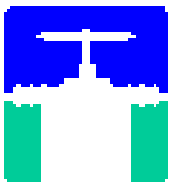

CRITICAL SKILLS FORECAST FOR THE NATURAL GAS TRANSMISSION INDUSTRY

Prepared for The INGAA Foundation, Inc. by:

Interliance Consulting, Inc.
1221 E. Dyer Road, Suite 200
Santa Ana, CA 92705
USA

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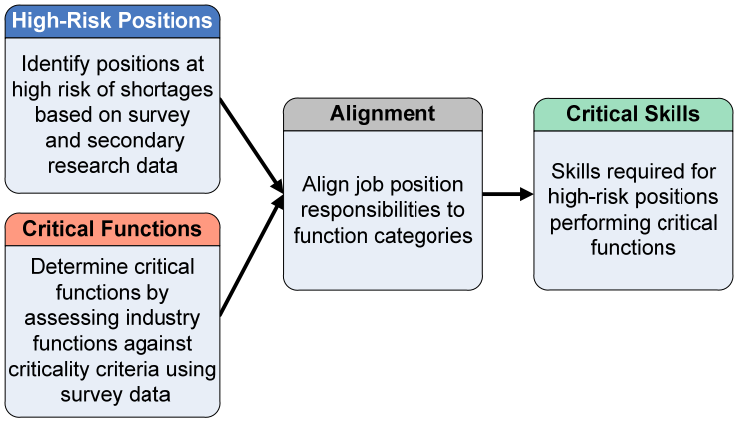
EXECUTIVE SUMMARY

STUDY OVERVIEW

The 2008 INGAA Foundation study, *Critical Skills Forecast for the Natural Gas Transmission Industry*, takes an in-depth look into the positions and functions required in the industry. By identifying positions, skills, and knowledge that may be in short supply and critical functions in the design, construction, operation and maintenance of pipelines, this study locates the largest risk "intersections" of workforce and tasks -- and gives the industry a place to focus efforts to enhance skill development methods and materials for these vital positions.

The figure below illustrates the study methodology for identifying the skills and functions of positions at highest risk for shortages in the industry.



This study is a follow-on to the Foundation's *2007 Securing our Future* study that highlighted overall risks to the natural gas industry if it failed to secure its workforce and knowledge assets. The *2008 Critical Skills Forecast* builds upon the earlier study's overall assessment of the state of the workforce by prioritizing the positions and functions requiring the industry's attention and action.

WORKFORCE SUPPLY FORECAST

In the short-term, the declining economy has eased the competition for new entrants into the workforce. Additionally, retention is not as significant a risk because of delayed retirements and workers' concerns for their job security after changing employers.

In the medium- to long-term, the construction industry, especially non-residential construction, will be the largest competitor for the workforce needed by the natural gas industry. In the past, the manufacturing industry has been a major competitor for skilled trades and engineering. However this is a declining industry in the US and is expected to continue losing employment over the next decade.

The Department of Labor also predicts declining employment for operations positions in the natural gas industry due to mergers and increasing automation. However, the Department of Labor cites retirement attrition without suitable replacement candidates as a major reason for an increase in the industry's use of automation.

Areas of lowest risk are:

- Positions with significant employment in the manufacturing industry, such as machinists, CNC operators, and first-line supervisors.

Areas of moderate to higher risk are:

- Positions in common with the construction industry for the design and construction of natural gas pipelines, facilities, and distribution infrastructure, such as surveyors, entry-level civil engineers and environmental compliance inspectors.
- Operations positions, such as gas controllers, gas compressor and gas pumping station operators.

Areas of greatest risk are:

- Positions that require significant industry experience and would be at risk from a shrinking industry workforce pool due to attrition, such as pipeline integrity engineers, project engineers/managers, and construction managers.

CRITICAL INDUSTRY POSITIONS AND FUNCTIONS

Executives in the industry have found that the recent weakened economy has reduced attrition of the workforce and increased supplies of skilled job applicants. However, these effects are expected to last only until the economy recovers. A larger problem may be created by an unprecedented level of attrition at that time.

This study has determined that the skills and knowledge required for the design and construction job functions are at the highest risk for present and future supply shortages. These high-risk positions are:

- Design and Construction
  - Pipeline Integrity Engineer
  - Architect
  - Civil Engineer
  - Electrical Engineer
- Construction
  - Construction Manager
  - Surveyor, Surveyor Technician, Pipeline Mapper
  - Environmental Compliance Inspector
  - Electrician

Critical functions these positions perform were identified by assessing the functions' business value, use of resources, skill level requirements, and cost for poor performance. The most critical functions identified by respondents are:

- Design
  - Pipeline structural analysis
  - Pipeline design for corrosion control
  - Pipeline design for compliance

  - Design of measurement systems
- Construction
  - Project management
  - Drilling/boring planning and performance
  - Quality inspections for new systems and stations
- Maintenance
  - Pipeline integrity
  - Management of compliance requirements

Industry personnel most often commented that superintendents, construction managers, project managers, and specialized natural gas engineers were difficult positions to hire for three reasons:

1. The industry experience required,
2. The difficulty in transferring knowledge because of the complexity of the job functions and
3. The limited availability of documentation or training materials.

RISKS TO INDUSTRY CAPABILITY

Complacency now can have significant impacts in the medium to long term:

- Although retention is not a significant concern today, the companies that ignore the risk factors for attrition (e.g., employee satisfaction, compensation benchmarking, and career development) will be at greater risk as the economy recovers.
- The expected bubble in retirement and non-retirement attrition poses a risk for draining skills and knowledge from companies that are not maintaining effective skill development and knowledge management practices.
- At the highest risk of supply shortages are specialized areas of the industry with limited numbers of practitioners and limited external training resources, such as: pipeline integrity engineers, reservoir engineers, project engineers/managers, and construction managers

Relying on previous practices may not be sufficient:

- The natural gas industry has relied on employees growing through the ranks to obtain expertise in design and construction.
- Increasing the speed and quality of skill development will be required to avoid unfilled positions or the costs of poor job performance in case of a bubble of deferred attrition and increasing competition from the construction or electric power generation industries.

RECOMMENDED ACTIONS FOR MEMBER COMPANIES

Identify and manage key skills and knowledge in critical positions that are at risk from attrition.

Look to those employees who have key skills and knowledge to ensure those talents are captured and perpetuated within the company. Each company should begin the evaluation process today to make sure they own the necessary knowledge that will allow them to succeed.

Develop a plan for managing expected and unexpected future attrition levels.

Continue activities that increase employee satisfaction and engagement. Consider methods of delaying retirements that can be quickly implemented if attrition exceeds the planned level.

Develop a median and a worst-case attrition model for workforce planning. Determine the likely level of attrition by year over the next five years. Also determine the worst-case attrition scenario where all eligible employees retire in a group and non-retirement attrition doubles from the historical attrition level.

Assess the present capability to bring on board and train in sufficient quantities the likely number of employees who will retire or change companies after the economy recovers. Put in place plans to meet expected attrition levels. Also, develop contingency plans for reducing attrition, improving skill development capability and effectiveness, managing headcount requirements (e.g., maintenance service from equipment manufacturers, overtime) and managing demand (e.g., flexible project schedules, subcontracting), to guard against the worst case where the in-house ability to recruit, retain or develop falls short of requirements.

RECOMMENDED ACTIONS FOR INGAA FOUNDATION

Develop materials and methods to quickly increase the industry's pool of employees with critical skills.

The present method of hiring experienced employees is not sustainable in light of expected industry growth and current demographics. To ensure industry-specific skills and knowledge are readily available for the development of new employees, the industry should collaborate on detailed specifications for skills and knowledge required for key positions with expected future shortages.

From the specifications, capture the knowledge from experts and develop training materials. Consider existing materials, the desired training lead-time, and the type of information or skills. The complex nature of these positions may require innovative training methods, such as tactical decision games or simulations in addition to the standard methods of process or procedure documentation.

Collaborate with local or national educational institutions to convey the industry's needs for critical positions.

Expand efforts to collaborate with specific institutes or organizations to ensure both the institutions and students understand the benefits of a career in the natural gas industry.

CONCLUSION

Now is the time for an investment in workforce planning, knowledge management and skill development.

There may not be enough time to react after the attrition bubble to develop and implement plans that will avoid the consequences of lost knowledge, excessive training lead-time and increasing attrition and compensation as companies work to maintain a competent workforce with a diminishing industry workforce pool.

INTRODUCTION

STUDY OVERVIEW

The *Critical Skills Forecast for the Natural Gas Transmission Industry* study identified critical skills that are in short supply today, and those that may be at risk in the future for the industry's technical workforce. The project combined a functional analysis of the technical workforce's responsibilities with the industry's forecasts for the applicable job classifications. A criticality assessment identified key functions and positions, which in turn were used to identify the critical skills.

CRITICAL SKILLS PROJECT STEERING COMMITTEE MEMBERS

- Nathan Ames, Edison Welding Institute, Inc.
- Lisa Beal, The INGAA Foundation
- Sharon Bergeon, Interliance Consulting, Inc.
- David Boulet, Bayou Companies
- Morris Brassfield, Southern Union Company
- Dwayne Burton, Kinder Morgan, Inc.
- Sam L. Clowney, Clean Air Consultant, Inc.
- S. Dhamotharan, URS Corporation
- Chad Fletcher, Dresser Rand Group Inc.
- Walt Ford, Interliance Consulting, Inc.
- Bill Hermstedt , Chesapeake Utilities Corporation
- Dany Jew, Mustang Engineering, L.P.
- Brad Kamph, Interliance Consulting, Inc.
- Flo Kellogg, Gas Technology Institute
- Mike Kress, The Bayou Companies (In memoriam)
- Chae Laird, Ph.D, AECOM Environment
- Kent Lamb, Pacific Gas and Electric Company
- Brian Leary, Pacific Gas and Electric Company
- Edmund Lunde, Alliance Wood Group Engineering L.P.
- Kim McCaig, Canadian Energy Pipeline Association
- Debbie Ristig, CenterPoint Energy Pipeline Services
- Gregory J. Rizzo, Spectra Energy
- Christina Sames, American Gas Association
- Marie Seath, Mears Group, Inc.

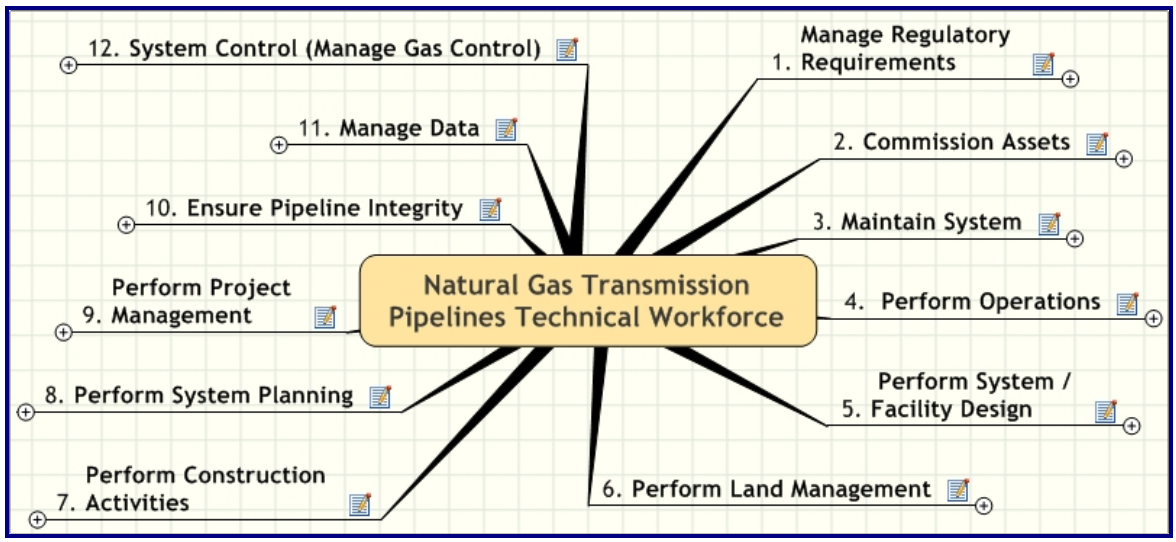
- Gary L. Sypolt, Dominion Transmission, Inc.
- Kate A. Szilagyi, The INGAA Foundation
- Lori Traweek, American Gas Association
- Jon Wrathall, TransCanada
- L. Diane Young, Spectra Energy Transmission

STUDY METHODOLOGY

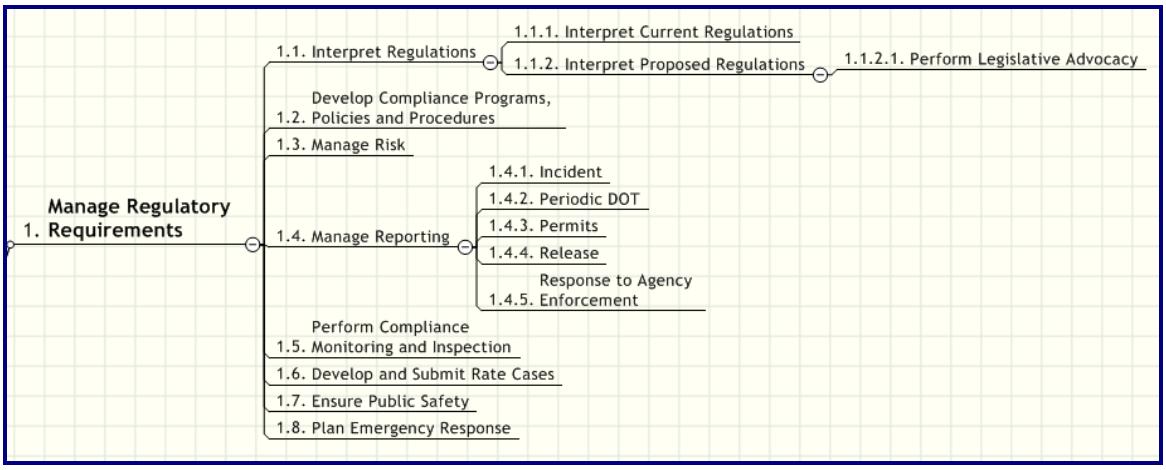
The study approach was to define, analyze and align the functions and job classifications required in the industry. The critical functions and high-risk job positions were identified from the overall list of industry requirements. The first project step was to define the industry in terms of functions and positions.

FUNCTION MODEL

The industry function model was developed through a collaborative effort by members of the steering team and other industry subject matter experts. This team defined the tasks performed by the industry's technical workforce. Functions are the key activities performed by the organization to achieve its objectives. Employees use their knowledge and skills to accomplish a function. The top-level function map is shown below with the 12 high-level function categories.



Each function category is accompanied by its functions and sub-functions. For example, the category “Manage Regulatory Requirements” has functions 1.1 through 1.8, and their sub-functions that define the main function. This example is shown in the following diagram.



A total of 487 function categories, functions and sub-functions were defined. The entire function model and function definitions are presented in *Appendix G - Industry Function Model*.

TECHNICAL POSITIONS

The job classifications were defined for the technical workforce in the transmission segment of the natural gas industry that is responsible for design, construction, operation and maintenance of pipelines. The major job categories are:

- Engineering, Architecture and Computer Science
- Management
- Operations
- Skilled Trades
- Quality Control, Regulatory, and Compliance
- Labor

Each job classification has associated job responsibilities, alternative job titles, and standard occupational codes (SOC). Some job titles in the natural gas industry do not have designated SOC numbers. When this occurs, SOC numbers are assigned using a base SOC from a similar job classification with a .9x suffix. A sample job position for a standard code is shown below.

3.1.1 GAS COMPRESSOR OR GAS PUMPING STATION OPERATOR

Job Responsibilities: Distribute or process gas for utility companies and others by controlling compressors to maintain specified pressures on main pipelines. Operate steam, gas, electric motor, or internal combustion engine driven compressors. Transmit, compress, or recover gases, such as butane, nitrogen, hydrogen, and natural gas.

Alternate Job Titles: Compressor Station Operator, Engine Room Operator, Gas System Operator, Bulk Plant Operator, Gas Compressor Operator, Gas Processing Compressor Operator, Gauger, Panel Operator, Tank Farm/ Terminal Operator

SOC Code: 53-7071.00

The industry positions are presented in *Appendix F - Industry Technical Job Positions*. After the functions and positions were defined, the next step was to gather data from members of the industry and secondary data sources.

EXECUTIVE INTERVIEWS

Executive interviews were conducted over the phone, from November 2008 through January 2009, with representative companies in the areas of pipelines, construction, consulting and other services. Comments were edited only for brevity, clarity, and to retain anonymity without changing the tone or meaning. Some major themes in the executive interviews were:

- People are more hesitant to leave due to uncertainties. Voluntary retention is better now.
- Resource shortages still exist for key positions and skills. Some companies are aggressively looking for talent.
- Many companies are taking this opportunity to enhance performance.
- Workforce is impacted by project delays inside and outside the industry.
- Salary and other compensation are becoming more reasonable than in the recent past.

More details from these interviews can be found in *Appendix A - Executive Interviews*.

HUMAN RESOURCES AND TECHNICAL AND MANAGEMENT SURVEYS

Two surveys were developed to gather information from managers in the natural gas transmission industry. The surveys were completed online and by paper submissions by a total of 30 participants in October through December of 2008, with respondents from these areas:

- Pipeline – 14 respondents
- Pipeline services – 4 respondents
- Construction, manufacturing, consulting and other services – 12 respondents

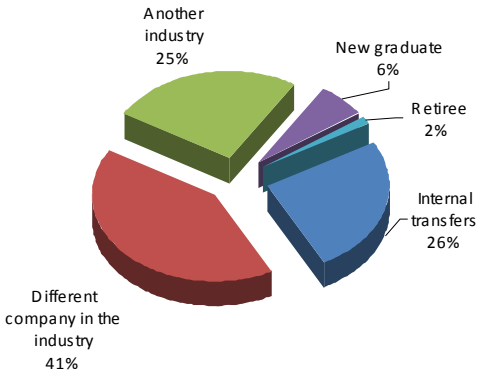
The surveys and responses can be found in *Appendix B - Human Resources Survey Results* and *Appendix C - Technical and Management Survey Results*. Some key findings were:

Recruitment is still difficult for some positions, especially when industry experience is required.

- Seventy-one percent of respondents do not expect supply shortages to abate in the near future for key positions, such as:
  - Engineers
    - Mechanical engineer
    - Electrical engineer
    - Specialists in natural gas or pipelines:
      - Pipeline integrity engineer
      - Corrosion engineer
      - Reservoir engineer
      - Petroleum engineer

  - Skilled Trades
    - Electrician, electrical engineering/electronics technician
    - Automation and control system programmer
    - Welders
  - Quality inspectors, compliance specialists
  - Natural gas trader
  - Project managers, construction managers
  - Operators, pipeline technicians

- When asked about skills that that are difficult to find in new candidates, industry experience for managers was the most frequent comment. However, the desire for industry experience was mentioned in every job category.
- New-hire candidates come from other companies in the industry 41% of the time, compared to 6% for new graduates.



