA guidebook on communicating benefits and risks, and the NAS reports on public participation and understanding risk speak to the importance of including such specialists as well as the public in the development of risk communication related guidelines and regulations.

Recommendation:

- Involve risk communication experts and public stakeholder groups in the development and application of future API RP and future regulations. The focus should be on "how" to involve these groups rather than on "whether to" involve these groups (National Research Council, 1996).

Goals of Risk Communication

The regulations and API RP 1162 indicate a number of goals for the public awareness programs; some focusing on informing the public and some on improving public safety behavior. The emphasis is on pipeline safety in terms of pipeline failures even though some of the stated goals could be interpreted to refer to a broader informed decision making related to pipelines. Confusion between the goals can limit pipeline operators' understanding that they should start the risk communication design process by systematically listening to their audiences.

Recommendations:

- Clarify the goals of public awareness programs: when is the goal to improve informed decision making and when is the goal to induce particular behaviors.

- Establish empirical standards for demonstrating success in meeting these goals.

Design and Implementation of Risk Communication

The guidance on the design and implementation of risk communications found in API RP 1162 does emphasize some important points from the risk communication research including the need for flexibility, iteration, and stakeholder contact. At the same time some of the guidance appears to deemphasize or confuse the importance of the audience-centered approach found in the risk communication literature.

For example, the overall program flow guidance suggests that "Assessing the need for program enhancement" comes later on in the design and implementation process than it should if it is to mirror best practices. Also, without a systematic audience-centered approach, the flexibility given to operators to determine the need for supplemental/enhanced program features may result in such features not being utilized when they should be.

Recommendations:

- Incorporate and/or promote procedures for determining what information decision makers need to make informed decisions as the essential first step in communication.
    - At a minimum API RP 1162 process flow for pipeline awareness programs should be clarified and reordered to emphasize the importance of knowing the audience and the audience's context prior to developing communications.
    - A more robust approach would be to incorporate and promote a style of approach to risk communication like that found in Figure 1, such as mental-model analysis, that enshrines the need to understand and compare the audiences' perceptions and contexts with that of the entities charged with risk communication, analyze the gaps between them and design communications to close those gaps.
- Incorporate language into regulations or guidance that emphasizes how strategies like the above, while they may require more resources upfront, result in more efficient and effective communications.
- Incorporate risk communication science into how operators are asked to determine the need for baseline or enhanced/supplemental actions.
- Emphasize two-way communication strategies as important in many baseline as well as enhanced/supplemental programs. Inform pipeline operators not just on the frequency of such interactions, but how to design and implement such interactions to minimize miscommunication.
- As stakeholder mental models can incorporate other aspects of pipeline systems even when the focus is on safety planning, efforts to build guidance for emergency communications and pipeline siting/new construction decisions should be considered.

Evaluation of Risk Communication

The evaluation of the implementation of the public awareness program is emphasized in both the API RP 1162 guidance and PHMSA's evaluation forms. The guidance on the evaluation of the effectiveness of such programs does not include an evaluation of whether the information being communicated helps or is needed by the audience in making informed decisions (which is one of the recommended criteria for determining communication adequacy). While several effectiveness evaluation tools are mentioned in the guidance, the emphasis is on focus groups and surveys and not on more open-ended audience-centered methods nor more involved testing, and some of the information presented in the guidance is not clearly presented.

Recommendations:

- Update self-assessment and PHMSA program evaluations to include additional measures of effectiveness in addition to the current emphasis on implementation.

- Incorporate the three criteria for communication adequacy (does it communicate the needed information for informed decision making, do audiences have access, do audiences understand) as part of the requirements for effectiveness evaluations.

- Expand discussions of effectiveness evaluations in the guidance to include and inform regarding all types of evaluations found in Table 3. Deep discussion should not be limited to focus groups and surveys. Current guidelines regarding these strategies should be reviewed and updated by risk communication and social science experts.

1. Introduction

Pipelines and Pipeline Safety

Currently in the United States, there are more than 2 million miles of pipeline that serve as the primary mode of transport for natural gas and hazardous liquids such as crude oil and gasoline. These pipeline networks are comprised of gathering lines that bring products from production sites to centralized collection points, transmission lines that transport products across the country, and distribution lines that bring gas directly to homes and other key points in each community. Gas pipelines are managed by more than 3,000 gathering, transmission, and distribution operators and 52,000 smaller operators. Hazardous liquid pipelines are managed by more than 200 operators (PHMSA 2013).

Hazardous gas and liquid pipelines both provide benefits to communities (in the transportation of fuels and products used in energy generation, industrial and transportation activities, and household heating) and present risks to human health and safety, property, and the environment from pipeline failures. While statistically safer (in terms of incidents per year) than road and rail transportation, pipeline leaks, spills, ruptures and other failures can and do occur. According to the Pipeline and Hazardous Material Safety Administration's (PHMSA) Office of Pipeline Safety (OPS), which regulates pipeline infrastructure in the United States, over the 20 years between 1997 and 2016, there have been on average 284 significant pipeline incidents per year, resulting in an annual average of 16 deaths and 65 injuries, as well as property and environmental damage (PHMSA 2017).

Pipeline failures can be due to a number of causes, both those that are naturally occurring and those related to human activity and decision making by both pipeline operators and third parties such as excavation companies. According to the annual report data made available by PMHSA, from 2004-2017 the most common causes of pipeline failures were Equipment Failure (28% of all reported incidents), Corrosion Failure (18%), and Excavation Damage (12%). Other categories of damage include Other Outside Force Damage (9%), Material Failure of Pipe or Weld (9%), Incorrect Operation (9%), Natural Force Damage (7%), and Other (7%)[1]. The majority of pipeline regulations mandated through PHMSA and the best practices reported by industry groups, such as the American Petroleum Institute (API), focus on physical design and siting, reporting, and operational requirements for pipeline operators to mitigate the risk of pipeline failure.