Most HR professionals expect increasing attrition, and a stable or increasing workforce.

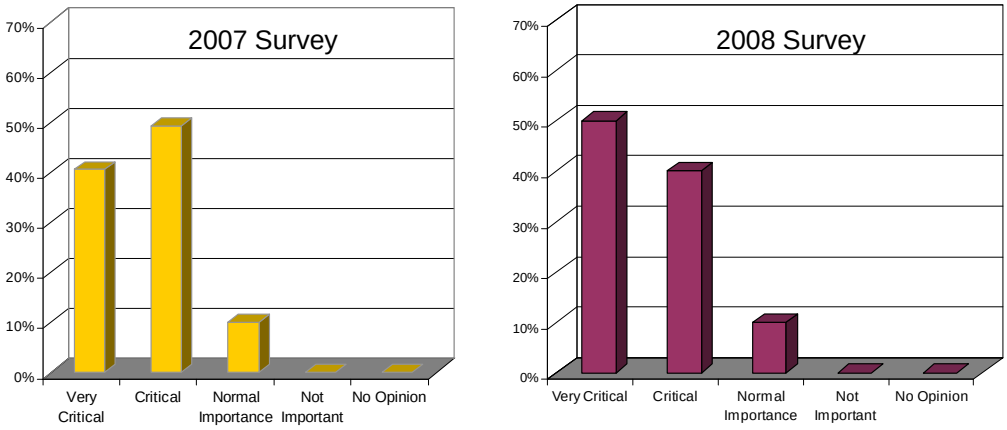
- Just 5% of HR or Technical respondents expect their companies to decrease the technical workforce in the short-term, and no respondents expect employment decreases in the medium timeframe.
- Seventy-eight percent of HR respondents expect an increase in attrition, 11% expect no change, and 11% expect a decrease over the next five years. In the recent past, Operations has had the most retirement attrition, followed by the Engineering, Architecture and Computer Science category, which also had the most non-retirement attrition.
- Technology may not help reduce the required manpower to compensate for expected attrition. Based on recent experience, over half of respondents report that increased technology has not reduced the size of the workforce. Forty percent of respondents report that increased technology makes recruitment and/or retention more difficult due to the requirement for more advanced technical skills.

Costs of skill development are significant for new-hires who do not meet baseline skill requirements. Some companies are choosing informal knowledge transfer.

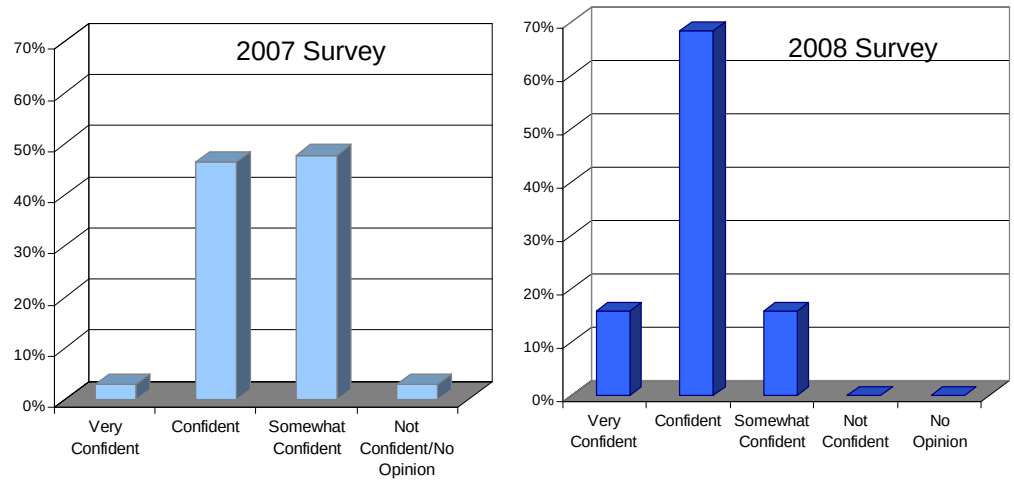
- Training new-hires who do not meet baseline skill development averages $45,000 and requires one year.
- Survey respondents' comments about difficulties in transferring knowledge in the recent past:
  - Field operations – "We recognized the need for a longer overlap time between the people retiring and their replacements. We are hiring more proactively in anticipation of future retirements to address this."
  - Mechanical Engineering – "Improved channels for developing and mentoring entry-level employees have been developed."
  - Superintendents – "We have started hiring foremen to work with the superintendents so we can train them to be superintendents in the future."

Respondents feel that workforce has become more important since the 2007 study, but are also more confident in their ability to retain their workforce and knowledge.

How do you rate safeguarding your workforce and knowledge assets?



Will your company be able to successfully maintain your workforce and knowledge assets?

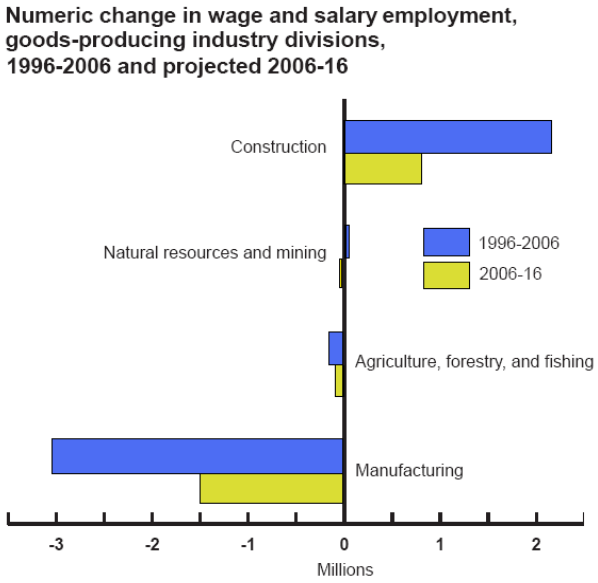


SECONDARY RESEARCH

The prosperity of other industries and their subsequent workforce needs directly impact the natural gas industry's workforce. New graduates or experienced industry employees may be drawn to other industries with strong growth forecasts. While individual companies may have had success hiring from within the existing natural gas industry employee pool, even they will feel the impact if the pool of experienced workers declines due to retirements or attrition out of the industry.

The smaller natural gas industry will be affected by trends in the larger industries.

The two largest industries that have common workforce needs with the natural gas industry are the construction industry and the manufacturing industry; a smaller factor is the electric power industry. Overall, government forecasts are expecting the manufacturing industry to continue to reduce employment, and the construction industry and electric power industry to continue their growth during the period from 2006 through 2016. The expected long-term changes in employment are shown for selected industries in the following chart.

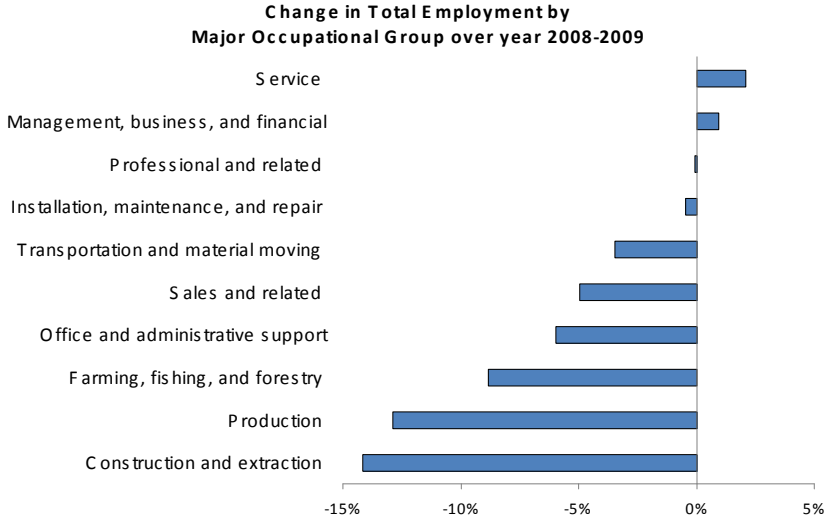


The effect is that many construction-related job positions (e.g., civil engineer, architect, construction manager and surveyor) will increase their total employment over the next decade. Job positions that have significant manufacturing employment (e.g., quality inspector, first-line supervisor and machinist) will continue to have declining employment. Some workers who are employed by both industries (e.g., welder, purchasing manager, and industrial machinery mechanic) are expected to have little change in total employment.

Specific to the natural gas industry, the Department of Labor predicts declining employment for operations job positions (e.g., gas control operator and gas pumping station operator) due to mergers and continuing efficiency improvements such as automation.

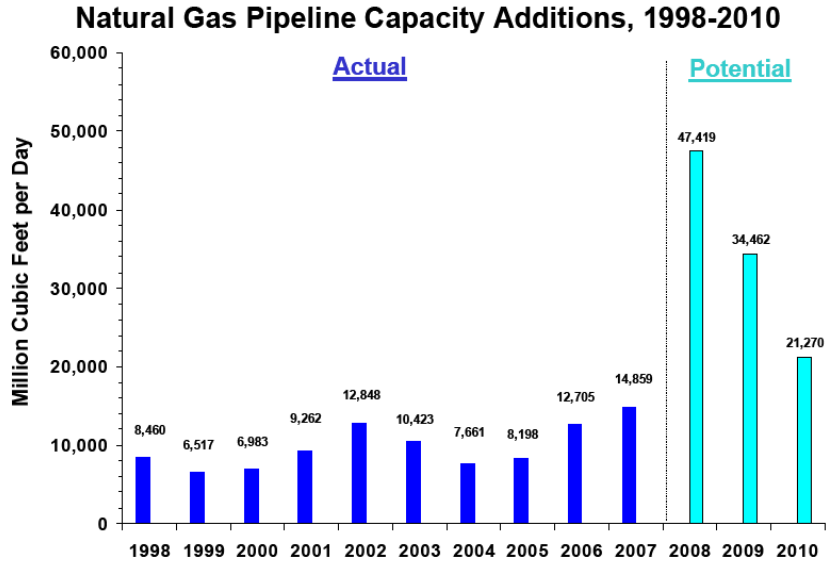
So far during this recession, the change in employment generally follows the trend expected by the Department of Labor for forecasted industry growth. That is, the industries expected to grow over the forecasted period have shown the least declines in employment over the last year as the

economy weakened. Construction showed the greatest deviation from this trend, possibly because of the fall in housing prices and reduced residential construction. The Department of Labor forecasts for the construction industry should be more accurate in the long-term, and may be positively impacted by the current government economic stimulus package. The recent changes in employment are shown by selected industries in the following chart.



Construction activities within the industry are forecasted to be strong for several years.

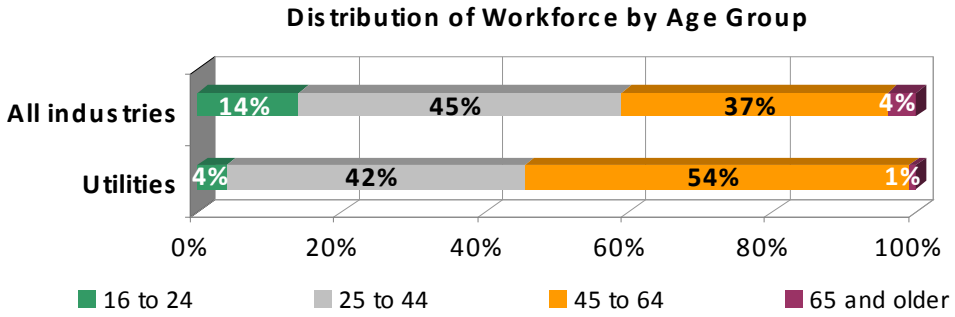
The short- to medium-term demand is expected to remain high for construction positions in the industry for completion of projects already underway. A study by the US Energy Information Administration published in 2008 analyzed the industry's projects by the capacity of natural gas pipeline completed and proposed. The study predicts that pipeline construction activity will be substantial, compared to historical levels, through at least 2010.



Note: Only projects under construction or approved that were judged to have the most likelihood of being completed in 2008 were included in 2008.
Source: Energy Information Administration, GasTran Natural Gas Transportation Information System, Natural Gas Pipeline Projects Database, as of May 2008.

Hiring employees with experience is expected to become more difficult.

A common theme in the responses to the online surveys of industry personnel was the difficulty finding appropriate job applicants with experience in the natural gas industry. Clearly, companies prefer to hire from within the industry and avoid the expense and time delays associated with orienting workers to the natural gas industry. However, expected attrition will reduce the potential pool of experienced employees. The following chart compares the age distribution of the utility industry workforce with the distribution for all industries in the US.



Data from this study and the *2007 Securing our Future* study shows that there is significant attrition out of the industry attributed to both non-retirement and retirement factors. Data from this year's surveys as well as numerous studies referenced in the secondary research indicate that the natural gas transmission industry and workforce are forecasted to grow in the next decade. The *Pipeline and Gas Journal* reports there are many projects planned for the near future and there is growing demand for clean fuels from domestic sources and a still-increasing US and world population requiring those fuels. The US Energy Information Administration forecasts natural gas prices will rise again as the world economy recovers. The increasing natural gas workforce will therefore need to attract new workers from other industries or employ more entry-level employees.

A full discussion of the secondary research findings along with Department of Labor forecasts by position are presented in *Appendix E - Secondary Research*.

CRITICAL FUNCTIONS

Two assessment tools were used to determine function criticality. The first was a detailed criticality assessment, and the second was a summary criticality assessment. The detailed criticality assessment used a spreadsheet that presented the 487 function categories, functions and sub-functions identified by the project steering committee and industry subject matter experts. Respondents were asked to assess the functions' relative criticality to the industry. The criticality was made up of twelve measures, grouped into operational impact and cost of quality.

- The Operational impact of the functions is measured in these terms:
  - Resources and manpower is the proportion of the company business that is involved in completing the function in terms of manpower, equipment, budget and capital.

  - Business value is the amount of value derived from performing this function, including expected revenue and profit, as well as whether this is a core function or a function that should be discontinued.
  - Knowledge required assesses the level of knowledge required to perform this function, and the difficulty and time involved in developing competence in this function. Respondents were asked to consider the level of documentation available, the skill and experience required, whether required knowledge tacit or explicit, and the availability of external training resources.

- The Cost of quality assesses the severity of errors resulting from the poor performance of a function. The most severe errors will be most likely to occur, difficult to detect, and costly to correct. This is measured in terms of:
  - Likelihood of error assesses the probability of making an error when performing this function.
  - Likelihood of early detection is the probability that any errors will be detected in time to avoid potential costs.
  - Cost of failure is assessed in terms of risk to assets, correction cost, delays, goodwill, legal, regulatory, and contractual, and health, safety and environmental impact of undetected errors.

Two pipeline companies, one consulting firm, and one distribution utility assessed the criticality of functions in the industry. The following table shows the overall criticality assessments by company type and function category, with the critical functions highlighted in yellow.

Function Category	Consulting	Distribution Utility	Pipeline
Manage Regulatory Requirements			
Commission Assets			
Maintain System			
Perform Operations			
Perform System / Facility Design			
Perform Land Management			
Perform Construction Activities			
System/Business Planning			
Project Management			
Ensure Pipeline Integrity			
Control Maps, Drawings, Databases			
Manage Gas Control (SCADA) Data			

Very High	High	Moderate	Low	Very Low

The most critical functions were rated as "very high" by at least one company type:

- System and facility design
- Construction
- Project management
- Pipeline integrity

The entire criticality assessment is in *Appendix D - Criticality Assessment*.

CRITICAL JOB POSITIONS

Eighty-nine industry positions were identified in six job categories for the technical workforce. The job categories along with their job descriptions and alternative titles are presented in the *Appendix F - Industry Technical Job Positions* document. The critical positions were identified using information from:

- Human Resources and Technical and Management survey data
- Department of Labor employment forecasts and analysis reports
- Monster.com indices of posted on-line job openings
- Manpower's *Employment Outlook Survey*

The following table shows the main job categories and percent of the technical workforce in each category, excluding unskilled labor, based on data from the Human Resources Survey and the overall risk assessment.

Job Position Category	Percentage of Workforce		Risk
	Pipeline	Services, Construction and Other	
1. Engineering, Architecture and Computer Science	**16%**	**53%**	
2. Management	**6%**	**8%**	
3. Operations	**59%**	**8%**	
4. Skilled Trades	**15%**	**13%**	
5. Quality Control, Regulatory, and Compliance	**4%**	**18%**	

The full job position listing contains 89 main job titles along with their alternative titles. Of these, 41 were selected as representative of the full set. For instance, pipe layer, pipefitter, plumber and pipeliner were grouped into one job category.

The risk assessments were based on:

- Difficulty in recruitment based on the percentage of Human Resources respondents indicating that this job position was difficult to fill, or that skills relating to this position were scarce in their applicants.
- Percent of workforce is the proportion of the category, and of the total technical workforce that this job position comprises.
- Skill availability was taken from the survey comments section where, for each category, respondents were asked to list positions which had limited availability of required skills.
- Overall expected supply and demand from Department of Labor forecasts and information from commercial recruitment companies.

The assessments identified the high-risk job positions as:

- Pipeline Integrity Engineer
- Electrical Engineer
- Civil Engineer
- Architect
- Construction Manager
- Surveyor, Surveyor Technician, Pipeline Mapper
- Electrician
- Environmental Compliance Inspector

ALIGNMENT OF FUNCTIONS AND POSITIONS

The relationship of function categories to job positions is shown in the alignment matrix in the *Appendix D - Criticality Assessment*. The intersections of high-risk positions and critical functions identify areas were critical skills may be located. The critical skills identification was based on the function criticality from the survey data.

CRITICAL SKILLS

The critical skills at highest risk in the industry are:

- Project management performed by construction managers, civil engineers, pipeline integrity engineers, or electrical engineers.
- Pipeline structural analysis and design for corrosion control performed by pipeline integrity engineers or civil engineers with assistance from construction managers.
- Pipeline design for compliance performed by pipeline integrity engineers with assistance from environmental compliance inspectors.

- Design of measurement and communication systems performed by electrical engineers.
- Pipeline integrity planning for maintenance, regulatory compliance, risk management and threat identification performed by pipeline integrity engineers with assistance from environmental compliance inspectors and operations managers.
- Drilling/boring planning and performance performed by civil engineers and managed by construction managers with input from environmental compliance inspectors and surveyors.
- Quality inspections for new systems and stations managed by construction managers or civil engineers.
- Management of compliance requirements during construction performed by construction managers with input from environmental compliance inspectors.

CONCLUSIONS

External competition and internal attrition are the most significant risks to the industry's workforce.

- Positions at lowest risk have significant employment in the manufacturing industry.
- Positions at moderate to high risk are those in common with the construction industry and the operations positions that are expected to experience higher retirement attrition.
- Of particular risk are specialized areas of the industry with limited numbers of practitioners – pipeline integrity engineers, reservoir engineers, project engineers/managers, and construction managers – that also have limited external training resources and require significant industry experience and are therefore particularly susceptible to retirement and non-retirement attrition.

Complacency now can have a significant impact in the medium- and long-term.

- Resource shortages still exist for key positions and skills. Some companies are still aggressively looking for talent.
- Although retention is not a risk factor today, the companies that ignore the deterrents to attrition (e.g., employee satisfaction, compensation benchmarking, and career development) will be at greater risk as the economy recovers.
- The expected bubble in retirement and non-retirement attrition poses a risk for draining skills and knowledge from companies that are not maintaining effective skill development and knowledge management practices.

Previous practices may not be sufficient to maintain and develop skills in the face of potentially historic levels of attrition.

- Many companies in the industry rely on informal employee development. That is, employees gain skills through years of experience instead of structured development plans.
- Without fast and effective skill development, companies may face unfilled positions or the costs of poor job performance quality.

RECOMMENDATIONS

Member companies should take advantage of this lull in attrition and use their Human Resources capacity to do two things:

1. Develop a robust workforce plan.
2. Capture knowledge at risk from attrition.

The workforce plan should include:

- An assessment of present capability to recruit, bring on board and train new employees in sufficient quantities to replace those likely to retire or change companies after the economy recovers, and new employees required for planned company growth.
- Contingency plans in case in-house capabilities fall short of requirements.
- Activities that reduce non-retirement attrition by increasing employee satisfaction and engagement.

The knowledge capture should target key skills and knowledge in critical positions that merit increased knowledge management.

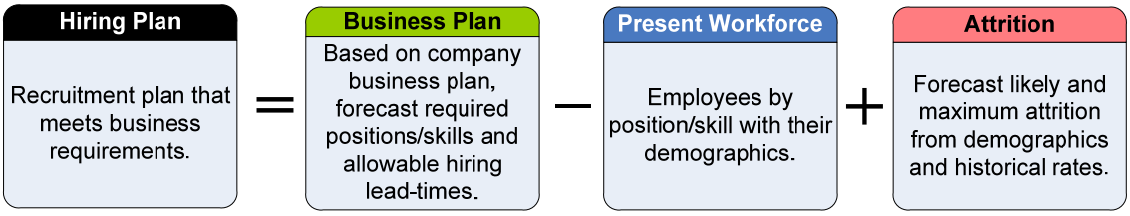
The INGAA Foundation (or an industry collaboration) should continue its existing workforce efforts and create skill development methods that can quickly enlarge the pool of experienced employees. Specifically:

- Communicate with local or national educational institutions to convey the industry's needs for critical skills and positions. Also, continue and expand efforts to collaborate with specific institutes or organizations to make sure both the institutions and students understand the benefits of all careers in the natural gas industry.
- Continue to investigate and communicate the state of the industry’s workforce, along with the workforce risks and corresponding recommendations. This study, along with the 2007 *Securing our Future* study, raised the awareness of the potential impact that workforce issues can have on the industry and helped focus industry and member company efforts to develop action plans for mitigating the potential risks.
- Ensure industry-specific skills and knowledge are readily available for the development of new employees. The industry should collaborate on a detailed specification of knowledge requirements, and develop learning tools for key positions with expected future shortages. This will minimize the present need to hire experienced employees that is not sustainable in light of expected industry growth and present industry demographics.

The next steps for implementing these recommendations are discussed in more detail in the next two sections of this report.

MEMBER COMPANIES

Workforce Planning



Each company should begin with the development of a hiring plan. If the hiring plan exceeds present capabilities, companies will need to increase capability and/or develop contingency plans.

1. Examine the present workforce by position (or position category or skill type).
   - Number of employees with their ages and years of service.
   - Expected retirement dates by surveying employees, or using demographic data with historical retirement profiles. For example, if historically operations employees retire at an average age of 61 with 26 years of experience, assume present employees will retire when they reach this age and experience, or reach a maximum retirement age.
   - Earliest retirement date that allows employees to retire with retirement benefits, although they may be partial benefits depending on each company's pension rules.
   - Historical non-retirement attrition rates by position category or for the overall company.
   - Lead-times for recruitment of replacement positions that may include formal new-hire training, informal on-the-job training, and expected recruitment time. For recruitment time, consider that positions that are projected to be in short supply may take longer to fill in the future. The allowable lead-times may also be constrained by budget limitations. Shorter lead-times will reduce headcount costs, but will also increase the risk of unfilled positions or partially skilled employees.

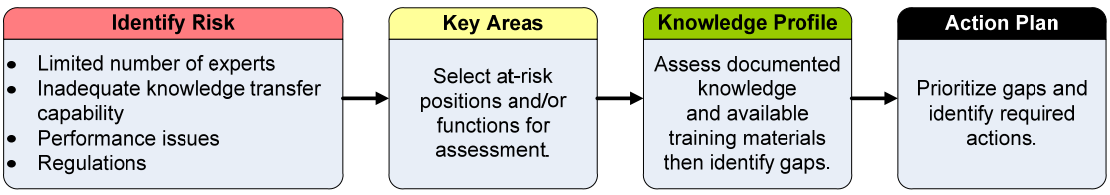
2. Model the recruitment requirements.
   - Headcount requirements by position for at least each of the next five years by month or quarter year, using estimates as required. Consider effects of changing technology, infrastructure, regulatory requirements, customer requirements and other impacts on the number and type of positions required to meet company objectives.
   - Projected hiring requirements based on expected retirement dates and historical non-retirement attrition.
   - Maximum hiring requirements based on earliest retirement dates and two times historical non-retirement attrition for companies with stable attrition rates and three times the historical rate for companies with variable non-retirement attrition.

3. Evaluate present capabilities to meet the model requirements.
   - Recruitment ability considering positions that are at risk of supply shortages may require longer recruitment lead-times or more recruitment resources.
   - Training capacity for formal or informal new-hire training and orientation.
   - Experienced employees available for job-shadowing, mentoring, or other on-the-job training.
   - Other constraints such as physical space, headcount limitations, and budget considerations.

4. Plan and implement actions to meet projected headcount requirements, and develop contingency plans that can quickly be implemented to meet maximum hiring requirements. Some of the possible actions are:
   - Attrition can be reduced by establishing or enhancing existing incentives for employees to remain with the company. Also, companies should benchmark and equalize compensation, as budgets allow.
   - Recruitment goals can be reached by reducing baseline skill requirements (will impact skill development), adding internal recruitment resources, contracting recruitment services, and increasing hiring bonuses and/or compensation.
   - Skill development capability can be increased by collaboration with local educational institutes, contracting training services, raising the baseline new-hire skill requirements (will impact recruitment), or increasing the effectiveness of training to condense duration or reduce trainer requirements.
   - Headcount requirements or Demand can be managed by enhancing performance to increase productivity, utilizing automation and other technology, hiring contractors or temporary employees, implementing overtime, negotiating flexible delivery schedules and subcontracting work.

Companies may want to review roadmaps from the *2007 Securing Our Future* report that discuss many of these recommended company actions for recruitment, development and retention of the workforce.

Knowledge Management



Implement a knowledge management action plan after identifying key skills and knowledge at risk from attrition, or required for knowledge transfer for novice employees.

1. Use the information from the Workforce Planning activity to identify key areas for investigation that have some or more of the characteristics that would indicate the need for knowledge capture or transfer:
   - Attrition risk for skill loss in areas with limited number of experts or experts approaching retirement eligibility.
   - Ineffective training materials or methods for skills and knowledge that at present require more time than is desired, or require more resources (e.g., must be taught by orally because written documentation does not exist).
   - Changes in hiring requirements that will make present methods of skill development insufficient to meet the demand.

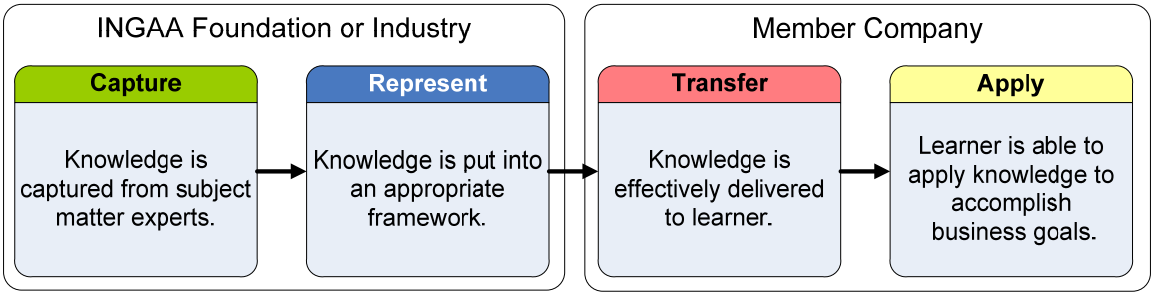
2. Consider other performance factors and requirements.
   - Non-uniform practices that result in employees performing the same functions using different methods and/or producing different levels of quality.
   - Regulations for processes and procedures and/or training methods that require additional documentation.

3. Evaluate the present knowledge management and identify gaps or weaknesses. Consider the two types of knowledge that must be managed.
   - Explicit knowledge is the type of knowledge that can be documented via processes, procedures, work aides, etc.
   - Tacit knowledge is the knowledge that has been gained through personal experience, and is not found in books, procedures, reference materials, etc. This includes:
     - Information that is known but difficult to document.
     - Pragmatic and situation-specific information.
     - Progressive problem solving and complex decision making.

4. Prioritize functions or skills based on risks and business requirements, and implement action plan.
   - For explicit knowledge, companies should ensure their specific processes and procedures, references, etc., are properly developed and maintained while the subject matter experts are still available.
   - Tacit knowledge that is more difficult to transfer, and may require one ore more of the following methods:
     - Job shadowing, mentoring programs, formal on-the-job-training.
     - Scenario-based learning.
     - Targeted job assignments that provide individual with opportunities for problem identification, problem solving and innovation.

INGAA FOUNDATION

Skill Development for Complex Positions



Develop methods and materials to increase knowledge transfer for key positions or critical skills that currently require extensive experience.

1. Select a position (or critical skills within the position) with expected future shortages, such as:
   - Project manager, construction manager, supervisor or foreman
   - Architect or civil engineer
   - Pipeline integrity engineer or other natural gas specific engineer
   - Surveyor or pipeline mapper
2. Select subject matter experts for elicitation of information.
3. Represent knowledge in the appropriate form, such as:
   - Process and procedure documentation or other job aides (e.g., reference tables, checklists, or story boards)
   - Best practices, case studies or lessons learned
   - Tactical decision games, simulations or decision-support tools
4. Determine appropriate training and skill development methods and subsequent assessments. Consider existing training materials, the desired training lead-time, and available training resources. Establish training guidelines for use with new training materials developed in step 3.
5. Distribute materials and guidelines to member/industry companies.

SUMMARY

The 2007 study revealed that the natural gas industry often overlooks investment in its workforce, whether it is retention, enhanced development methods or knowledge management. Few managers reported even having the time or resources to plan for their workforce needs. To meet their requirements, companies relied on quickly filling vacancies with more recruitment resources, hiring experienced employees whenever possible, and trying to reduce the required training time.

Since then, the downturn in the economy has resulted in reduced attrition and a reduced need for large recruitment efforts. Now, both executives and managers report much more confidence in their ability to maintain the workforce, while also reporting that workforce has become more critical to their companies.

The ease of hiring and retention, however, are not expected to continue in the long-term, and may not even continue in the medium-term. In fact, when the economy picks up, along with natural gas prices, there may be a surge in attrition coupled with a surge in workforce requirements for the industry. All companies that took the Human Resources and Technical and Management surveys reported plans to increase their workforce in the medium-term. Meanwhile, the Department of Labor forecasts that the operations portion of the industry will be forced to shrink due to the lack of replacements for impending retirement attrition. Therefore, the industry should be very concerned and take action to secure the next generation of skilled workers.

Following this study's recommendations will pay large dividends in the future by allowing companies to:

- Forecast their workforce needs far enough in advance to allow lead-time for implementing their carefully considered plans.
- Maintain their critical knowledge even with losses of company experts.
- Develop methods for skill development in complex positions that reduce the need to hire employees with extensive industry experience.
- Continue to educate the industry, educational institutions and the public about the impending workforce needs of this attractive industry.

Now is the time for investing in the workforce planning, knowledge management and skill development that will ensure the future of the natural gas industry's workforce.

APPENDIX A - EXECUTIVE INTERVIEWS

INTRODUCTION

This document summarizes the executive interviews for the Critical Skills Forecast for the Natural Gas Transmission Industry project. Interviews were conducted over the phone, from November 2008 through January 2009, with eight representative companies in the areas of pipelines, construction, consulting and other services. Comments were edited only for brevity, clarity, and to retain anonymity without changing the tone or meaning.

EXECUTIVE INTERVIEW RESULTS

State of the Workforce

- People are more hesitant to leave due to uncertainties. Voluntary retention is better now.
  - Salaries and overall compensation is getting more reasonable.
  - Delays in potential retirements may move the expected bubble of retirements out a few years.
- Shortages still exist.
  - Resource shortages still exist for key positions and skills. Some companies aggressively looking for talent.
- Many companies are taking this opportunity to enhance performance.
  - Companies are starting to focus on workforce performance issues. Economic conditions present an excellent opportunity to streamline operations and quality.
  - During the recent growth period, cost and quality of work was suffering due to the lack of qualified workforce.
- Workforce is impacted by project delays inside and outside the industry.
  - Many companies haven't seen changes to date, however, there have been delays in certain projects, and the cost of capital may impact the workforce issues within six months to two years.
  - Some service companies are now reporting excess capacity. This may result in letting project staff go between projects.

  - Opportunities are opening to acquire key workforce from parallel industries.

How has the recent economic situation changed the needs of your company regarding the workforce or knowledge management issues?

- The quality and quantity of work has been significantly impacted.
- We still have critical staffing needs, and continue to hire from other companies in the industry. There are not many new employees entering the industry.
- Retirement is still the biggest risk. While some retirements have been delayed, the problem will be even larger in one to two years.

Have you seen any specific patterns changing regarding:

- Hiring:
  - It is now easier to hire from other parallel industries, such as petrochemical.
  - Signing bonuses are being removed.
  - People are more hesitant to change companies.
- Compensation:
  - Salaries have flattened.
  - Merit increases are being minimized.
- Retention:
  - Not an important issue at this time, it is much easier to keep staff.
  - Retention will have an even a bigger impact in the near future after the economy recovers.

Are you changing your strategy regarding the workforce?

- Executives reported multiple strategies. Some companies are freezing hiring, while others are still hiring, especially for targeted skills.
- Most are spending much more time forecasting projects and resources.
- Not focusing just on critical skills, but looking at the best skill mix to maximize performance.

APPENDIX B - HUMAN RESOURCES SURVEY RESULTS

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INTRODUCTION

This document presents the results of the Human Resources Survey for the INGAA Foundation Critical Skills Forecast for the Natural Gas Transmission Industry Project. For the purposes of this survey, "technical employees", "fully-qualified" and "technical new-hires" refer to permanent and temporary employees and full-time contractors of your company who are covered by the following definition:

The technical workforce in the transmission segment of the natural gas industry that is responsible for design, construction, operations and maintenance of pipelines.

Technical Workforce Job Positions

The following job positions should be considered for this survey:

1. Engineering, Architecture and Computer Science
   - 1.1 Mechanical Engineer
   - 1.2 Pipeline Integrity Engineer
   - 1.3 Electrical Engineer
   - 1.4 Environmental Engineer
   - 1.5 Petroleum Engineer
   - 1.6 Industrial Engineer
   - 1.7 Geoscientist
   - 1.8 Chemical Engineer
   - 1.9 Materials Engineer
   - 1.10 Civil Engineer
   - 1.11 Architect
   - 1.12 Computer Programmer
   - 1.13 Computer Engineer
2. Management
   - 2.1 Operations Manager
   - 2.2 Construction Manager
   - 2.3 Engineering Manager
   - 2.4 Purchasing Manager
   - 2.5 Training and Development Manager
3. Operations
   - 3.1 Natural Gas Operations
   - 3.2 Scheduling and Accounting
   - 3.3 Surveying and Land Management
   - 3.4 Power Plant Operations
4. Skilled Trades
   - 4.1 Electrical Maintenance

4.2 Computer Control

4.3 Pipe Installation

4.4 Welding

4.5 Equipment Operation

4.6 Equipment Maintenance

5. Quality Control, Regulatory, and Compliance

5.1 Construction/Building Inspector

5.2 Quality Inspector

5.3 Regulatory and Environmental

Functional Areas

Following is a list of the functions for transmission and distribution that are considered for this study:

Commission Assets - Develop a systematic approach to ensure that facilities and projects brought on line meet design requirements and system and performance objectives, and that they use appropriate methods for construction/overhaul.

Maintenance - Maintain station assets to ensure the ability to operate effectively and efficiently to meet station requirements.

Operations - Operate gas transmission facilities (including pipeline, storage, LNG and others) effectively, efficiently and safely under normal and abnormal conditions.

System / Facility Design - Design systems and facilities, including pipelines, corrosion control, plant/facility, storage, and measurement systems, so that projects meet business and operational objectives.

Land Management - Manage land for natural gas transmission needs, including acquisition of land for projects, negotiation of leases and easements, sales of surplus land as well as land owner communication and notification.

Construction - Construct projects supporting the transmission of natural gas including pipelines, facilities, storage, LNG and warehousing functions. Integrate measurement and control systems to monitor system performance.

System Planning - Perform system planning and modeling to ensure overall system optimization and integration with business needs and requirements.

Project Management - Manage significant organizational projects including definition of scope and design engineering functions.

Ensure Pipeline Integrity - Organize and maintain a system to support pipeline integrity management, assessment, remediation and repair.

Manage Data - Manage the control and revision of the organization's data assets, including map and drawing resources.

System Control - Manage gas control systems, including effective system control and appropriate operator qualifications.

RESPONDENT DEMOGRAPHICS

6. What is your function?
    - Human Resources - 91%
    - Other Management - 9%
7. Select your company type:
    - Pipeline - 36%
    - Construction - 18%
    - Pipeline Services - 27%
    - Consulting - 18%
8. Select your technical workforce size:
    - Up to 100 - 27%
    - 100 - 500 - 36%
    - 500 - 1,000 - 18%
    - Over 1,000 - 18%
9. Which segment of the industry?
    - Transmission - 70%
    - Distribution - 30%

PRESENT WORKFORCE

10. How many total technical employees does your company have? 543
11. How much do you expect this to increase or decrease in the next 2 years? +8%*
12. How much do you expect this to increase or decrease in the next 5 years? +15%
13. How many technical positions are at present unfilled? 5%
14. What is the average age of your technical workforce? 42 years
15. How many contract employees do you have for your average workload? 8% of technical workforce
16. How much do you expect this to increase or decrease in the next 2 years? + 5%
17. How much do you expect this to increase or decrease in the next 5 years? + 12%

*Note: Averages in this report are weighted by company size to show a more meaningful picture of the overall industry. That is, the average of a 50% increase in a 100 person company (50 people) and a 10% increase in 5,000 person company (500 people) equals 550/5,100 or an 11% increase in the workforce.