[1] These percentages are based on data for gas distribution, gathering, and transmission and hazardous liquid pipelines from the PHMSA Operator Annual Report database: https://www.phmsa.dot.gov/pipeline/library/data-stats/distribution-transmission-and-gathering-lng-and-liquid-annual-data

Pipeline Risk Management and Communication

The experiences of those affected by high-profile failures (such as the Kalamazoo River oil spill and the San Bruno pipeline explosion, both in 2010) and high-profile siting disputes (such as the recent Standing Rock/Dakota Access Pipeline protests) have increased public demand for information on the risks associated with pipelines, and a voice in both the siting and routing process and in ensuring ongoing pipeline safety.

At the same time, there has also been a push for increased public awareness related to pipelines and pipeline safety from regulators and pipeline operators. Most gas and hazardous liquid pipelines are located underground which increases their security in many ways, but also results in unique challenges to pipeline risk management. One of those challenges is that non-operator awareness of the existence and operation of such pipelines may be low or non-existent. As mentioned above, many pipeline failures are the result of third-party activity like excavation, making overall pipeline safety a shared responsibility for operators, regulators, and the public.

PHMSA has stated, "Public awareness of where pipelines are located and an understanding of the safety concerns and risks associated with pipeline transmission are vital to the continued safe operation of pipelines," (PAPWG 2016) and the federal government has promulgated regulations and rules to promote public awareness over the last 15 years. The Pipeline Safety Improvement Act of 2002 mandated public education[2] program activities by pipeline operators. Final rulemaking in 2005 set the current requirements, which can be found in the Code of Federal Regulations: 49 CFR 192.616 for gas pipelines, and 49 CFR 195.440 for hazardous liquid pipelines. These regulations incorporate by reference API Recommended Practice 1162 (1st Edition) which sets the guidance for the development, implementation, and evaluation of public education programs that pipeline operators must follow. As part of the regulations, operators are also required to evaluate the effectiveness of their public education programs. Although industry-recommended practice in the form of API RP 1162 (2nd Edition) was revised in 2010, this new version has not been incorporated into the regulations.

Since the final rule making and adoption of API RP 1162 (1st Edition) as integral to public awareness regulations, there have been ongoing discussions about whether current regulations and recommended practices have been effective at creating an informed public, whether they reflect best practices for risk communication and management, and whether they should be updated. For example, in its 2011 report on the 2010 explosion of a PG&E gas transmission pipeline in San Bruno, CA, the National Transportation Safety Board recommended that PHMSA require operators to provide "system-specific" information to first responders along their

[2] PHMSA refers to "public awareness" and "public education" interchangeably

pipelines.[3] In 2013, PHMSA created the Public Awareness Program Working Group (PAPWG) to review the public awareness program data from the first set of operator evaluations and perform a SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis (PAPWG 2016).

The PAPWG Final Report found that there were some strong components in the existing public awareness programs that were spurred on by the regulatory framework and industry guidance. For example, the promotion of 811 "Call Before You Dig" programs were reported as successful, and the identification of opportunities for the consolidation of messages across operators was seen as a positive step.

The PAPWG Final Report also concluded that operator public awareness programs fell short in other areas. It was identified that there was inadequate communication of the risks posed by pipeline failures and that operators are not consistent in identifying and interacting with important stakeholders (both stakeholders that are explicitly mentioned in the regulations and those that are not).

Many of the identified Weaknesses and Opportunities in the PAPWG SWOT report reflect issues that have long been the subjects of study in the risk communication and management literature. Those include striking a balance between "information saturation and desensitization" in the provision of risk and benefit information, the "lack of understanding of how to measure behavior change," the "lack of customization of messaging to sub-groups," limited guidance for selecting the method of communication and evaluation tools, and failure to address situations where understanding a risk does not ensure effective action. One general weakness identified in the report is that "Traditionally, assumptions have been made on how to best communicate with stakeholders," without testing risk communication messages and programs prior to, during, and after implementation – in order to see whether those assumptions are valid.

As PHMSA seeks to improve its regulatory mandates and guidance, it may be helpful to investigate how well current rules reflect the best practices established by risk communication research and where results from that research could inform future actions.

[3] Specifically, the NTSB recommended that the information include pipe diameter, operating pressure, product transported, and potential impact radius.

https://www.phmsa.dot.gov/portal/site/PHMSA/menuitem.6f23687cf7b00b0f22e4c6962d9c8789/?vgnextoid=489c603415d13310VgnVCM1000001ecb7898RCRD&vgnextchannel=2a0dd7dcb2588110VgnVCM1000009ed07898RCRD&vgnextfmt=print

Purposes of this Report

The purposes of this report are therefore as follows:

1. Summarize the science of risk communication and current best practices based on the research (Chapter 2).

2. Summarize current pipeline public awareness regulations and guidance. Examine how well these regulations and guidance reflect the science of risk communication (Chapter 3).

3. Provide initial recommendations on improving risk communication related to pipeline safety (Chapter 4).

These goals were met through a review of the research on risk communication and management and a review of the current regulations and guidance. A focus was put on the following aspects of risk communication: the Stakeholders involved, the Goals of the risk communication programs, and the Processes by which such communications are designed, implemented, and evaluated.