ATTRITION PROFILE

18. What is your present yearly non-retirement attrition? 7%

19. What is your present yearly retirement attrition? 3%

20. How do you expect that number to change over the next 2 years? 56% expect an increase, 33% expect no change, 11% expect a decrease

21. How do you expect that number to change over the next 5 years? 78% expect an increase, 11% expect no change, 11% expect a decrease

22. Are you actively trying to delay retirements?
    - Yes - 36%
    - No - 64%

23. If yes, what are you doing?
    - We are offering phased retirement programs (2 comments)
    - Not really delaying, but using retired personnel on a limited basis to fill voids
    - Flexible schedule, attractive compensation
    - Economy has assisted us

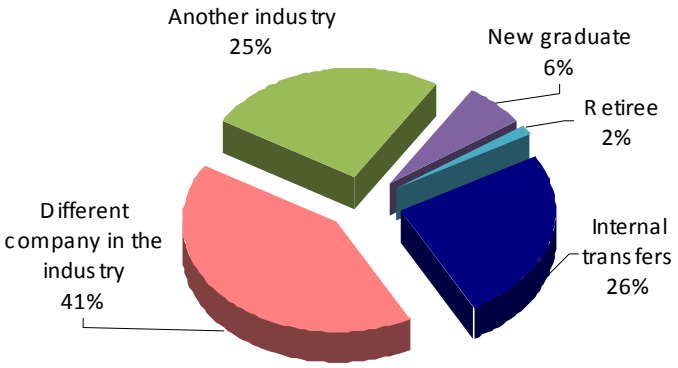
24. Is it working?
    - Yes - 100%
    - No - 0%

25. Are you targeting specific skills or job positions for delayed retirements?
    - Yes - 75%
    - No - 25%

26. If yes, which categories?
    - Engineering, Architecture, and Computer Science - 50%
    - Management - 25%
    - Operations - 25%
    - Skilled Trades - 0%
    - Quality Control, Regulatory, and Compliance - 0%
    - Labor - 25%
    - Other - 0%

RECRUITMENT

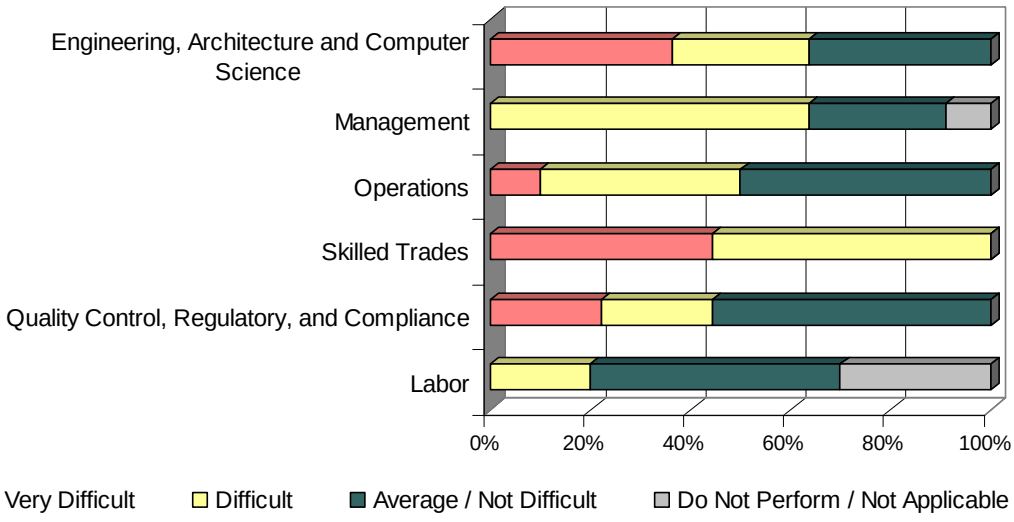
27. Estimate the percentage of your candidates who come from each of the following groups:



28. Considering the technical applicants you have interviewed, please estimate the percentage that is fully qualified for the job.

- Engineering, Architecture and Computer Science - 53%
- Management - 61%
- Operations - 56%
- Skilled Trades - 57%
- Quality Control, Regulatory, and Compliance - 61%

29. From your experiences with any of the job categories listed below, how difficult has it been over the last 2 years to hire new employees?



JOB POSITION DETAILS

Engineering, Architecture or Computer Science

- **Percentage of Category** - Estimate the percentage of your employees in each job position within the category, this should roughly add to 100%.
- **Difficult to Hire** - Select "yes" for positions that take at least 50% more than the average time to fill for all technical positions in your company.

Job Position Category	Position Percent of Category	Difficult to Hire
Mechanical Engineer	25%	78%
Pipeline Integrity Engineer	10%	80%
Electrical Engineer	11%	86%
Environmental Engineer	4%	0%
Petroleum Engineer	2%	75%
Industrial Engineer	1%	33%
Geoscientist	0%	100%
Chemical Engineer	5%	60%
Materials Engineer	4%	60%
Civil Engineer	20%	67%
Architect	3%	67%
Computer Programmer	9%	29%
Computer Software Engineer	6%	43%

30. Are there any other job positions in this category that your company employs? If so, list the position, percentage of category and difficulty to hire.
    - Software development
    - Sr. engineer compression - 5% of category and difficult to hire
    - Sr. measurement - 5% of category and difficult to hire
    - Pipeline integrity technologist - 5% of category and difficult to hire
31. Does this category on average take at least 50% more time than the average technical job position to fill?
    - Yes - 83%
    - No - 17%
32. How many employees are in these job positions? (Include equivalent job positions.) 23% of technical workforce
33. How many funded but unfilled positions are there for these job positions? (Include equivalent job positions.) 7%
34. Estimate the change in headcount as percentage growth (%) or reduction (-%) that you expect in these job positions in two years. (Include equivalent job positions.) + 20%

35. Estimate the change in headcount as percentage growth (%) or reduction (-%) that you expect in these job positions in five years. (Include equivalent job positions.) + 40%

36. Estimate the change in headcount as percentage growth (%) or reduction (-%) that you expect in these job positions in ten years. (Include equivalent job positions.) + 59%

37. For the average new-hires in these positions, which of the following are required? Check all that apply:
    - College degree in a technical field - 100%
    - Specific college degree - 36%
    - Specific course work or specialization - 55%
    - Experience in the natural gas transmission industry - 45%
    - Specific skills or experience required for the job posting - 55%
    - Other (please specify) - 0%

38. Estimate the percentage of these applicants meets the baseline skill requirements for their positions. 55%

39. Which skills/qualifications would you like to see more of for applicants for these job positions?
    - Natural gas transmission/pipeline experience (7 comments)
    - Specialization, or possess specific skills (2 comments)
    - Specialization in LNG
    - Increase in communication skills (both oral and written)
    - Solid technical skills and ability to address a wide range of engineering problems (critical thinking)
    - Data analysis and system integration skills
    - Ability to cross over into cost control and negotiation
    - Leadership skills

40. Are you aware of any projects in the planning stages where you need specific skills that your present workforce does not currently possess?
    - Yes - 27%
    - No - 73%

41. If so, what are they?
    - Foreign language
    - Pipeline integrity

42. Are you aware of any changing technology that is also changing the required skills for these positions in your company?
    - Yes - 36%
    - No - 64%

43. If so, what are the technologies?

- Construction technique, materials, design/engineering software
- LNG transmission experience
- Computer technology is changing on a daily basis. Employees have to constantly train to keep up with changes.
- Automation and control system software and hardware
- Three-dimensional drafting

44. Specify the skills and whether they are affected positively or negatively.

- Knowledge and skills must be updated
- Project management will be a skill which will increase in demand
- Learning skills must increase in velocity and depth
- Additional computer skills

45. Are you aware of any other skills or job positions your company will need to recruit that you have not in the past?

- Yes - 0%
- No - 100%

Management

- **Percentage of Category** - Estimate the percentage of your employees in each job position within the category, this should roughly add to 100%.
- **Difficult to Hire** - Select "yes" for positions that take at least 50% more than the average time to fill for all technical positions in your company.

Job Position Category	Position percent of category	Difficult to Hire
Operations/Pipeline Manager or Supervisor	54%	57%
Construction Manager	12%	63%
Engineering Manager	25%	50%
Purchasing or Land Manager	7%	20%
Training and Development Manager	2%	20%

46. Are there any other job positions in this category that your company employs? If so, list the position, percentage of category and difficulty to hire.

- Natural gas transmission

47. Does this category on average take at least 50% more time than average technical job position to fill?

- Yes - 55%
- No - 45%

48. How many employees are in these job positions? (Include equivalent job positions.) 6% of technical workforce

49. How many funded but unfilled positions are there for these job positions? (Include equivalent job positions.) 2%

50. Estimate the change in headcount as percentage growth (%) or reduction (-%) that you expect in these job positions in two years. (Include equivalent job positions.) +3%

51. Estimate the change in headcount as percentage growth (%) or reduction (-%) that you expect in these job positions in five years. (Include equivalent job positions.) +5%

52. Estimate the change in headcount as percentage growth (%) or reduction (-%) that you expect in these job positions in ten years. (Include equivalent job positions.) +7%

53. For the average new-hires in these positions, which of the following are required? Check all that apply:

    - College degree in a technical field - 82%
    - Specific college degree - 36%
    - Specific course work or specialization - 45%
    - Experience in the natural gas transmission industry - 73%
    - Specific skills or experience required for the job posting - 73%
    - Other (please specify) - 9%

    If you selected other, please specify.

    - Nearly always filled from within organization

54. Estimate the percentage of these applicants meets the baseline skill requirements for their positions. 56%

55. Which skills/qualifications would you like to see more of for applicants for these job positions?

    - Leadership experience or skills (3 comments)
    - Experience in the natural gas transmission industry (3 comments)
    - Communication skills (both oral and written)
    - Analytical skills for critical analysis

56. Are you aware of any projects in the planning stages where you need specific skills that your present workforce does not currently possess?

    - Yes - 18%
    - No - 82%

57. If so, what are they?

    - Foreign language
    - Broader understanding of all facets of the natural gas pipeline industry.

58. Are you aware of any changing technology that is also changing the required skills for these positions in your company?

- Yes - 9%
- No - 81%

59. If so, what are the technologies?

- Specific types of software

60. Specify the skills and whether they are affected positively or negatively.

- Need to update skills

61. Are you aware of any other skills or job positions your company will need to recruit that you have not in the past?

- Yes - 9%
- No - 81%

62. If so, what are they?

- Project management

Operations

- **Percentage of Category** - Estimate the percentage of your employees in each job position within the category, this should roughly add to 100%.
- **Difficult to Hire** - Select "yes" for positions that take at least 50% more than the average time to fill for all technical positions in your company.

Job Position Category	Percent of category - Pipeline	Percent of category - Services	Difficult to Hire
Compressor/Pumping Station Operator	2%	0%	67%
Measurement Technician	1%	13%	25%
Gas Plant Operator	0%	40%	50%
LNG or Pipeline Technician	84%	32%	60%
Chemical Operator	0%	0%	0%
Gas Controller	6%	4%	40%
Natural Gas Trader	0%	4%	100%
Natural Gas Accountant	4%	0%	0%
Surveyor/Pipeline Mapper	1%	5%	75%
Land Agent	1%	0%	67%
Power Plant Operator	0%	0%	0%

Note: 71% of Service respondents did not report any employees in the "Operations" category. Remaining responses were normalized to 100% for all categories.

63. Are there any other job positions in this category that your company employs? If so, list the position, percentage of category and difficulty to hire.

    - Our technicians are multi functional technicians. Their skills sets are controls, measurement, plant, pipeline, corrosion, communications

64. Does this category on average take at least 50% more time than the average technical job position to fill?

    - Yes - 29%
    - No - 71%

65. How many employees are in these job positions? (Include equivalent job positions.) 47% of technical workforce

66. How many funded but unfilled positions are there for these job positions? (Include equivalent job positions.) 2%

67. Estimate the change in headcount as percentage growth (%) or reduction (-%) that you expect in these job positions in two years. (Include equivalent job positions.) 1%

68. Estimate the change in headcount as percentage growth (%) or reduction (-%) that you expect in these job positions in five years. (Include equivalent job positions.) 2%

69. Estimate the change in headcount as percentage growth (%) or reduction (-%) that you expect in these job positions in ten years. (Include equivalent job positions.) 2%

70. For the average new-hires in these positions, which of the following are required? Check all that apply:

    - College degree in a technical field - 27%
    - Specific college degree - 0%
    - Specific course work or specialization - 36%
    - Experience in the natural gas transmission industry - 27%
    - Specific skills or experience required for the job posting - 55%
    - Other (please specify) - 9%

71. Estimate the percentage of these applicants meets the baseline skill requirements for their positions. 43%

72. Which skills/qualifications would you like to see more of for applicants for these job positions?

    - Technical/mechanical training
    - Natural gas industry-related knowledge, including safety
    - LNG operating experience
    - Current SCADA skills
    - Higher level of technical education (automation measurement, electrical theory and mechanics of fluid)
    - Special concepts for gas controllers; analytical skills

- For all field positions, ability to meet company standards, such as drug testing, acceptable driving and criminal background records.

73. Are you aware of any projects in the planning stages where you need specific skills that your present workforce does not currently possess?

- Yes - 0%
- No - 100%

74. If so, what are they?

75. Are you aware of any changing technology that is also changing the required skills for these positions in your company?

- Yes - 18%
- No - 82%

76. If so, what are the technologies?

- Computer technology
- New scheduling software
- Continuing to automate processes

77. Specify the skills and whether they are affected positively or negatively.

- Learning skills must have more velocity and depth
- Automation will required enhanced computer skills

78. Are you aware of any other skills or job positions your company will need to recruit that you have not in the past?

- Yes - 0%
- No - 100%

79. If so, what are they?

Skilled Trades

- **Percentage of Category** - Estimate the percentage of your employees in each job position within the category, this should roughly add to 100%.
- **Difficult to Hire** - Select "yes" for positions that take at least 50% more than the average time to fill for all technical positions in your company.

Job Position Category	Percent of Category	Difficult to Hire
Electrician	2%	100%
Electrical Power-Line Installers /Repairers	0%	100%
Electrical Engineering/Electronics Technician	5%	100%
Automation And Control System Programmer	4%	100%
Instrument and Control Technician	15%	75%
Operating Engineer	17%	67%
SCADA Engineer/Technician	7%	50%

Job Position Category	Percent of Category	Difficult to Hire
Equipment Maintenance	15%	50%
Welder	5%	33%
Pipe Layers/Pipefitters/Pipeliners	17%	0%
Industrial Machinery Mechanic	12%	0%
Substation Electrician	0%	0%

80. Are there any other job positions in this category that your company employs? If so, list the position, percentage of category and difficulty to hire.

- Our technicians are multi functional technicians. Their skills sets are controls, measurement, plant, pipeline, corrosion, communications

81. Does this category on average take at least 50% more time than average technical job position to fill?

- Yes - 44%
- No - 56%

82. How many employees are in these job positions? (Include equivalent job positions.) 15% of technical workforce

83. How many funded but unfilled positions are there for these job positions? (Include equivalent job positions.) 4%

84. Estimate the change in headcount as percentage growth (%) or reduction (-%) that you expect in these job positions in two years. (Include equivalent job positions.) +2%

85. Estimate the change in headcount as percentage growth (%) or reduction (-%) that you expect in these job positions in five years. (Include equivalent job positions.) +4%

86. Estimate the change in headcount as percentage growth (%) or reduction (-%) that you expect in these job positions in ten years. (Include equivalent job positions.) +8%

87. For the average new-hires in these positions, which of the following are required? Check all that apply:

- College degree in a technical field - 9%
- Specific college degree - 0%
- Specific course work or specialization - 27%
- Experience in the natural gas transmission industry - 36%
- Specific skills or experience required for the job posting - 45%
- Other (please specify) - 9%

88. Estimate the percentage of these applicants meets the baseline skill requirements for their positions. 41%

89. Which skills/qualifications would you like to see more of for applicants for these job positions?

- LNG or cryogenic experience

- We would like to have more pipeline welders available in the market.
- Equipment Maintenance - knowledge of natural gas industry; properties of natural gas; automation fuel controls and engine balancing; safety.
- Telecommunication - telemetry, microwave, and SCADA and troubleshooting of each
- All field positions - ability to meet company standards, such as drug testing, acceptable driving record and background record.

90. Are you aware of any projects in the planning stages where you need specific skills that your present workforce does not currently possess?
    - Yes - 0%
    - No - 100%
91. If so, what are they?
92. Are you aware of any changing technology that is also changing the required skills for these positions in your company?
    - Yes - 38%
    - No - 62%
93. If so, what are the technologies?
    - All installation tasks require more advanced tooling and application understanding
    - Computer technology
    - Telecommunication - internet protocol (IP)
    - Equipment maintenance - ultrasonic meters; automated pipeline welding (specific to our contract employees)
94. Specify the skills and whether they are affected positively or negatively.
    - Better reading/comprehension, math and electronic skills are required for several tasks
    - Equipment operation, gas sensing, etc.
    - Sophisticated SCADA systems will require a broader and faster learning curve
    - Equipment maintenance - technical measurements - positive
    - Telecommunications - skills in routers, switches, fiber, etc., such as terminating, splicing and troubleshooting - positive
95. Are you aware of any other skills or job positions your company will need to recruit that you have not in the past?
    - Yes - 0%
    - No - 100%
96. If so, what are they?

Quality Control, Regulatory and Compliance

- **Percentage of Category** - Estimate the percentage of your employees in each job position within the category, this should roughly add to 100%.
- **Difficult to Hire** - Select "yes" for positions that take at least 50% more than the average time to fill for all technical positions in your company.

Job Position Category	Percent of Category	Difficult to Hire
Quality Specialist	11%	100%
Regulatory and Environmental	25%	100%
Quality Inspector	25%	67%
Construction/Building Inspector	26%	50%
Regulatory Specialist	13%	40%

97. Are there any other job positions in this category that your company employs? If so, list the position, percentage of category and difficulty to hire.

98. Does this category on average take at least 50% more time than average technical job position to fill?
    - Yes - 33%
    - No - 67%

99. How many employees are in these job positions? 9% of technical workforce

100. How many funded but unfilled positions are there for these job positions? (Include equivalent job positions.) 4%

101. Estimate the change in headcount as percentage growth (%) or reduction (-%) that you expect in these job positions in two years. (Include equivalent job positions.) 61% for all respondents, removing one outlier average drops to 0%

102. Estimate the change in headcount as percentage growth (%) or reduction (-%) that you expect in these job positions in five years. (Include equivalent job positions.) 74%, removing one outlier average drops to 1%

103. Estimate the change in headcount as percentage growth (%) or reduction (-%) that you expect in these job positions in ten years. (Include equivalent job positions.) 93%, removing one outlier average drops to 2%

104. For the average new-hires in these positions, which of the following are required? Check all that apply:
    - College degree in a technical field - 64%
    - Specific college degree - 27%
    - Specific course work or specialization - 45%
    - Experience in the natural gas transmission industry - 36%
    - Specific skills or experience required for the job posting - 64%
    - Other (please specify) - 0%

105. Estimate the percentage of these applicants meets the baseline skill requirements for their positions. 67%

106. Which skills/qualifications would you like to see more of for applicants for these job positions?

- Communication
- Financial acumen, written communication skills, modeling skills

107. Are you aware of any projects in the planning stages where you need specific skills that your present workforce does not currently possess?