2. Evidence-Based Risk Communication Best Practices

Modern societies benefit enormously from advanced technologies and infrastructure. Along with their benefits, these socio-technological systems may expose those societies and their environments to unique risks. The last century has seen an explosion in the complexity of these systems and an increase in our dependency on them. With the increasing complexity has come a sharper divide between experts who are most familiar with the systems' properties and typically are responsible for managing them, and members of the public who are affected by the risks and benefits that those systems create and who may wish to participate in their governance. The public and the experts may differ both in their perceptions of these systems and in the tradeoffs that they find acceptable. Successful risk communication between groups is, therefore, important in order to inform decision making on the part of all groups – so that the experts understand what the public wants and the public understands what the experts can (and do) provide.

But what are the best ways of deciding on and communicating risk messages and evaluating program success? These are the issues that risk communications research investigates. This section of the report presents some historical background to the field, discusses the goals and directions of that research, and summarizes some of the best practices based on the science. This report draws heavily on two recent reports that summarize evidence-based practices: the FDA *Communication of Risk and Benefits: An Evidence-Based User's Guide* (Fischhoff et al. 2011), and the NAS *Public Participation in Environmental Assessment and Decision Making* (National Research Council 2008). Although neither is directly related to pipeline safety, the behavioral principles that they have identified are relevant to communication about any risk.

Goals of Risk Communication

The overall goals of risk management programs are typically to reduce the incidence of acute accidents and chronic hazards and to increase the capacity of individuals and groups to respond to such events. Risk communication is an important component of the overall risk management strategy. As the risks involved in complex systems can range from short-term acute risks to chronic ones, so, too, there can be different goals of risk communication.

Lundgren and McMackin (2015), in their handbook for communicating environmental, safety, and health risks categorize risk communications into 3 functional types as shown in Table 1:

Table 1: Types of Communication (Lundgren and McMakin 2015)

Type of Communication	Definition	Pipeline Safety Example Communication	Pipeline Safety Example Decisions/Actions
1. Care	"Communication about risks for which the danger and the way to manage it have already been well determined through scientific research that is accepted by most of the audience."	Advisory notices regarding One-Call Systems/811/"Call-Before-You-Dig".	Where to dig (there is already agreement that puncturing pipelines is a bad outcome).
2. Consensus	"Communication to inform and encourage groups to work together to reach a decision about how the risk will be managed (prevented or mitigated)."	Advising communities on the benefits of pipelines and the risks associated with pipeline failures.	Whether to support the installation of a new pipeline. What types of land use planning policies and regulations there should be near pipeline ROWs.
3. Crisis	"Communication in the face of extreme, sudden danger—an accident at an industrial plant, the impending break in an earthen dam, or the outbreak of a deadly disease."	Evacuation announcements related to a pipeline failure.	Whether or not to evacuate.

The goal of both Care and Consensus communications is to inform individuals and groups so that they can make informed decisions about the risks they face. Informed decision making is defined as when the costs, benefits, and uncertainties of choices are understood well enough so that decisions can be made in accordance with the decision maker's values and preferences. In a straightforward example, pipeline safety information related to the location of local pipelines can help an individual excavator make a decision about where and how to dig. Another example would be when information regarding the risks and impacts of pipeline failures is provided to potential property owners so that they can make the personal decision as to whether they want own property in the vicinity of a pipeline right-of-way (ROW).

In Care communications, the optimal action may already be well known and agreed upon, whereas in the more complicated (and common) case of Consensus communications, the optimal action may not be known or agreed upon. It should be noted that while Consensus Communication, as defined by Lundgren and McMakin, involves "encouraging groups to work together," that it need not lead to consensus.

In contrast to Care and Consensus, the implicit goal of Crisis communications is to get individuals and groups to do something immediately. Such communications are, therefore, more likely to be persuasive forms, rather than just informative. It should also be noted that the illustrative decisions and actions summarized in Table 1 do not depend solely on the

effectiveness of the risk communication, but also on the resources available. For example, someone who receives an evacuation order and wants to evacuate, might not be physically able to do so.

Whether the goal is to inform independent decision making or to persuade someone to act in a certain way, the form, content, and implementation of the risk communication matters. Simply sharing information is a straightforward goal, but as Brewer points out in his summary chapter on risk communication goals, "the goal of just saying it will rarely match the implicit goals of responsible and ethical communication" (Fischhoff et al. 2011). To understand why this is, and why such communications can be ineffective, it will be helpful to review how the understanding and practice of risk perception and communication has changed over the past 50 years.

Improving and Informing Risk Communication

Early in the history of formal risk analysis, risk was both thought of and communicated as only a numbers game. Analysts would calculate the expected outcomes of risky events based on assessments of their probability (e.g. one event per month) and the magnitude of the associated harm (e.g. number of injuries per event). Some early risk perception studies appeared to confront (and even disrespect) the public, claiming that, based on such expert calculations, public fears regarding, for example, nuclear power or air plane crashes, were irrational (Morgan 2017). In this model of risk management, no consultation was needed with the public, given that the answers were known and merely needed to be communicated.

However, further study into the public's perceptions of such risks revealed that numbers and expected outcomes are only part of the story. Work by Slovic and his colleagues demonstrated that there are other aspects of specific hazards that influence individual perceptions of risk, such as, how familiar the individual is with the hazard and how much the risk is perceived to be indicative of a greater societal or technological problem (Slovic et al. 1980). Individual risk perceptions depend on a host of personal, social, and environmental factors. If risk perceptions are different from person to person, then the communication of risk becomes more difficult and the need for audience-centered, evidence-based communication becomes more important.