- Yes - 0%
- No - 100%

108. If so, what are they?

109. Are you aware of any changing technology that is also changing the required skills for these positions in your company?

- Yes - 22%
- No - 78%

110. If so, what are the technologies?

- Construction techniques, software, communications
- New tariff-filing requirements and related software (E-filing)

111. Specify the skills and whether they are affected positively or negatively.

- Computer skills - positive

112. Are you aware of any other skills or job positions your company will need to recruit that you have not in the past?

- Yes - 0%
- No - 100%

113. If so, what are they?

EXTERNAL EDUCATION, PR, LOBBYING, AND STRATEGIES

114. Do you have programs in place or planned with regional educational providers, such as colleges or skilled trade schools, to increase the size and quality of your recruitment pool for technical employees?

- Yes - 73%
- No - 27%

115. If so, what type?

- Internships (2 comments)
- Simply awareness by the schools that we are a quality employer looking for skilled trades in and effort to motivate students to pursue classes which yield qualified people.
- Recruitment activities

- Partnered w/trade schools and colleges
- Plan to work with local colleges to focus on course work for accredited LNG technical career tracks
- Work with National Association of Colleges and Employers
- We have in the past and are starting to contact more technical trade schools for recruitment of technical positions
- Executive involvement in university councils and/or alumni associations.

116. If not, do you feel these would be beneficial?

- Yes - 80%
- No - 20%

117. What type of help do you need to implement this type of longer-term strategy?

- People, resources and money
- More understanding of state level influence on curriculum development
- It would be good if these schools were more familiar with the types of technical jobs the pipeline industry has.
- Partner with larger company or companies
- Development and implementation of curriculum for critical skills specific to the natural gas industry that could be shared with colleges, universities and technical trade schools.

118. Do you feel that the development and implementation of a standardized industry curriculum for critical skills sets would be helpful as a longer-term strategy?

- Yes - 100%
- No - 0%

119. Is your company aware of or involved in programs for government grants for funding educational programs?

- Yes - 30%
- No - 70%

120. If yes, which program(s) are they?

- Ohio has grants available to pay for a portion of the instruction cost for classes which improve our workforce and make us more competitive
- Michigan Works
- Consortium for Connecticut Energy Group to work with educational facilities in early implementation stages

121. If not, would this information be beneficial?

- Yes - 86%
- No - 14%

122. Would additional lobbying activities specific to workforce shortages be valuable?

- Yes - 67%
- No - 33%

123. If so, which type?

- A continued message to the younger generations which shows the need for skilled workers and the quality of life that can be achieved for a good tradesman
- Focus on changing younger mindsets current image of energy industry. develop lobbying/marketing strategies to appeal to the more mobile and environmentally focused age groups
- Career change options, publicize energy careers
- Not certain at this time. The response above is dependent on the degree of input required as well as the odds of success

124. Would there be value in an alliance with companies outside the gas industry in addressing the skills shortage as a longer-term strategy?

- Yes - 89%
- No - 11%

125. Are there any other external actions that should be considered?

- For technical experience take it down to high school levels as in discussions at the freshmen sophomore level versus graduating seniors
- Not certain at this time. The response above is dependent on the degree of input required as well as the odds of success.

OVERALL ASSESSMENT

126. How do you rate safeguarding your workforce and knowledge assets?

Use the following scale:

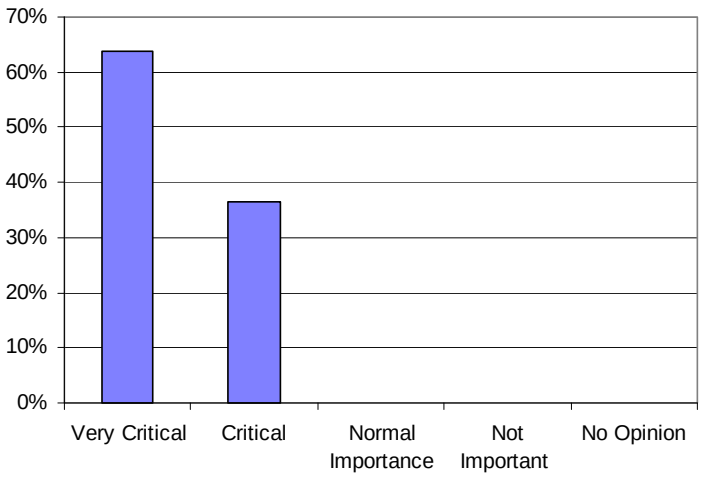
Very Critical - Workforce and knowledge issues are a very high priority for my company and receive considerable attention at the upper management level.

Critical - Workforce and knowledge issues are a priority for my company and receive attention at the upper management level.

Normal Importance - Workforce and knowledge issues are of normal importance for my company and receive the same attention as they have received over the last several years.

Not Important - Workforce and knowledge issues have a low importance in my company.

No Opinion



127. Do you feel your company will be able to successfully maintain your workforce and knowledge assets?

Use the following scale:

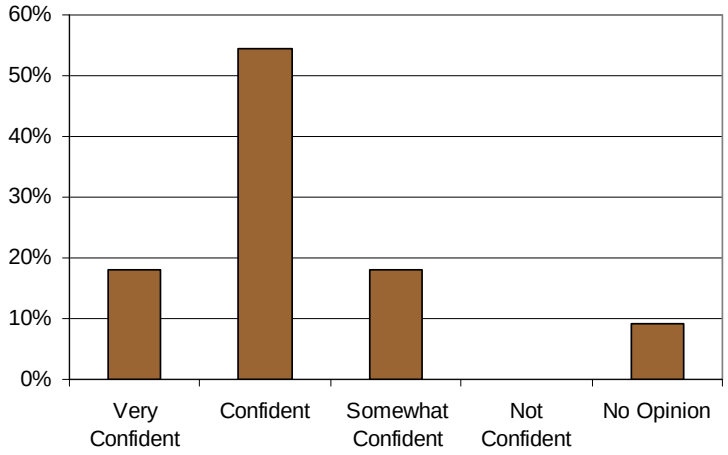
Very Confident - These issues receive high visibility in the company, and have been addresses in a comprehensive manner. The risks have been quantified, adequate resources have been allocated, and a plan is being implemented according to schedule.

Confident - These issues receive visibility within the company, and have been addressed. The most important risks have been quantified, some resources have been allocated, and necessary steps are being taken to secure the company's knowledge and workforce.

Somewhat Confident - These issues have some visibility in the company, and actions to address them are in the planning stages.

Not Confident - Workforce issues are not being allocated the required resources or manpower.

No Opinion



128. Have workforce issues become more critical to your company's management over the past year? If yes, please comment.

- We are nearing the construction of a dedicated training center and staff to meet our needs.
- Market for talent is very competitive.
- We have a major void in qualified candidates and we are facing a major exodus of our older workers who will be retiring.
- Our company has moved from a development phase to an operating phase. The location of our facility is remote and as such, retaining a qualified technical workforce is a constant focus.
- We have been initiated a workforce planning team to look at workforce needs in critical areas of the company
- Because we are small, each individual is critical to the operation of the company.
- Workforce issues have become more critical to our management. Steps have been taken to engage an outside consultant to assist with knowledge transfer and documented on-the-job training process and tracking.
- No.

129. What actions should the INGAA foundation take to help you with your workforce planning strategy?

- Industry cooperation (3 comments)
  - Foster an environment where companies cooperate to the extent that they feel comfortable expending resources without fear that their trained people will be stolen by other companies.
  - Push the industry to standardize the OQ definitions so companies can use them as a guideline for training programs.
  - Support industry alliances to focus on developing strategies for creating a skilled workforce within a 5-15 year horizon.
- Promote education (1 comment)
  - Lobby for support and money for our educational system to include colleges, technical schools, and high schools.
  - Introduce energy careers in high schools. Develop career tracks for the natural gas industry in colleges. Publicize opportunities in the industry.
- Continue workforce projects (1 comment)
  - Keep this as an outstanding issue in the future so that focus and progress can be made to address the issue.
- Not certain (1 comment)

130. Please add any additional comments. No comments added.

APPENDIX C - TECHNICAL AND MANAGEMENT SURVEY RESULTS

TABLE OF CONTENTS

INTRODUCTION

This document presents the results of the Technical and Management Survey from the INGAA Foundation Critical Skills Forecast for the Natural Gas Transmission Industry Project. For the purposes of this survey, "technical employees", "fully-qualified" and "technical new-hires" refer to permanent and temporary employees and full-time contractors of your company who are covered by the following definition:

The technical workforce in the transmission segment of the natural gas industry that is responsible for design, construction, operations and maintenance of pipelines.

Technical Workforce Job Positions

The following job positions should be considered for this survey:

1. Engineering, Architecture and Computer Science
   - 1.1 Mechanical Engineer
   - 1.2 Pipeline Integrity Engineer
   - 1.3 Electrical Engineer
   - 1.4 Environmental Engineer
   - 1.5 Petroleum Engineer
   - 1.6 Industrial Engineer
   - 1.7 Geoscientist
   - 1.8 Chemical Engineer
   - 1.9 Materials Engineer
   - 1.10 Civil Engineer
   - 1.11 Architect
   - 1.12 Computer Programmer
   - 1.13 Computer Engineer
2. Management
   - 2.1 Operations Manager
   - 2.2 Construction Manager
   - 2.3 Engineering Manager
   - 2.4 Purchasing Manager
   - 2.5 Training and Development Manager
3. Operations
   - 3.1 Natural Gas Operations
   - 3.2 Scheduling and Accounting
   - 3.3 Surveying and Land Management
   - 3.4 Power Plant Operations

4. Skilled Trades
   - 4.1 Electrical Maintenance
   - 4.2 Computer Control
   - 4.3 Pipe Installation
   - 4.4 Welding
   - 4.5 Equipment Operation
   - 4.6 Equipment Maintenance
5. Quality Control, Regulatory, and Compliance
   - 5.1 Construction/Building Inspector
   - 5.2 Quality Inspector
   - 5.3 Regulatory and Environmental

FUNCTIONAL AREAS

Following is a list of the functions for transmission and distribution that are considered for this study:

Commission Assets - Develop a systematic approach to ensure that facilities and projects brought on line meet design requirements and system and performance objectives, and that they use appropriate methods for construction/overhaul.

Maintenance - Maintain station assets to ensure the ability to operate effectively and efficiently to meet station requirements.

Operations - Operate gas transmission facilities (including pipeline, storage, LNG and others) effectively, efficiently and safely under normal and abnormal conditions.

System / Facility Design - Design systems and facilities, including pipelines, corrosion control, plant/facility, storage, and measurement systems, so that projects meet business and operational objectives.

Land Management - Manage land for natural gas transmission needs, including acquisition of land for projects, negotiation of leases and easements, sales of surplus land as well as land owner communication and notification.

Construction - Construct projects supporting the transmission of natural gas including pipelines, facilities, storage, LNG and warehousing functions. Integrate measurement and control systems to monitor system performance.

System Planning - Perform system planning and modeling to ensure overall system optimization and integration with business needs/ requirements.

Project Management - Manage significant organizational projects including definition of scope and design engineering functions.

Ensure Pipeline Integrity - Organize and maintain a system to support pipeline integrity management, assessment, remediation and repair.

Manage Data - Manage the control and revision of the organization's data assets, including map and drawing resources.

System Control - Manage gas control systems, including effective system control and appropriate operator qualifications.

RESPONDENT DEMOGRAPHICS

1. What is your function?
   - Technical Manager - 32%
   - Other Manager - 16%
   - Technical Staff - 5%
   - Operations or Maintenance - 21%
   - Other (please specify) - 26%
     - Operations Director
     - Vice President - General Manager
     - HR in association with area managers
     - Engineering and Compliance
     - Construction Management Supervisor
2. Select your company type:
   - Pipeline - 53%
   - Construction - 5%
   - Pipeline Services - 16%
   - Consulting - 5%
   - Other - 21%

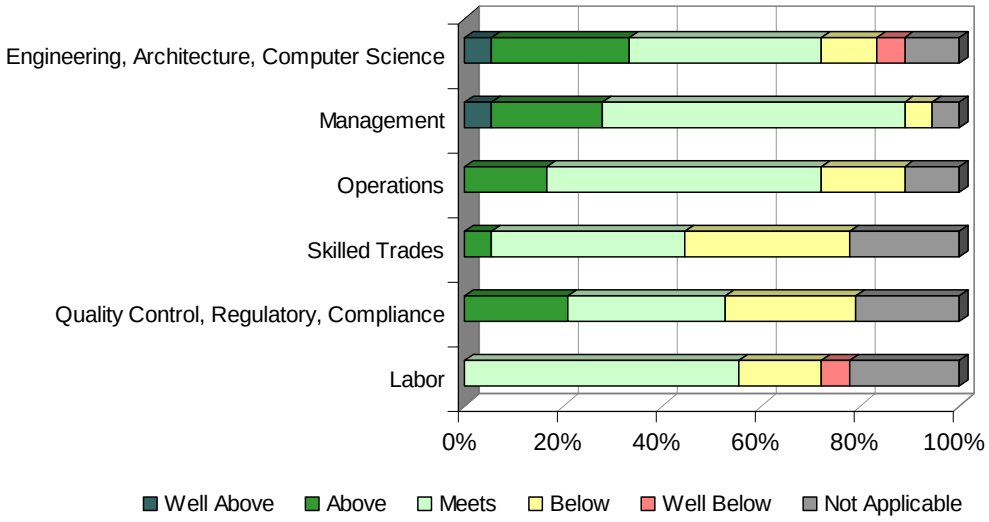
   If you selected other, please specify
   - Storage company
   - Utility and Pipeline - Gas
   - Manufacturer
   - LNG Plant/Terminal
3. Select your technical workforce size:
   - Up to 100 - 37%
   - 100 - 500 - 21%
   - 500 - 1,000 - 32%
   - Over 1,000 - 11%
4. What segment of the industry?

   Transmission - 94%

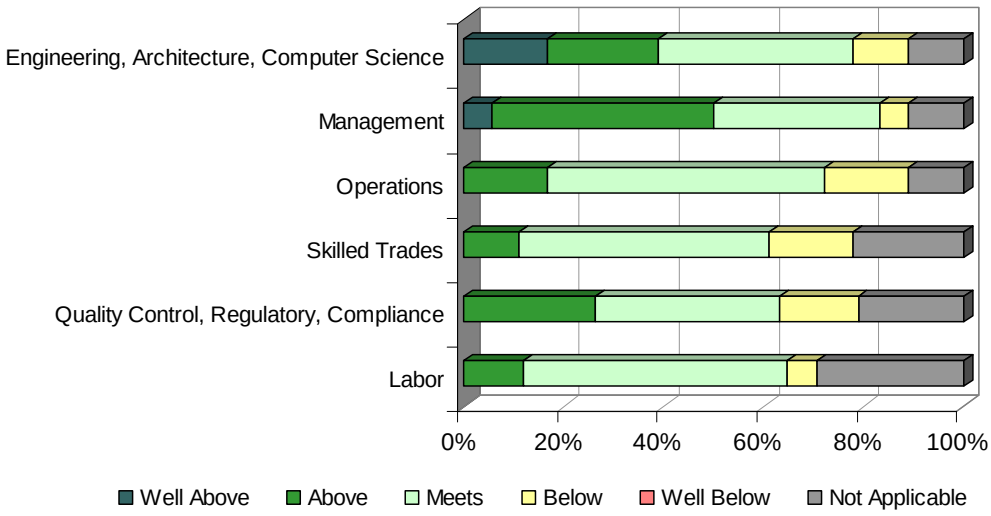
   Distribution - 6%

RECRUITMENT

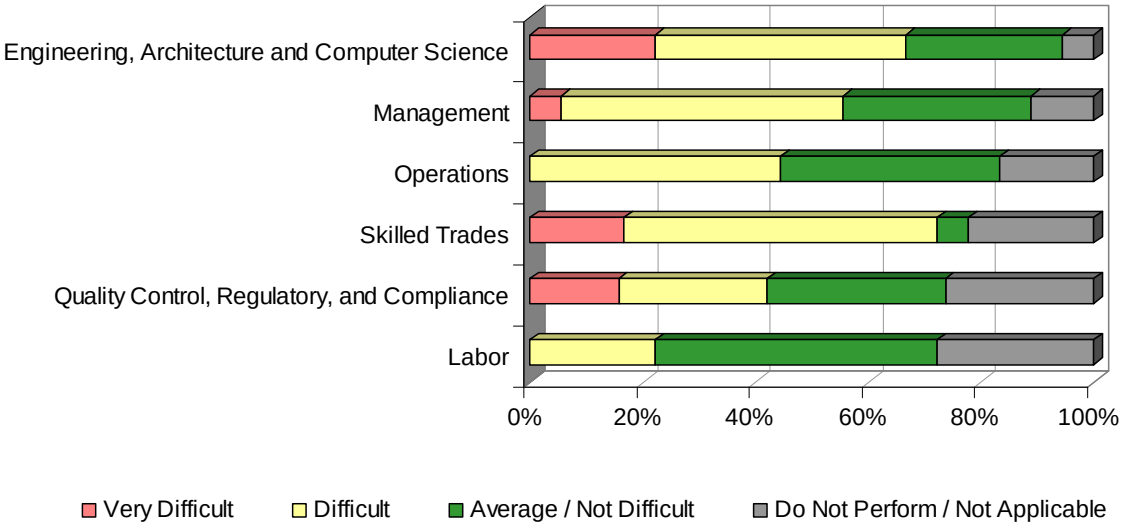
5. By job category, rate how satisfied you are with the pool of new applicants in the past two years with respect to meeting your baseline requirements.



6. By job category, rate how satisfied you are with the new-hires in these areas over the past 2 years, with respect to meeting your baseline requirements.



7. From your experiences with any of the job categories listed below for which you may have tried to hire, how difficult has it been over the last 2 years to hire into these areas?



8. Please add comments concerning specific job positions and reasons that delayed filling open positions.

- Difficulty in recruiting because of lack of applicants (3 comments):
  - Petroleum engineers (Northeast)
  - Materials engineer (work demands)
  - Experienced project engineers (availability)
  - Welders (availability)
  - Automotive mechanics (Wyoming and Eastern Utah)
- Limited qualified applicants and competition (2 comments)
- Limited applicants with necessary experience (4 comments)
  - The difficulty in the natural gas industry is finding people who have experience in the industry. It is easy to find laborers but it is very difficult to find laborers that have worked in the natural gas industry. The same holds true for skilled trades and engineers. (2 comments)
  - Recruiting for a reservoir engineer, automation engineer and surveyor has been challenging. We believe there are limited applicants as well as competition for individuals with the required skills.
  - Finding skill sets has not been as difficult as finding any related experience.
- Capability and training required to learn industry and application needs.
- Takes above market reference point pay to bring in above average personnel.
- Resource hiring freeze and pool of qualified candidates is very limited. The college candidate pool has been very good at providing entry level engineers.

9. Estimate the percentage of your new hires that meet the ideal level of skills for their positions. 53%

10. Estimate the cost (in dollars or time or other measure of your choosing) of required skill development for new-hires that do not meet baseline requirements.

- Costs - average $35,000, median $45,000
  - Cost of training $50,000 (2 comments)
  - $40,000 / year
  - $50,000 / year
  - $10,000 per person on average to get up to speed on gas industry knowledge level
  - $5,000 - $10,000
- Time or man hours - average one year, range (excluding laborers) three months to two years
  - Two months
  - 250-500 hrs/year
  - Six months
  - Considering their time and mentor/training time approximately 4,000 man hours in year one.
  - Laborers: two weeks; Welders: thirteen weeks
  - Two years to get up to top form
  - You generally lose six months of productivity when you have to make compromises in skill sets
  - Estimate we spend one to two years developing the skills that are weak
  - Six months plus
  - Six months to one year
- Unknown
  - Unable to quantify
  - Depends

11. Are there any specific skills you need that entry level employees may not possess?

- Skilled trades
  - Pipeline welding (2 comments)
  - Sandblasting and coating
  - Hands-on construction experience
  - Electronics/Control Systems
  - Basic electronics
  - Basic hydraulics (understand in flow in pipelines)
- Other

  - DOT Operator Qualification (2 comments)
  - Quality control and compliance
  - Equipment operator certifications
  - Skills specific to pipeline engineering
  - Pipeline integrity
  - Better communication skills, both oral and written
- Knowledge of the industry
  - Gas industry (3 comments)
  - Petroleum industry
- No specific skills
  - Due to the nature of business, do not hire entry level applicants. Hire very skilled employees (ready-to-run)
  - Most skills require training
- Safety skills appropriate to the work environment (3 comments)

12. Are there any other skills that are in short supply for your industry?

- Skilled trades
  - Welders (3 comments)
  - Electricians
  - Maintenance technicians
  - Measurement at subject matter expert level
  - Automation and controls for pipeline facilities
  - Design and drafting
  - Communication specialist
- Operators
  - Crane operators
  - Live side boom operators
  - Experienced machine operation skills
  - Mechanical & compressor operations including rotating shift work. Applicants tend to take this as a way in and desire to move away from this work. Hard to find mechanical expertise.
- Engineering
  - Pipeline engineers (2 comments)
  - Transmission engineers
  - Gas storage engineers
  - Engineers
  - Project engineers

  - Controls engineering
  - Metallurgists
  - Experienced engineers - It has been fairly easy to find qualified entry engineers. Due to the high level of industry pipeline activity, it has been more difficult to find seasoned engineers with a specific skill set when a position needs to be filled by an experienced new-hire.
- Management
  - Project management
  - Construction managers
- Other
  - General technical skills (2 comments)
  - Construction
  - Pipe buyers
  - In-line inspection log analysis
  - Material quality inspectors
  - Analytical and technical skills

13. What specific skills/qualifications are you most likely to look for when hiring engineers, architects or computer science professionals to your company?

- Experience
  - Construction experience (2 comments)
  - Subject matter expertise (2 comments)
  - Technical background and experience
  - Training in natural gas/petroleum (2 comments)
    - Ten years in gas pipeline business
  - Design experience
  - Plant operations and maintenance experience
  - Pipeline design or operation experience
  - Experience in pipeline engineering functions
  - Integrity management
  - Compliance
- Personal characteristics
  - Oral and written communication skills (3 comments)
  - Ability to problem solve/analytical skills (2 comments)
  - Good people skills (2 comments)
  - Job-related characteristics of integrity, strong work effort, and ability to work in a team environment.
  - Desire to learn

  - Leadership skills, especially for engineers
  - Good attitude
  - Capability to work in teams
  - Organizational skills
- College degree
  - Technical degree (2 comments)
  - Mechanical engineers
  - Mechanical engineers with effective communication skills
  - B.S. degree in engineering
  - Ability to acquire professional engineer's license
- Specific skills
  - Skills related to the technology or systems currently in use at our company (2 comments)
  - Solid modeling skills
  - Structural analysis
  - Drafting experience
  - Project management
  - Good base level engineering knowledge (hydraulics and thermodynamics)
  - Data analysis and system integration skills
  - Understanding of need for quality control and compliance

14. What specific skills/qualifications are you most likely to look for when hiring <u>managers</u> to your company?
    - Experience
      - Experience in management (3 comments)
      - Experience in the industry (4 comments)
        - Over ten years in gas pipeline business
      - Pipeline operations experience (2 comments)
      - Experience in managing diverse groups
      - Strong background in construction
      - Plant operations and maintenance experience
    - Specific skills or degrees
      - Technical skills (3 comments)
      - Financial skills (2 comments)
      - Direct knowledge and education in technical field (2 comments)
        - Engineering degree
      - Analytical skills

  - Project management and business
  - Knowledge of pipeline compliance
  - DOT compliance background
  - College education or equivalent experience
- Personal characteristics
  - Excellent personal skills (7 comments)
    - Ability to listen
  - Leadership traits (6 comments)
  - Communication skills (2 comments)
  - Good decision making (2 comments)
  - Independent
  - Good attitude
  - Organizational skills
  - Collaborative skills
  - Able to manage our workforce
  - Stability and proven performance
- No requirements
  - Mostly hire from current workforce so this has not been a problem

15. What specific skills/qualifications are you most likely to look for when hiring operations employees to your company?

- Experience
  - Natural gas industry experience (3 comments)
  - Experience with different systems (2 comments)
  - Experience at the field level or control room in a pipeline or storage operation
  - Construction/Customer service background
  - Safety experience
  - Educated
- Specific skills or degrees
  - Computer skills (4 comments)
    - PC/internet skills including MS Office package, Outlook and Excel are a priority
  - Mathematical ability (3 comments)
  - Controls technology (2 comments)
  - Electronics skills (2 comments)
  - Machinery operation
  - Measurement

  - SCADA
  - Corrosion
  - Pipeline construction
  - Understanding of processes and procedures
  - Basic mechanical, measurement or pipeline and corrosion skills
  - Technical skills
  - Electrical skills
- Personal characteristics
  - Ability to learn over time (2 comments)
  - Good attitude (2 comments)
  - Good verbal and written communication skills (2 comments)
  - Willing to work a variety of shifts (2 comments)
  - Intelligence and cognitive ability (2 comments)
  - Hardworking and dedicated
  - Ability to work in a team
  - Willingness to live in remote areas
- No requirements (1 comment)

16. What specific skills/qualifications are you most likely to look for when hiring skilled trades to your company?
    - Experience
      - Senior, expert or subject matter expert level
      - Direct experience
      - Construction or customer service background
    - Specific skills or degrees
      - Technical skills (4 comments)
      - Qualified for pipeline welding (3 comments)
      - Cryogenic process experience
      - Industry certification
      - Electronic and mechanical skills
      - Good PC and internet skills including MS Office package with Outlook and Excel as a priority
      - Mechanical aptitude
      - Measurement
      - Pipeline and corrosion
      - Chemical and metallurgy lab
      - Instrumentation and measurement

  - Combustion and compression
  - Heavy equipment operation
  - Construction inspection
  - Drafting and design
  - Automation skills
  - Telemetry
  - Internet protocol (IP)
  - Microwave
  - SCADA
  - Equipment installation
  - Maintenance and repair
  - Automotive maintenance and repair
  - Understanding of compliance requirements
  - Quality
- Personal characteristics
  - Ability to learn at an accelerated pace, flexibility in learning (2 comments)
  - Cognitive ability
  - Willing to travel
  - Physical fitness
  - Good attitude
  - Ability to work in a team, demonstration of knowledge
  - Good communication skills, both verbal and written
  - Proper attitude towards safety

17. What specific skills/qualifications are you most likely to look for when hiring quality control, regulatory, and compliance employees to your company?

- Experience
  - Past experience (4 comments)
  - Experience with regulatory bodies
  - Field experience
  - Plant operations experience
- Specific skills or degrees
  - B.S degree (2 comments)
  - Technical degree
  - Basic quality control, regulatory and compliance practices
  - Read specifications
  - Understand technical issues

  - Federal, state and local safety, construction and environmental regulations and codes
  - Quality control employees need to understand ASME Section VIII and API 1104
  - Read drawings and isometric drawings
  - Solid knowledge of DOT 192
  - ISO 9001 experience
  - U.S. based FERC and D.O.T. experience
  - Subject matter expertise in DOT compliance, environmental
  - Knowledge of integrity management
  - Part 192 previous experience
  - Advanced mathematical and financial principles
  - Experience with rate-making
  - Certificate and/or tariff principles
  - Computer operation and general programming
- Personal characteristics
  - Technical aptitude
  - Problem solving skills
  - Independent work effort
  - Desire to learn and attention to detail
  - Collaborative and communication skills
  - Ability to learn the job
  - Oral and written communication skills

18. Name any specific job titles/positions that your company has had difficulty hiring qualified applicants in the recent past. (Do you expect that to change?)

- Engineering, architecture and computer science
  - Pipeline engineers (yes, no, no)
  - Gas storage reservoir engineer (no, no)
  - Engineer (no, no)
  - Two to five year engineers (yes)
  - Petroleum engineer (no)
  - Integrity engineer (no)
  - IT systems analyst (no)
  - Controls engineer (yes)
  - Automation engineer (no)
  - Plant engineer (no)
  - Project engineer (no)

  - Metallurgical engineer (no)
- Management
  - Safety director (no)
  - Foreman (no)
  - Construction manager (yes)
  - Project manager (yes)
  - Lab supervisor (no)
- Operations
  - Operators (no)
  - Purchasing agents (no)
  - Logistics (no)
  - Surveyor (no)
- Skilled trades
  - Welders (yes, no, no, no)
  - Drafters (yes, no)
  - Experienced machine operators and instructors (yes)
  - Designers (yes)
  - Design drafter (no)
  - High and medium voltage industrial electricians (no)
  - Corrosion technician (no)
  - O&M technician with electronics or mechanical vocational training/background (no)
  - SCADA technician (no)
  - Fleet mechanic in southwestern Wyoming (no)
  - Equipment operators (no)
- Other
  - Overseas representatives or remote located assignments, globally-mobile individuals (no)
- No difficultly hiring

19. Do you expect that to change?
    - Yes - 29%
    - No - 71%
20. Please add any related comments.
    - Work conditions
      - Younger generation not willing to commit to leaving friends and family for long periods of time.

  - The downturn in the economy could increase the number of qualified applicants. Nevertheless, staffing for positions in Southwestern Wyoming and Eastern Utah will likely remain challenging.

- Impact of the economy
  - Slowdown in the economy may free up certain resources. (2 comments)
  - May have temporary relief with economic setback, but macro trends still alert us to future shortages.
  - The year 2008 was not as difficult as 2007, as we have developed processes to help train these new employees in our industry.
  - With the current economic impact and the slowdown in future expansion projects, the issues may ease up.
- Other
  - The difficulty with the safety director is finding someone who not only understands OSHA but also understands the natural gas industry.
  - There is high demand for experienced operators in the field.
  - Industry needs more trade schools fostering pipeline construction skills.

ATTRITION

21. Name any specific job titles/positions where your company has had high non-retirement attrition in the recent past. (Do you expect that to change?)
    - Engineering, architecture and computer science
      - Engineers (yes, yes, yes, no)
      - Design engineers (yes)
      - Electrical and controls engineer (yes)
      - Sr. construction manager (yes)
      - Mechanical engineers (no)
      - Corrosion engineering (no)
      - Information technology (yes)
    - Management
      - Project management (yes)
    - Operations
      - Field operations (yes)
      - Gas controllers (no)
      - Field operators (no)
      - Purchasing agents/buyers (yes)
    - Skilled trades
      - Welders (no, no)
      - Electricians (no)

  - Instrument technicians (no)
  - Mechanical skills (no)
  - Fleet mechanics (no)
- Quality control, regulatory, and compliance
  - Air compliance (no)
  - Environmental permitting (no)
- No significant non-retirement attrition (5 comments)

22. Do you expect that to change?
    - Yes - 40%
    - No - 60%

23. Please add any related comments.
    - Impact of the economy
      - Slow down in the economy may reduce opportunities elsewhere for these positions. (4 comments)
    - Competition for skills
      - We needed to do a market pay study to make sure we weren't vulnerable to losing newer engineers to other companies that were pursuing them via headhunters. We made some salary adjustments, as well as laying out career plans for specific high-potential employees.
      - High demand for engineers in the pipeline industry.
      - We don't normally have an issue with this in the area I work in; however, competition for technically skilled personnel is increasing in the area. So we could see an up-tick in this of type attrition.
      - It is a very competitive market.

24. Name any specific job titles/positions where your company has had high retirement attrition in the recent past. (Do you expect that to change?)
    - Engineering, architecture and computer science
      - Computer systems engineers (yes)
      - Project engineer (yes)
      - Sr. engineer (yes)
      - Mechanical engineer (no)
      - Pipeline engineer (no)
      - Engineering is expected to have higher retirement in 2-5 years
    - Management
      - Sr. project manager (no)
      - Construction foreman (no)

- Operations
  - Sr. designer (no)
  - Operations employees (yes)
  - Rates supervisor (yes)
  - Operations supervisor (yes)
  - Field operators (yes)
  - Gas controller (yes)
- Skilled trades
  - Operations and maintenance technician (no)
  - Lead mechanic specialist (yes)
  - Measurement and electronics (no)
- Other
  - All (no, no)
  - None (yes, yes, no, no, no)

25. Do you expect that to change?
    - Yes - 35%
    - No - 65%

26. Please add any related comments.
    - Expecting increased retirements
      - A large percentage of the workforce is of retirement age.
      - Once the construction boom we are seeing in our industry is over, we will see a high number of people that will retire.
      - The workforce over 55 is approximately 45%.
      - In about five years, employee demographics will cause a higher retirement rate.
      - We expect retirement attrition to increase over the next ten years. However, the downturn in the economy could impact turnover both for non-retirement attrition and retirement attrition.
      - We have some superintendents that within a few years I would expect to retire.
      - I expect more retirement attrition in the future.
    - Other
      - High demand in the pipeline industry.
      - Over the next three to five years we'll see continued attrition. Then a five year gap, and we start again with retirement attrition.
      - Economic downturn has had a big impact on this.

SKILL DEVELOPMENT AND KNOWLEDGE TRANSFER

27. Name any specific job titles/positions where your company has had difficulty transferring knowledge in the recent past.

- Engineering, architecture and computer science
  - Mechanical engineering (yes)
  - Engineering (no)
  - Mechanical/Combustion engineering (no)
  - Pipeline integrity engineer (no)
  - Pipeline (local/historical knowledge), (no)
  - Mechanical, running 1950 vintage reciprocating [equipment]. Historical knowledge and unit specific changes/fixes may have altered the unit from OEM specifications. (no)
  - Areas of new technology, such as I.T. systems and items such as G.I.S., etc. (no)
  - Integrity management (yes)
- Management
  - Superintendents (yes, yes)
- Operations
  - Operations (no)
  - Field operations (yes)
  - Historical knowledge related to pipeline right-of-way and property owner experiences along the pipeline. (no)
- Skilled trades
  - Welding (yes)
  - All technical positions because we don't hire until someone leaves (no)
  - Measurement specialists (no)
  - Automation and controls specialist (no)
  - Meter automation (yes)
  - Engine maintenance (yes)
  - Pipeline inspection areas (yes)
  - Journeymen employees have tremendous institutional knowledge. We have difficulty gathering and sharing this data. (no)
- Quality control, regulatory, and compliance
  - Environmental Specialists (no)

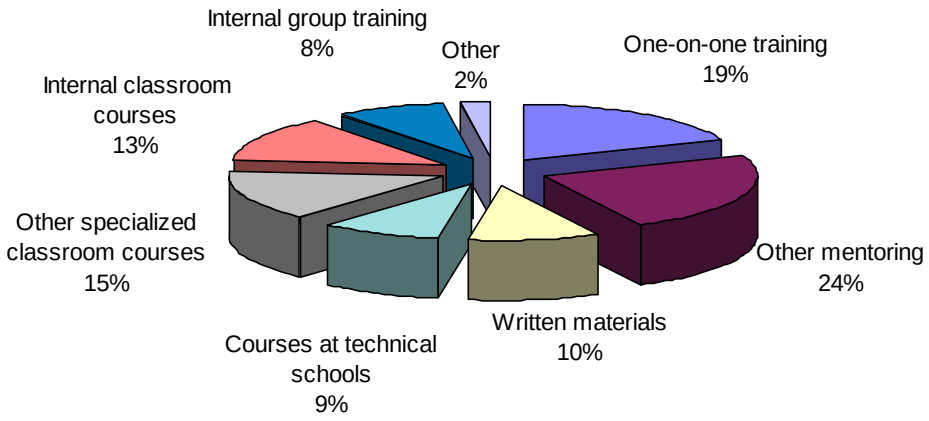
- Other
  - Technical consultants (no)
  - Marketing specialists (no)
- None (no, no, no)

28. Do you expect that to change?
    - Yes - 38%
    - No - 62%

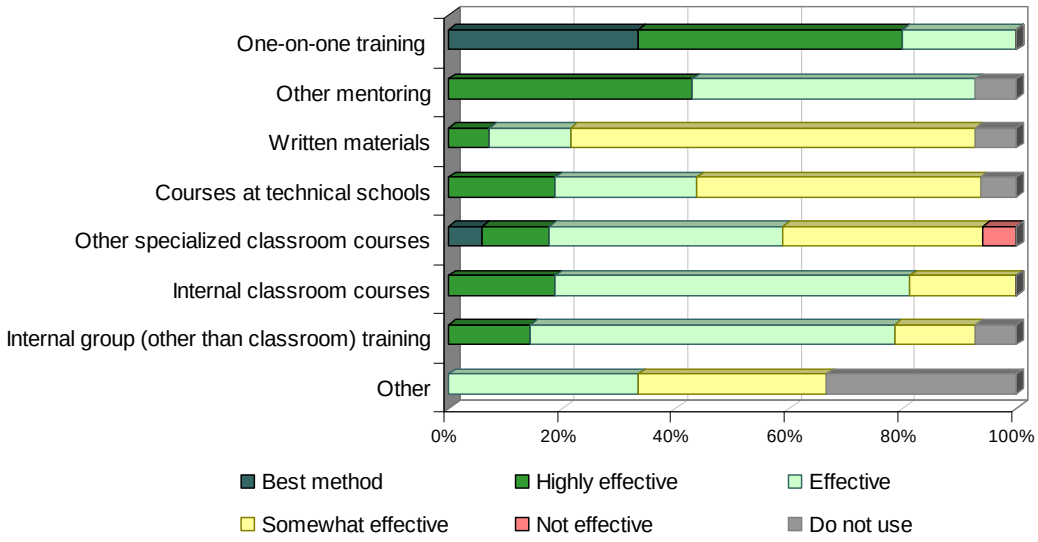
29. Please add any related comments.
    - We recognized the need for a longer overlap time between the people retiring and their replacements. We are hiring more proactively in anticipation of future retirements to address this.
    - We have started hiring foremen to work with the superintendents, so we can train them to be superintendents in the future.
    - Improved channels for developing and mentoring entry level employees have been developed.
    - We are currently working on a knowledge transfer process in these areas that would include a formalized on-the-job training program.