In his review of two decades worth of risk communication work, Fischhoff (1995) summarized the historical trajectory of such communications as moving through the following stages, with a gradually widening scope (See Appendix A for a summary of these stages):

1. "All we have to do is get the numbers right."
2. "All we have to do is tell them the numbers."
3. "All we have to do is explain what we mean by the numbers."
4. "All we have to do is show them that they've accepted similar risks in the past."
5. "All we have to do is show them that it's a good deal for them."
6. "All we have to do is treat them nicely."
7. "All we have to do is make them partners."

As the science and practice of risk communications have progressed through these stages, there has be an increasing emphasis on the fact that the audience for such communications can be diverse, with varying beliefs, opinions, and values that affect what information is salient and useful to their decision making. Communications and communicators that assume their audience's perceptions match their own can create confusion and animosity. This mistake can be thought of as a confusion between Care and Consensus communications, and is one of the core reasons behind the need for audience-centered, two-way communication in lieu of the older top-down, one-way model.

The final stage in Fischhoff's summary touches on the realization that audiences can be not only the target of risk communications but also participate and provide information to the sender of those communications (agency or operator). This final step also acknowledges that one-way risk communication is only, "one part of the larger requirement for risk management, which includes other aspects such as the responsibility to listen and create fair decision-making processes." (Morgan et al. 2001).

This trajectory towards partnerships in risk communication is mirrored in research on public participation in environmental assessment and management. The National Academies study (National Research Council 2008) concludes that both research and practice have found that public participation in the management of environmental risks can greatly enhance the

1. Quality of decision making,
2. Legitimacy of the process, and
3. Capacity building that occurs during such processes.

In complex socio-technical systems, such as those related to pipeline safety management, public participation is both necessary (some pipeline failures are due to third-party intervention; emergency response happens at the local level), and can be advantageous to the groups involved (in building trust for monitoring and siting decisions). Successful risk communication requires not just understanding the technology, but also what information about it the audience needs and how that audience processes information that is presented in different ways. Properly managed public participation can help connect audiences and senders of risk information (see Appendix B for general recommendations from the NAS report).

Evidence-Based Design of Risk Communications

Connecting and sharing information may be necessary for risk communication to achieve its goals, but it is not sufficient. As mentioned above, individuals and groups may perceive risks differently. Risk communication research on a topic (e.g., pipeline safety), therefore, begins by assessing those perceptions, rather than relying on observers' intuitions, especially when those observers are technical experts who may see the world very differently than the audiences that they seek to reach. For the same reason, the research places a high premium on empirically testing the efficacy of communications, rather than relying on intuitions, perhaps colored by wishful thinking, about how well they have worked.

Evidence-based risk communication uses systematic evaluation to determine both the design of a communication and how well it meets its goals. While such systematic design may use more resources at the outset, the end result is more effective communication that make efficient use of limited resources in the future, build trust between groups, and avoid needless conflicts.

How should this be done? As mentioned, it begins by analyzing the information that well-informed people most need to know in order to make choices in their own best interests. It then proceeds to assess what they currently believe, followed by addressing the critical gaps in their understanding. A structured view of this process (Fischhoff et al 2011, Fischhoff 2013, Bruine de Bruin 2013, Morgan et al. 2002) is presented in Figure 1:

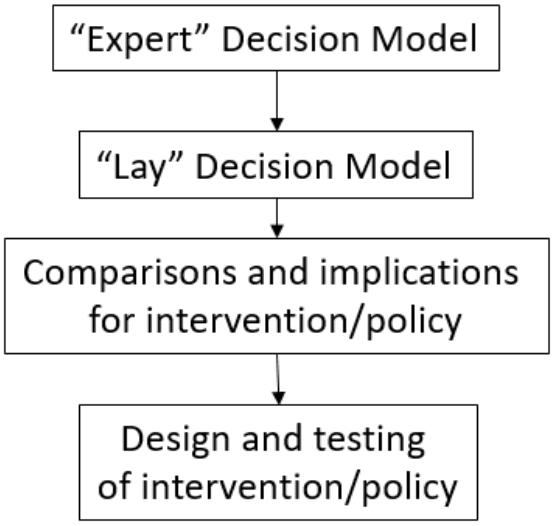

Figure 1: Model for Evidence-Based Risk Communication Development and Evaluation

Such communication begins by systematically creating an "expert" decision model, establishing what information people most need in order to make informed decisions and take effective action, as informed by knowledge held by the expert community. The research then studies

decision makers in order to create a "lay" decision model, describing their beliefs in terms that can be compared to the expert model. The gaps between the two models then become the focus for risk communications. In some cases, the experts have all of the knowledge (Morgan et al 2002). In other cases, different stakeholders are actually "experts" within their own domains and have knowledge that the experts need to know. As an example, emergency response personnel are aware of their own context in which risk information from a pipeline operator may be helpful but is not the only information that they need to consider.

In the Evaluation chapter of the FDA guidebook (Fischhoff et al. 2011), Downs summarizes the 4 options from the literature for gathering the data for these models and comparisons. These options are summarized in Table 2:

Table 2: Methods of Evaluation (Fischhoff et al. 2011)

Method	Description
1. Focus Groups	Open and/or directed conversation in a group setting. Commonly used and understood. Problematic for statistical analyses due to members influencing each other.
2. Usability Testing	Users asked to "think aloud" in order to gain insight to the understanding of a new communication or product.
3. Key Informant Interviews	Open and/or directed discussion about individual experience.
4. Mental Models approach	Uses a mix of semi-structured interviews and confirmatory surveys to compare Lay and Expert models.

While guidance for the content and design comes through these formative evaluation process, there have also been years of research on specific messages and message designs (see Fischhoff et al. 2011 for summaries of this research on issues such as how to present numeric risk information). Once the information content is known, the available methods and designs of the communication must be considered. Downs also emphasizes that the process by which the communication is implemented should be determined in advance, followed, and documented (Fischhoff et al. 2011).

Evaluation of Risk Communications

Following the processes mentioned above, and drawing on the relevant basic research, should help in designing and implementing successful communications. However, assessing the success of communications requires structured outcome evaluations. Communications, like any product, need to be tested (Morgan et al. 2002). The FDA guidebook provides examples of evaluation methods that are suited for budgets of different sizes as summarized in Table 3 (Fischhoff et al. 2011):

Table 3: Evaluation Strategies by Level of Expense

No/Low Expense	Moderate Expense	Substantial Expense
Ask friends, family, coworkers, and staff to review and say what they think. "Think-Aloud" process with convenience sample focused on opinions on: - *comprehension* - *completeness* *-bias* Ask internal experts to review communication Some focus groups Search of public data	Strategies from No/Low Expense category plus: One-on-one structured interviews Transcript/text analysis of interviews and focus groups Some survey approaches Search of harder to find data	Strategies from Moderate Expense category plus: Randomized control experiments Surveys with representative samples and pre/post testing

Evaluation is essential because, as mentioned, intuition cannot be trusted. Communications that are not evidence-based can waste resources and produce an uninformed or misinformed audience. Many of the evaluation methods and design tools presented benefit from expertise in communication and behavioral science, meaning that such experts should be consulted in the design, implementation, and evaluation stages. Evaluations in the Substantial Expense category that are performed correctly provide the most evidence for determining what is successful and what is not.

The overall goal of these different types of evaluations should be to determine whether the communication meets the following requirements (Fischhoff et al. 2011):

1. The communication contains the information needed for effective decision making.

2. The communication connects users to that information.

3. The communication is understood by users.

A communication that is evaluated on these criteria and found wanting in one or more aspects can be improved and reevaluated. Iteration is an important part of this process and another reason why participation and maintaining stakeholder connections are important. A tested communication that succeeds in all three has a better chance to inform decision making and improve risk management.

3. Current Pipeline Safety Risk Communication Requirements and Guidance

As mentioned, PHMSA considers an informed public to be essential to the safety of the pipeline systems it regulates. In the final rule on regulatory requirements for public awareness efforts by pipeline operators, PHMSA OPS states, "Promoting pipeline safety requires enhanced communications by pipeline operators with the public to increase public awareness of pipeline operations and safety issues." The 2002 Pipeline Safety Improvement Act mandated that pipeline operators must carry out public education programs and that the Secretary of Transportation may issue standards prescribing the elements of an effective public education program. The regulatory requirements are codified in 49 CFR 192.616 (for natural gas) and 49 CFR 195.440 (for hazardous liquids), both of which incorporate API RP 1162 (1st ed.) by reference. 49 CFR 192.616 and 49 CFR 195.440 require identical public awareness programs from both gas and liquid pipelines, with the exception that 49 CFR 192.616 contains separate regulations for operators of master meter or petroleum gas systems. API RP 1162 was revised in 2010 but as of yet is not incorporated into the current regulatory requirements.

This section summarizes the stakeholders, goals, and design and evaluation processes laid out in these rules and guidelines, and then discusses how they consistent they are with the best practices discussed in the previous chapter.

Stakeholders and Participation

There are two aspects related to stakeholders and public participation that this section examines: 1) which groups participated in the development of both API RP 1162 and the PHMSA regulations, and 2) who are the target audiences of the risk communication programs mandate by the regulations.

In regards to the first question, the final rule issued by PHMSA OPS in 2005 provides a summary of the outreach and consultation efforts related to promulgation of the current regulations (Pipeline Safety: Pipeline Operator Public Awareness Program, 2005). Federal, state, local government agencies, the pipeline industry (operators and trade organizations), community representatives, environmental organizations, first responders, and members of the public were identified as taking part in formal technical committees and public meetings organized by PHMSA. During the rulemaking process, PHMSA received written comments from pipeline operators, trade associations, third party vendors, members of the public and government agencies and committees. API RP 1162 (1st ed.) was developed with input from pipeline operators, and federal and state regulators (Pipeline Safety: Pipeline Operator Public Awareness Program, 2005). API RP 1162 (2nd ed.) was developed with input from the same groups as well as trade associations and some, "other stakeholders, such as emergency

responders." (API RP 1162 2nd ed.) Though PHMSA indicated early on in the process that API RP 1162 would be considered for inclusion in its rulemaking, members of the public were not explicitly involved in the development of API RP 1162.

In regards to the target audiences for the mandated public awareness programs, the overall statute that authorizes the relevant regulations refers specifically to "municipalities, school districts, businesses, and residents of pipeline facility locations" as those groups which the public awareness programs must advise (Pipeline Safety Improvement Act, 2002). The regulations themselves, 49 CFR 192.616 and 49 CFR 195.440, specifically identify the "public, appropriate government organizations, and persons engaged in excavation related activities". API RP 1162 which is incorporated into the regulations by reference identifies four main audiences:

1. The affected public (including residents, schools, and businesses)
2. State and local emergency response and planning officials
3. Local public officials
4. Excavators

API RP 1162 provides additional guidance in the form of examples of each of the various categories of stakeholders to assist operators in identifying who they need to target with their public awareness programs. API RP 1162 mandates that consideration be given to the different needs and contexts of the various groups and provides different baseline and supplemental risk communications requirements for communication with the different audiences. API RP 1162 combines some subgroups together in its guidance. For example, residents and places of congregation (schools, businesses) are grouped together so that the recommended baseline and supplemental programs for these subgroups are the same.