Engineers, Architects and Computer Science

30. Estimate how often you use each skill development method as a percentage of all skill development for this job category.



How effective is each method?

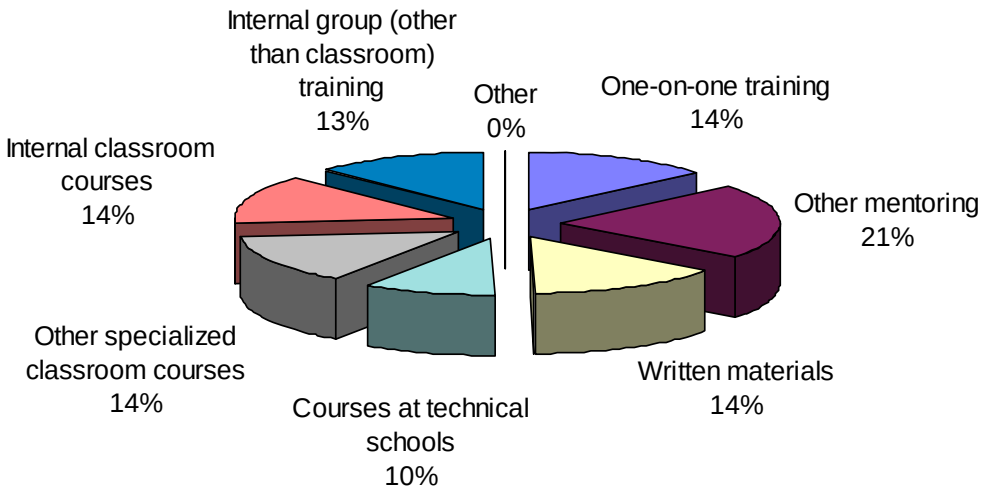


31. Please add any related comments, or discuss "other" skill development methods. (2 comments)

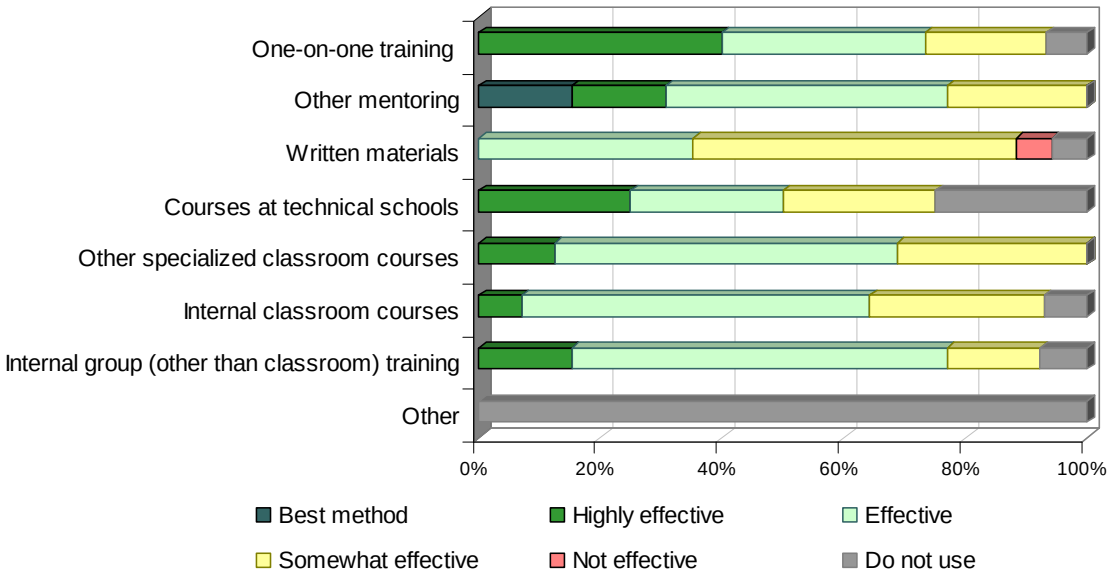
- To mitigate the level of training required to "hit the ground running", hire at senior level or better.
- New entry-level engineers go through a one year training program of three four-month rotations through different engineering areas of the company.

Management

32. Estimate how often you use each skill development method as a percentage of all skill development for this job category.



How effective is each method?

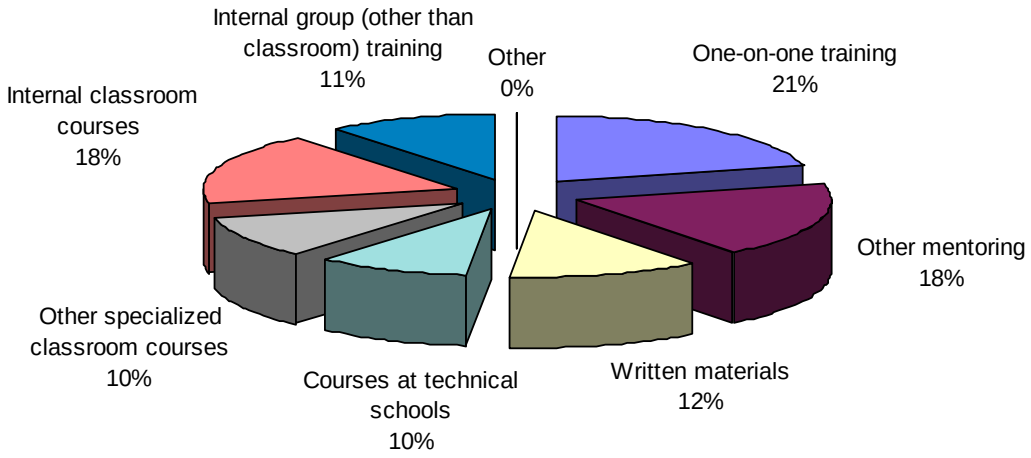


33. Please add any related comments, or discuss "other" skill development methods.

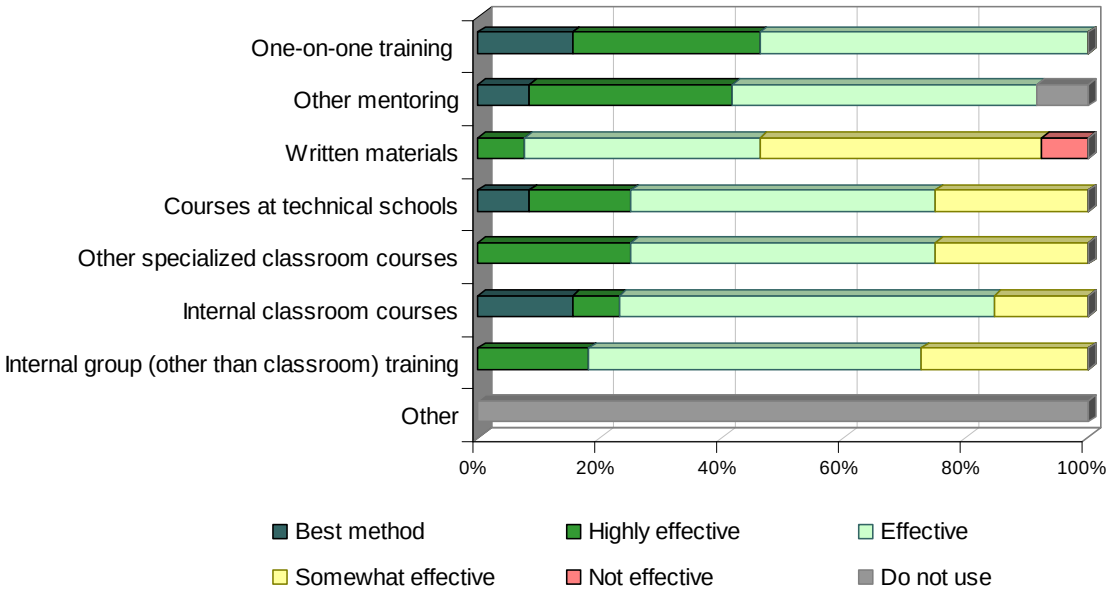
No Comments

Operations

34. Estimate how often you use each skill development method as a percentage of all skill development for this job category.



How effective is each method?

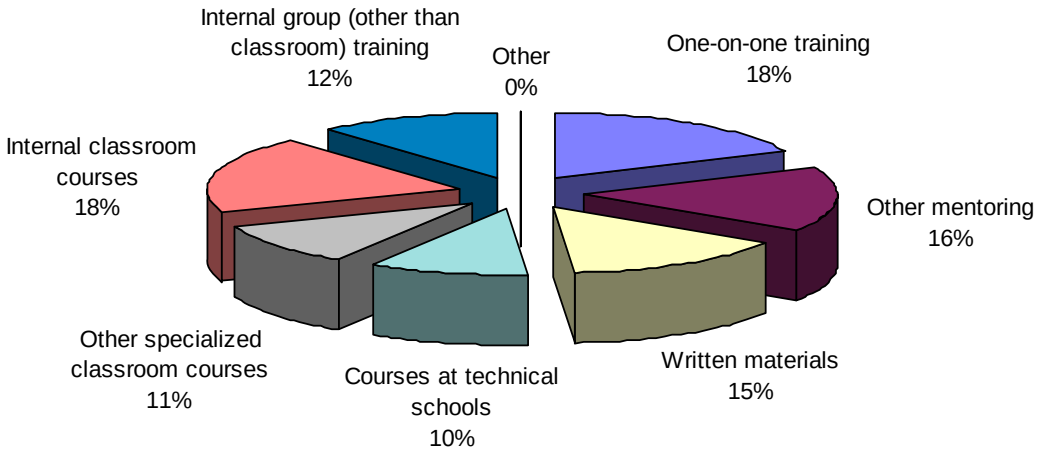


35. Please add any related comments, or discuss "other" skill development methods.

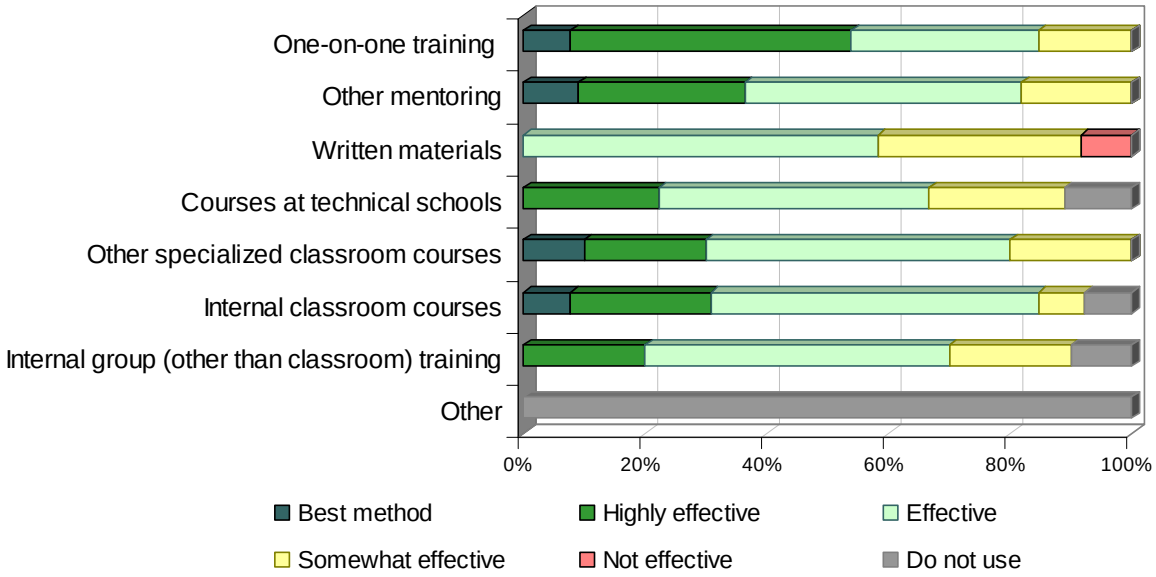
No Comments

Skilled Trades

36. Estimate how often you use each skill development method as a percentage of all skill development for this job category.



How effective is each method?

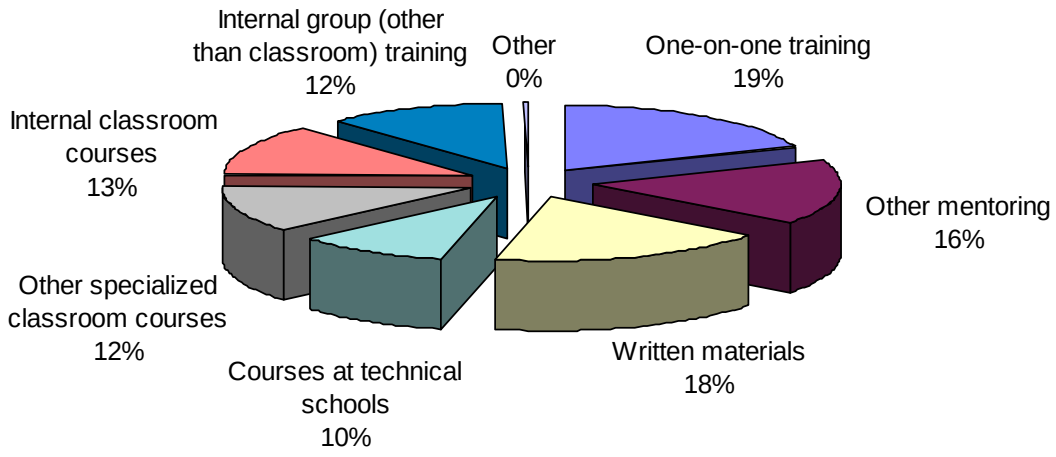


37. Please add any related comments, or discuss "other" skill development methods. (2 comments)

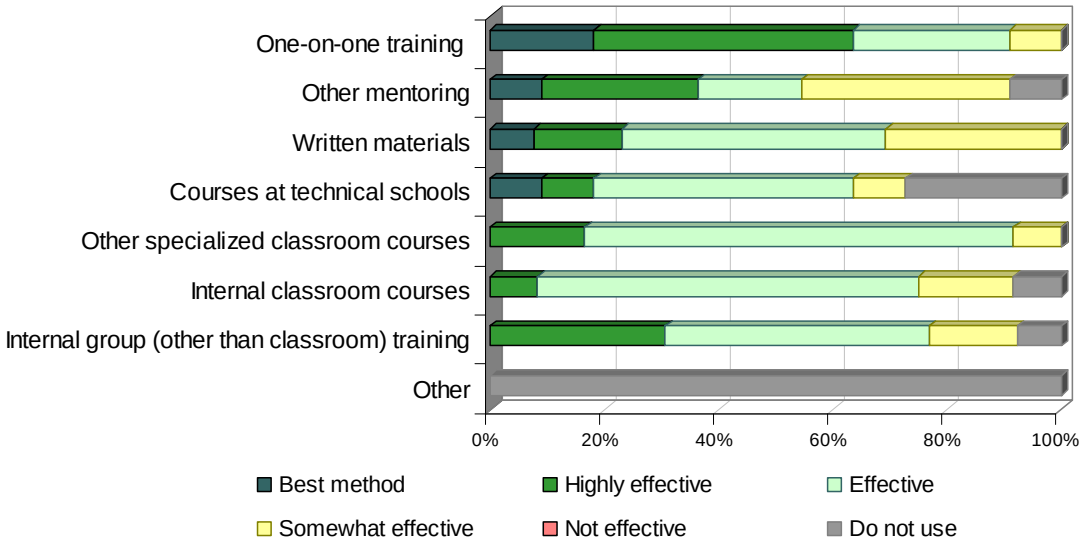
- We find a combination of written material, one-on-one training and mentoring is the best approach. Mentoring is the most critical.
- Specialized in-house training that is topic-specific is usually effective. Internally, formal classes held annually are very effective. These classes involve both written material and hands on work. Written materials, specifically the eWeb OQ, is not effective (It is good for orientation only). Other mentoring includes any qualified individual (SME's or high-level techs) mentoring one-on-one with a trainee.

Quality Control, Regulatory and Compliance

38. Estimate how often you use each skill development method as a percentage of all skill development for this job category.



How effective is each method?



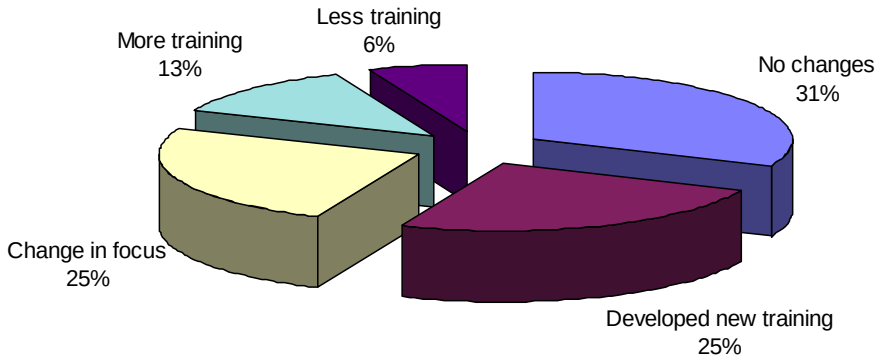
39. Please add any related comments, or discuss "other" skill development methods. (1 comment)

- Feet on the ground one-on-one training (other skill development methods)

40. Are you aware of any gaps in internal or external training curriculum related to skills required by your industry?

- Engineering (2 comments)
  - Reservoir engineering, petroleum engineering training
  - In drafting, we see a gap in training for piping design
- Operator training (4 comments)
  - Operator training, service training skills
  - Although we have a robust, well-documented Operator Qualification process, we have need for a more formalized documentation process for our on-the-job training. We are currently developing this process.
- Skilled trades
  - Welders (3 comments)
    - There is no training for welders except for in-house training
    - Pipeline welding (API 1104) training
  - Corrosion
  - Live side boom operators
  - Bending engineers
  - Tie-in foreman
  - Hydrostatic testing foreman
- Other
  - OEM specific for mechanical applications
  - Being up to date on current technology and instrumentation
- No gaps (5 comments)

41. Have you changed your training plans in the last 12 months? If so, please add comments about the changes and their impact on the organization's skill development.