Discussion

Overall, while the PHMSA rulemaking did include public input, it is unclear how much public input was solicited and used in the formation of API RP 1162. Neither the development of the overall regulation or API RP 1162 appeared to have explicit input from risk communications experts or behavioral science researchers. The FDA risk communication guidelines posit that, "strategic (risk) communication requires deeper organizational commitment" in the form of coordination and input from subject matter experts, risk and decision analysts, behavioral science, and communications experts (Fischhoff et al. 2011). Both the NAS *Public Participation* report (National Research Council 2008) and the earlier NAS *Understanding Risk* (National Research Council 1996) emphasize that agencies should determine how to involve the public early on and throughout their risk identification and communication processes. The inclusion of a broad range of stakeholder voices may be even more important when recommended practice is likely to become a legal requirement as was the case with API RP 1162.

Beyond being necessary for demonstrating compliance with the regulations, delineating different audiences is important in the design and implementation of risk communications. The

API and operators should be cautious though with assuming that subgroups such as residents and stakeholders involved with schools and business are the same. In some contexts such subgroups may well be similar, but in other situations differences between subgroups will require different risk communication strategies and guidance.

Goals of Risk Communications

In the final rule, PMHSA lists a number of goals related to the public awareness education programs: establish communications with affected stakeholders, enhance public awareness of pipelines, communicate stakeholder roles in regards to safety, increase understanding of the important energy transportation role of pipelines, operations, communicate public and environmental risks, improve prevention and mitigation actions, enhance emergency response coordination, reduce ROW encroachments, and improve safety and performance (Pipeline Safety: Pipeline Operator Public Awareness Program, 2005). API RP 1162 includes mention of additional desired results such as building trust and better relationships, reduced resistance to maintenance and ROW activities, improved operator reputation, and increased public understanding of the safety and safety measures of pipelines.

Discussion

The goals summarized above are a mix of both those related to informing the public and those related improving its safety behavior. Most of these goals appear to fall under either Care or Consensus type communications according to Lundgren and McMackin's framework. Most of the language in the regulations and RP implies the Care type communication; that the public just needs to know certain pieces of information or to act in certain way in order to have better pipeline safety. The emphasis is also squarely on pipeline safety in terms of pipeline failures even though some of the stated goals mentioned above could be interpreted to refer to a broader informed decision making related to pipelines. This may create some confusion related to the overall goals. Clarity in the goals is discussed in the literature as important for processes that include public participation as an integral component (National Research Council 2008).

Design and Implementation of Risk Communications

API RP 1162 breaks down the necessary components and processes of the public awareness program in their simplified version as follows:

1. Establish Public Awareness Program Administration with Management Support
2. Identify the Stakeholder Audiences
3. Determine the messages
4. Establish the frequencies
5. Establish the delivery methods
6. Assess the need for program enhancement
7. Implement the program and track progress
8. Evaluate the program and Implement Continuous Improvement
9. Return to 2.

API RP 1162 sets out schedules pertaining to the specific messages, the frequency and the modes of delivery of these messages to different stakeholder groups. These aspects of the communication program are separated into baseline activities and supplemental/enhanced activities. Baseline guidance is that which operators are mandated to follow unless they provide justification for why that it is not necessary or practicable. Supplemental activities are required based on the pipeline operator's consideration of several factors outlined in RP 1162.

The regulations also mandate that specific types of information be provided to identified stakeholder groups. The regulation-mandated programs are expected to include information on:

1. Use of a one-call notification system prior to excavation and other damage prevention activities;

2. Possible hazards associated with unintended releases from a gas/liquid pipeline facility;

3. Physical indications that such a release may have occurred;

4. Steps that should be taken for public safety in the event of a gas/liquid pipeline release; and

5. Procedures for reporting such an event.

These are all messages that relate to potential hazards from existing pipelines only. API RP 1162 specifically states that the guidance is not intended for "public awareness activities appropriate for new pipeline construction or for communications that occur immediately after pipeline-related emergency," even though such activities may help meet some of the broader goals listed above.

Discussion

The way in which the overall program flow is laid out in RP 1162 appears inconsistent with risk communication research. The program flow laid out in RP 1162 does communicate the need for iteration, which is helpful, but, “Assessing the need for program enhancement” for example should come before decisions are made about messages, frequencies, and delivery modes. Best practices based on risk communication research identify what information is needed and salient, which is essential to determining the content, form, and channel of specific messages. Additionally, operators can decide whether to adhere to baseline guidelines or adopt supplemental/enhanced ones. Unless operators have expertise with evidence-based risk communication, then their decisions here may not be supportable. For example, if the operator subscribes to a more ad-hoc theory of risk communication, they may believe supplemental efforts are not needed when they may be.

The specific messages that are mandated by the regulations and guidance to be part of the public awareness program support the categorization of the mandated communication as Care communication. As mentioned the overall goals presented by the regulations and guidance suggest that there are also Consensus communication needs. Confusion between the two goals can limit pipeline operators' understanding that they should start the risk communication design process by systematically listening to their audiences.

The emphasis on and discussion of different frequencies of communication in the guidance suggests an appreciation for the need for continual conversation between pipeline operators. Most of the two-way communication modes though are relegated to supplemental/enhanced status, and there does not appear to be guidance as to how such conversations should go to minimize confusion. Also, relegating two-way conversations to supplemental/enhanced status may exacerbate the general tendency to think of gathering data from the audience as an extra, instead of necessary, step for successful risk communication development.

The reasoning provided for not communicating messages regarding new pipeline construction and during pipeline-related emergencies is that such guidance is highly specific to the location and other factors. While natural gas pipeline operators have additional requirements related to emergency planning[4] , the lack of communications guidance in API RP 1162 appears to leave a gap in the types of information some stakeholders may need to make informed decisions about pipelines.

[4] 49 CFR 192.615(c) requires operators to "establish and maintain liaison with appropriate fire, police, and other public officials"

Evaluation of Risk Communications

The need for evaluation is separated into measuring program implementation and measuring program effectiveness in API RP 1162. The emphasis in evaluation forms such as those provided on PHMSA's website appears to be on implementation.

In API RP 1162, evaluation of effectiveness is divided into 4 outcomes:

1. Percentage of Each Intended Audience Reached with Desired Message
2. Understandability of the content of the message
3. Desired behaviors by the intended Stakeholder audience
4. Achieving bottom-line results.

Discussion

Outcomes 1 and 2 mirror two of the three requirements for the duty to inform presented in the FDA guidebook. Missing is an evaluation of whether the information being communicated helps the audience make informed decisions. Outcomes 3 and 4 may be outside of the scope of risk communication, if they depend upon resources limits and other constraints on behavior. In measuring these outcomes RP 1162 emphasizes the use of focus groups and surveys. There is less mention of more open-ended audience-centered methods like those mentioned in the best practices section in addition to focus groups. As Downs mentions in the FDA guidebook, while focus groups can be useful, "Statistical analyses of focus groups require large samples because the interdependency of what members say requires using groups (rather than individuals) as the unit of analysis." (Fischhoff et al. 2011).

There is little mention of more involved testing of the communications such as controlled experiments or pre-post surveys. Section E.3 of the API RP 1162 which discusses surveys appears to have some errors and lacks discussion of additional methods of evaluation found in the literature. One quick example is that the report mentions the need to sample a, "random number of the target stakeholder audience," when in fact good practice is to try to find a sample that is a certain number of randomly chosen participants. This could be a typo or it could be an indication that rigorous social science experts were not consulted.

In the PHMSA evaluation forms there does not appear to be any criterion given for demonstrating that that communications are adequate, just that they have been tested (and that the program has been implemented and is flexible).

4. Recommendations for Improving Pipeline Risk Communication

Based on the above review, some initial recommendations follow:

Stakeholders and Participation

- Involve risk communication experts and public stakeholder groups in the development and application of future API RP and future regulations. The focus should be on "how" to involve these groups rather than on "whether to" involve these groups (National Research Council, 1996).

Goals of Risk Communication

- Clarify the goals of public awareness programs: when is the goal to improve informed decision making and when is the goal to induce particular behaviors.

- Establish empirical standards for demonstrating success in meeting these goals.

Design and Implementation of Risk Communication

- Incorporate and/or promote procedures for determining what information decision makers need to make informed decisions as the essential first step in communication.

    - At a minimum API RP 1162 process flow for pipeline awareness programs should be clarified and reordered to emphasize the importance of knowing the audience and the audience's context prior to developing communications.

    - A more robust approach would be to incorporate and promote a style of approach to risk communication like that found in Figure 1, such as mental-model analysis, that enshrines the need to understand and compare the audiences' perceptions and contexts with that of the entities charged with risk communication, analyze the gaps between them and design communications to close those gaps.

- Incorporate language into regulations or guidance that emphasizes how strategies like the above, while they may require more resources upfront, result in more efficient and effective communications.

- Incorporate risk communication science into how operators are asked to determine the need for baseline or enhanced/supplemental actions.

- Emphasize two-way communication strategies as important in many baseline as well as enhanced/supplemental programs. Inform pipeline operators not just on the frequency of such interactions, but how to design and implement such interactions to minimize miscommunication.

- As stakeholder mental models can incorporate other aspects of pipeline systems even when the focus is on safety planning, efforts to build guidance for emergency communications and pipeline siting/new construction decisions should be considered.

Evaluation of Risk Communication

- Update self-assessment and PHMSA program evaluations to include additional measures of effectiveness in addition to the current emphasis on implementation.

- Incorporate the three criteria for communication adequacy (does it communicate the needed information for informed decision making, do audiences have access, do audiences understand) as part of the requirements for effectiveness evaluations.

- Expand discussions of effectiveness evaluations in the guidance to include and inform regarding all types of evaluations found in Table 3. Deep discussion should not be limited to focus groups and surveys. Current guidelines regarding these strategies should be reviewed and updated by risk communication and social science experts.

Following these recommendations will lead to regulations and guidance that make pipeline public awareness programs more effective and cost efficient, by spending resources in accordance with existing science and providing feedback for continuous improvement.

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Appendices

A. Summary of historical stages of Risk Communication from Fischhoff 1995.

Table 1.2 Historical stages in risk communication.

One way to think about risk communication is as an evolutionary process in which communicators gradually reach higher levels of understanding about the nature and complexity of their task. Communicators at each stage lack some of the understanding of public concerns that become apparent at later stages.

1. All we have to do is get the numbers right. The simplest communications rely on words rather than deeds. If risks are well managed, or obviously worthwhile, or have no clear substitutes, then no one may ever be interested in hearing about them. Indeed, many risk managers aspire to this status, hoping to do their job well and be left alone. If this strategy works, then time and trouble have been saved by all parties. However, if it fails, then people may ask awkward questions about the long silence. Was something being hidden? Or did the experts just not care?

2. All we have to do is tell them the numbers. The quickest response to the demand for information is to share one's work. As a result, when risk managers discover that they have a public risk perception problem, they may be tempted to present the research that convinced them that the risk was acceptable – in something close to the form in which it was produced. Although there can be something touching and forthright in such a straightforward delivery, it is unlikely to be very effective. Moreover, not understanding the public's perspective may be interpreted as not caring about it.

3. All we have to do is explain what we mean by the numbers. When risk estimates do not speak for themselves, an obvious next step is to explain them. That can be a difficult task with an audience that shares no common vocabulary or conceptual background with the risk experts. For example, a candid disclosure of risk information will include the degree of scientific uncertainty surrounding it. However, accomplishing that task for a specific risk requires a prior understanding of the general nature of scientific inquiry and disputation. Without it, the candid communicator may seem to be evasive, equivocating, or contentious. Furthermore, the numbers alone do not tell the entire story about risks. Often, people need to understand how a risky process works, in order to devise strategies for dealing with it or to feel competent to follow public debate.

4. All we have to do is show them that they've accepted similar risks in the past. Having done their best to get the numbers across, communicators may be frustrated to find that little is resolved.One common expression of their frustration is to argue something like, "the risks of technology *x* [which we promote] are no greater than those of activity *y* [which you already accept], so why not accept *x*?" Although such comparisons can be worth considering, they are no more than suggestive. Acceptability depends on benefits as well as risks. Those who advocate consistency in risk levels too vociferously endanger their own credibility.

5. All we have to do is show them that it's a good deal for them. Considering both risks and benefits in communication means, in effect, adopting recipients' full perspective, because they will have to live with both kinds of consequences. Doing so may lead to changing the activity in question so that it actually provides a better balance of risks and benefits. Explaining benefits encounters difficulties that are analogous to those involved in explaining risks, along with some added twists. For example, logically equivalent ways of presenting the same options can produce systematically different choices (known as "framing effects").

6. All we have to do is treat them nicely. People judge communications by their form and their substance. The form suggests, among other things, how much faith to place in the content and how respectfully the communicator regards them. If people do not feel respected, then they have more reason to suspect that they are not being fully informed. They also have more reason to fear that risks are not being managed on their behalf and that the risk-management process is part of a larger trend to disenfranchise them. Although sympathetic delivery is no guarantee of respect, it does show that one is recognized as a person with feelings (even if those are being manipulated).

7. All we have to do is make them partners. Stages 1 through 6 involve increasing stages of viewing the recipients of the message as individuals with complex concerns. However, the understanding is cultivated in order to get across a message whose content has been determined by the communicator. That means seeing recipients as individuals but not engaging them as such. This stage takes on the public as partners in risk management. It means providing them a seat at the table and allowing them to communicate their own concerns. In effect, it means opening a communication channel in the opposite direction.

Source: Fischhoff (1995).

B. Recommendation Summaries from the National Research Council's *Public participation in environmental assessment and decision making* (2008).

Recommendation 1: Public participation should be fully incorporated into environmental assessment and decision-making processes, and it should be recognized by government agencies and other organizers of the processes as a requisite of effective action, not merely a formal procedural requirement.

Recommendation 2: When government agencies engage in public participation, they should do so with:

1. clarity of purpose,
2. a commitment to use the process to inform their actions,
3. adequate funding and staff,
4. appropriate timing in relation to decisions,
5. a focus on implementation, and
6. a commitment to self-assessment and learning from experience.

Recommendation 3: Agencies undertaking a public participation process should, considering the purposes of the process, design it to address the challenges that arise from particular contexts. Process design should be guided by four principles:

1. inclusiveness of participation,
2. collaborative problem formulation and process design,
3. transparency of the process, and
4. good-faith communication.

Recommendation 4: Environmental assessments and decisions with substantial scientific content should be supported with collaborative, broadly based, integrated, and iterative analytic-deliberative processes, such as those described in *Understanding Risk* and subsequent National Research Council reports. In designing such processes, the responsible agencies can benefit from following five key principles for effectively melding scientific analysis and public participation:

1. ensuring transparency of decision-relevant information andanalysis,
2. paying explicit attention to both facts and values,
3. promoting explicitness about assumptions and uncertainties,
4. including independent review of official analysis and/or engaging in a process of collaborative inquiry with interested and affectedparties, and
5. allowing for iteration

Recommendation 5: Public participation practitioners, working with the responsible agency and the participants, should adopt a best-process regime consisting of four elements:

1. diagnosis of the context,
2. collaborative choice of techniques to meet difficulties expected because of the context,
3. monitoring of the process to see how well it is working, and
4. iteration, including changes in tools and techniques if needed to overcome difficulties.

Recommendation 6: Agencies that involve interested and affected parties in environmental assessments and decision making should invest in social science research to inform their practice and build broader knowledge about public participation. Routine, well-designed evaluation of agency public participation efforts is one of the most important contributions they can make. Because public participation makes a useful test bed for examining basic social science theory and methods, the National Science Foundation should partner with mission agencies in funding such research, following the model of the successful Partnership for Environmental Research of the National Science Foundation and the Environmental Protection Agency.