- Yes, changes have occurred (11 comments)
  - Developed new training (4 comments)

        - Developed training materials for deployment
        - They are in year two of development
        - We have developed a more detail/in-depth entry level training. As well as, added more details and emphasis to our mentor programs
        - Same methods in regards to training and performance, but revising the format to address concerns
    - Change in focus (4 comments)
        - Focus on quality management and on sustainable development
        - Much more focused on compliance and specific skills training, less on conference attendance, etc
        - Changing to a more functionally specific training and work plan to increase depth of knowledge on key technical functions
        - In the past 12 months, we have placed greater focus on knowledge transfer and have recently implemented a web-based Operator Qualification training program.
    - More training (2 comments)
        - We have increased training efforts
        - More one-on-one training
    - Less training (1 comment)
        - Technical training with operations staff reduced to as-needed basis
- No changes have occurred (5 comments)

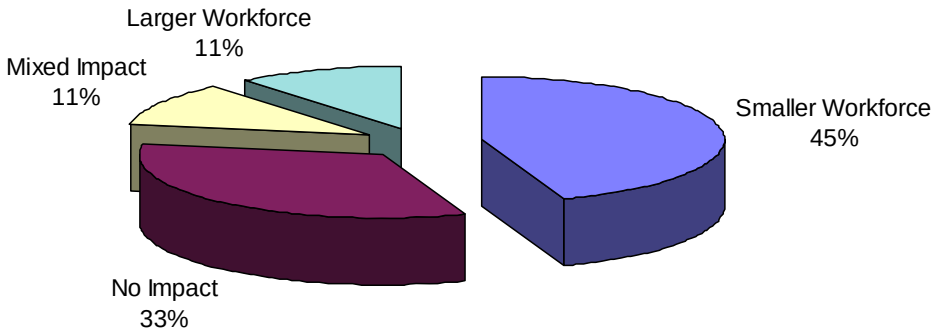
42. Are there any plans at your company to change or expand the types of training used?
    - Yes (11 comments)
        - Expanding internal training capability (8 comments)
            - Internal operator training
            - Continue to develop and refine our training processes
            - We have added computer based training to regulatory refresher training
            - More leadership coaching for managers
            - More formal group training
            - Constantly expanding opportunity for individual training
        - Improving existing training capability
            - We plan to continue our current training programs and develop a more formalized documentation process for our on-the-job training.
        - We would like to see "standard" curriculum's established for major functions by INGAA or SGA for transmission industry.
    - No or do not know (5 comments)

43. Please add any further comments you have about today's educational opportunities, as they relate to your industry. (3 comments)
    - Opportunities are available but are difficult to come by

- Business application skills are lacking in technical college graduates
- Continue to bring outside SME to the company for one-on-one or small group training or refresher

FUTURE WORKFORCE AND SKILL REQUIREMENTS - TRENDS IN TECHNOLOGY

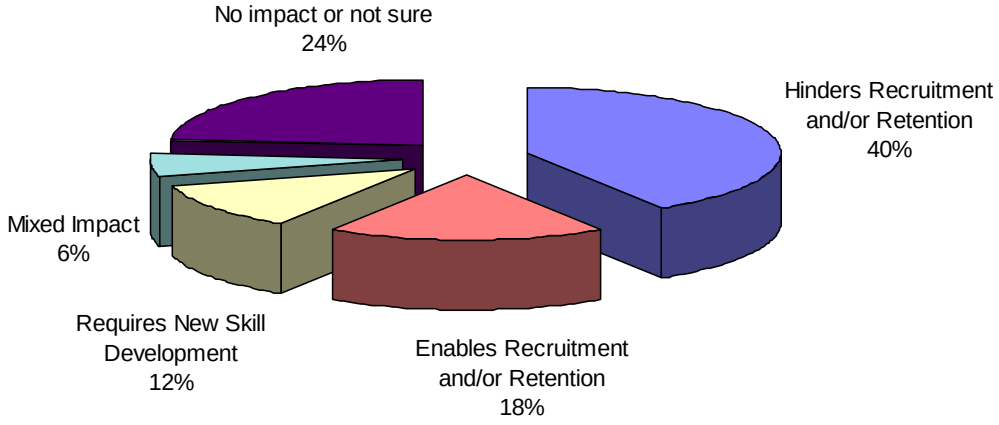
44. Has technology affected the need for a larger or smaller workforce? If so, please estimate the impact and time period.



- Smaller workforce (8 comments)
  - More technology, properly applied, should require smaller workforce.
  - Because with its advances there are less people needed but those people need have to have a higher skill set.
  - Design/drafting technology enables us to do more with fewer people.
  - Automatic welding has helped reduce the number of welders required on large diameter pipeline projects.
  - Our company had an early retirement program in 2000, which resulted in the loss of a number of workers. Automation and the efficiencies it brought allowed fewer workers to be more productive to meet our business needs.
- No impact (6 comments)
  - Same size staff meets higher expectations (volume and complexity) through the use of technology. (2 comments)
  - Technology has not made any real impact to our industry.
  - Our industry is very slow to transition to new technology, due to high level of expense.
- Mixed impact (2 comments)
  - Initially during development of systems the work force is larger. The work force decreases as efficiencies increase.
  - It's shifted the need to a requirement for a better educated workforce and increased the need for electronics and electronic communication skills.
- Larger workforce (2 comments)
  - Larger because of all the regulatory requirements.

- Compliance monitoring requires changes in resource positions and tends to add to the technical manpower requirements.

45. How has technology affected your ability to find and retain a qualified workforce?



- Hinders recruitment and/or retention (7 comments)
  - Technology makes it difficult to find and retain a qualified workforce because of the specialized skill set required to be able to use this technology available. (2 comments)
  - Harder to find qualified operations people who also can function electronically.
  - Many tenured technicians find the electronic and PC world challenging.
- Enables recruitment and/or retention (3 comments)
  - Technology has benefited our ability to retain our current workforce.
  - Internet job posting has increased qualified applicant pools. Automation in our industry also helps us attract and retain employees, because the jobs are more interesting.
- Requires new skill development (2 comments)
  - New skill sets require understanding of computers and ability to diagnose problems.
  - The use of computers is widespread. We need to train our superintendents and foremen on basic computer tasks.
- Mixed impact (1 comment)
  - It creates it challenges, but also offers opportunities.
- No impact or not sure (4 comments)

46. How has technology affected the skills or knowledge set required of the workforce?

- Personal computer skills required (7 comments)
  - The use of computers is widespread. we need to train our superintendents and foreman on basic computer tasks.
- Other skill requirements (6 comments)
  - Electronic controls (2 comments)

  - Digital systems
  - GIS based experience
  - Electronics
  - Programmable Logic Controllers
  - Communications
- Impact on older workforce (2 comments)
  - Technology advances have made it difficult for the older workforce to adjust and keep up.
- Enables faster communications (1 comment)
- Impact on salaries (1 comment)
  - It requires them to possess higher skill sets and therefore demand higher pay.
- More difficult to retain lower skill workers (1 comment)
  - Increased the educational requirements and once educated it presents a challenge in that the employee wants to perform the high end work and desires not to do the "dirty work". For example a compressor mechanic needs electronic/controls skills (high end) and we still need them to be willing/able to complete an oil change or bearing change out...dirty work.
- No impact (2 comments)

47. What do you expect the impact of technology will be on your workforce or skill requirements in 2 years? In 5 years?

Short-term (two year) impact

- The impact will be minimal due to the relative slow advance of required technology and skill requirements will advance slowly as well.
- New systems (GIS), new tools (GPS) will be rolled out
- Increased productivity (1 comment)

Medium-term (five year) impact

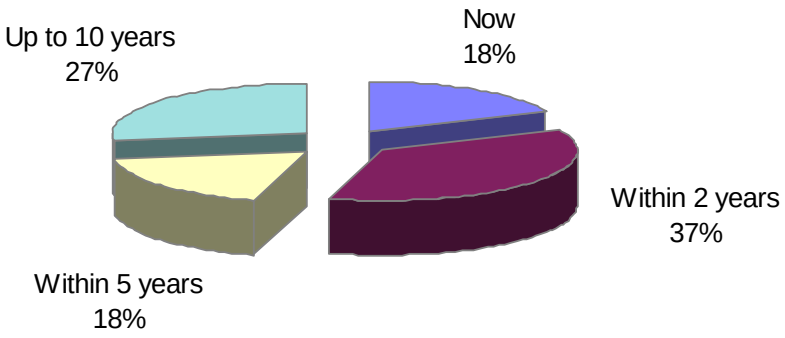
- More training and education requirements (7 comments)
  - The equipment is becoming more sophisticated and will require more training.
  - Field maintenance and operation need will be primarily for electronic controls expertise. Operations need will have computer base skills.
  - Skill requirements will increase for both regulations and technology
  - Need to upgrade and refresh skills
  - More automation and higher levels of skill will be required. We see no indication of this trend changing in the two-year to five-year period.
- Significant impact (3 comments)
  - In 5 years, there will be a significant change in the workforce due to turnover and retirement due to the inability to acquire the required skill sets.
- Minor impact (4 comments)

  - Engineering will have a minor impact. There will be some learning curve issues first two years, but a better workforce in five years.
  - Younger employees are quick to learn the technology side, but need a lot of experience which just takes time.
- Smaller workforce (1 comment)
  - Allow smaller work force, but require a much "smarter" work force with wider breadth of skills.
- Increased customer expectations (1 comment)
  - As technology increases demand for immediate response/repair increases because the expectation is the "reading" will be there 100% of the time.

48. Do expected technology changes have adequate skill coverage within your company?
    - Yes 84%
    - No 16%

49. If not, what skills will be required?
    - Training will be required for new systems and tools
    - More IT related understanding
    - Electronic controls and communication skills and programming skills, including trouble shooting programs.

50. In what time period will this affect the required skills in your workforce?



FUTURE WORKFORCE AND SKILL REQUIREMENTS - MARKET CHANGES

51. Do you expect significant changes in your market the next 2 years? Increase of 31% for companies with less that 100 employees, decrease of 2% for companies with more than 100 employees.

52. Do you expect significant changes in your market the next 5 years? Increase of 41% for companies with less that 100 employees, increase of 11% for companies with more than 100 employees

53. How do you expect this to affect your technical workforce headcounts within 2 years?

Comments from companies increasing market within two years:

- Headcount impact (6 comments)
  - Increased headcount (4 comments)
    - I believe there will be an small increase in the younger technical workforce within 2 years.
    - Headcount increase of 50%.
  - Mixed headcount impact (1 comment)
    - I think we will need to add employees for the next two to three years. I believe the industry will slow down in about three years.
- Difficulty recruiting
  - Local drilling/gathering systems could put a drain on local expertise.
- Small impact (4 comments)
  - Very little effect, we are running very lean currently.
  - Status quo to slight increase.
  - Anticipate 2% growth in our workforce in the next two years.
- No impact (2 comments)

Comments from companies reducing market within two years:

- Need to increase retention (1 comment)
- Headcount reduction (1 comment)

54. Do you expect changes in 5 or 10 years?

- Yes (5 comments)
  - Headcount increase
  - Drilling and media attention should swing the pendulum of available/trained/interested people back to our industry.
  - I believe there will be significant changes in 10 years but minimal changes in 5 years.
  - We'll continue to see changes, retirement attrition comes into play along with local competition for talent.
- Moderate changes (2 comments)
  - I think the industry will peak in two to three years and then slow down.
  - Anticipate 4% growth in our workforce in the next five years and a return to 2% growth in our workforce in ten years.
  - Should be able to maintain once the workforce is up to speed.
- Not sure (1 comment)
  - I would have said yes, three months ago [July 2008]. Right now I don't know.
- No (1 comment)

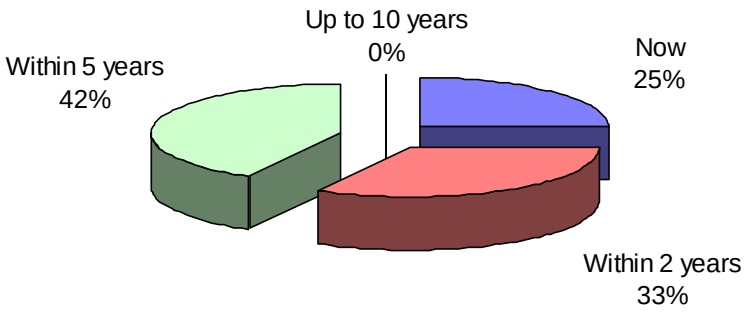
55. Do you have adequate skill coverage to respond to market changes?

- Yes - 75%
- No - 25%

56. If not, what skills will be required?

- Petroleum engineers
- Reservoir engineers
- Welders
- Electricians
- More electronic trouble shooting capability.
- Electronic controls and communication coupled with measurement and mechanical skills

57. In what time period will this affect the required skills in your workforce?



FUTURE WORKFORCE AND SKILL REQUIREMENTS - OTHER INFLUENCES

58. Are there any other trends that will affect the required workforce for the natural gas industry? Please explain the trend, effect, and anticipated time frame.

- Retirement attrition (5 comments)
  - The lack of skilled operators will effect the natural gas industry as the older workforce will retire within the next 5-10 years. This effect will decrease the amount of operator experience available on the pipeline right-of-way.
  - Retirement of mechanical based skills.
  - Baby boomers will eventually be gone, whether they want to be or not. Currently they are hanging on due to economic reasons.
  - There will be an increase in retirements from current workforce. The marketplace lacks qualified potential employees
  - Engineering - expected higher levels of retirement attrition will be the number one trend that will affect our workforce in the next 5 years. Aging pipeline systems will require skilled workforce for replacement and maintenance.
- External factors (4 comments)
  - The economic downturn may result in some workers leaving the natural gas industry for other industries over the next year. (2 comments)

  - The upcoming presidential election. Depending on who wins the election will affect the natural gas drilling programs.
  - Climatic changes, specifically hurricanes, have devastated and displaced workers and their families in Louisiana.
- Industry implemented changes (3 comments)
  - Outsourcing trend continued over next 5 years.
  - Flex hours and work/life options. Demand for reasonable work hours and family time. I'm all in favor, however the reality is our industry has historically been very demanding and reliability of service limits flexibility in work hours etc.
  - LNG will require a new skill set to operate those plants.
- Cyclical nature of industry (2 comments)
  - The construction business is very cyclic and seasonal, so there will always be changes.
  - The drilling trends (shale, oil sands) in the lower 48 and the Alaska pipeline will have an impact on our workforce.

59. Are there any new skills that you think it is important for your company to recruit?
    - Yes - 60%
    - No - 40%
60. If so, what are they?
    - Project management (2 comments)
      - We need to recruit knowledgeable employees that understand what it takes to run a project. We can them teach them about the natural gas industry.
    - The ability to understand and flexibility to learn about the new technology implemented in the pipeline equipment.
    - Skilled craft personnel - welders, operators, live side boom operators, bending engineers, tie-in foreman and hydrostatic testing foreman
    - Computer and electronics technology
    - Programmers for measurement applications
    - Mechanical, corrosion, measurement and pipeline
    - Continue to push computer skills and use of technology
    - Marketing

WORKFORCE PLANNING

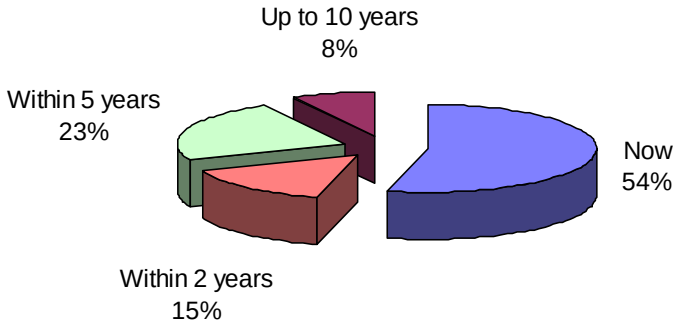
61. Do you have any projects in the planning stages where you need additional skills?
    - Yes - 68%
    - No - 32%
62. If so, what type of project? Please be as specific as possible.
    - LNG plants (2 comments)

- Construction (2 comments)
- ECDA integrity projects, distribution integrity mandates (2 comments)
- Compression and compressor installation (2 comments)
- Pipeline and pipeline expansion (2 comments)
- New GIS system
- New pipelines
- Expansion of gas storage
- Measurement installation projects
- Salt cavern projects
- Technical support
- In developing new equipment to satisfy the needs of pipeline contractors, new products need to be designed and tested
- Maintenance

63. What skills do you need? Please be as specific as possible.

- Engineers (3 comments)
  - Pipeline integrity engineers (2 comments)
  - Petroleum engineers
  - Reservoir engineers
  - Engineers that understand LNG
- Welders (3 comment)
- Design expertise
  - Equipment design
  - Structural design
  - System design
- Solution mining
- GIS technicians
- Language capabilities with Chinese and English proficiency
- Computer expertise, advanced computer aided design expertise
- Live side boom operators
- Data acquisition technician
- Electronics, controls, and programming.
- Project manager
- LNG/Process plant operations
- Construction supervision, quality control

64. In what time period will this affect the required skills in your workforce?



65. Is your company taking steps to secure the skills required for these new projects?

- Yes - 89%
- No - 11%

66. If so, what are they?

- Skill development (9 comments)
  - Continue to educate current employees on technical training for needed skill sets
  - Updating and implementing the training of the existing and incoming workforce
  - We are conducting a TIG class internally to train our welders
  - Mentoring
- Recruitment (6 comments)
  - Increased on-campus recruiting, working directly with professors at universities that have the degrees we need, on-going hiring
  - Resource planning groups for recruiting
  - Work with local HR sources in the country
- Planning (2 comments)
  - We are working with a workforce planning model
- Other (3 comments)
  - Conscious of the location and stability of work
  - Planning to use contractors
  - Conferring with consultants

67. Is it working?

- Yes - 62%
- No - 0%
- Conditional - 38%

68. If conditional, please explain:

- We started to late and are heavily dependent on mentoring (2 comments)

- Some increase in hiring of qualified candidates, but still have a need
- Just under way, too early to tell
- The cyclic nature of the construction business will always make this a challenge
- Young people don't want to weld, too hot and too much hard work

69. Would you consider participating in an industry-wide effort to increase the supply of critical skills?

- Yes - (7 comments)
- No - (2 comments)
  - I already have too many irons in the fire! Good luck!
  - This gap will only be resolved by labor market supply and demand in the coming years.
- Conditional (3 comments)
  - Depends on competition.
  - Depends on the degree of input as well as the odds of success.
  - Possibly, we would need to understand what the industry wide effort consisted of. I believe there is a distinct difference in attracting and retaining professional (engineers) and full time operational (live at home) staff as to attracting and retaining skilled craft personnel willing to travel all over the US.

OVERALL ASSESSMENT

Using the following scale:

Very Critical - Workforce and knowledge issues are a very high priority for my company and receive considerable attention at the upper management level.

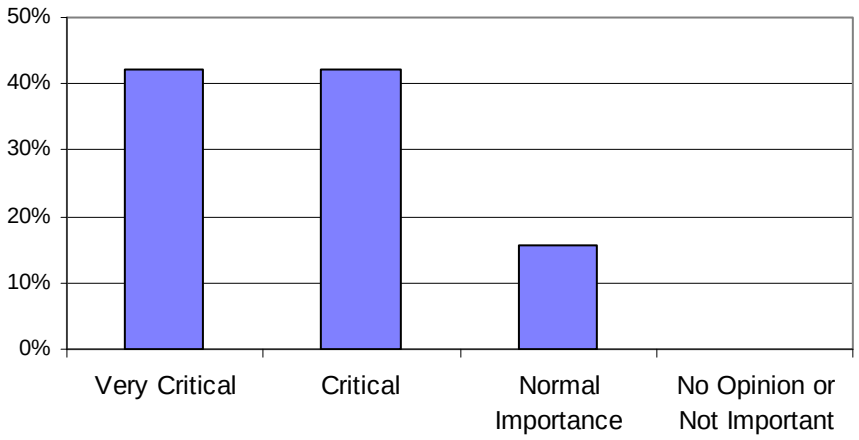
Critical - Workforce and knowledge issues are a priority for my company and receive attention at the upper management level.

Normal Importance - Workforce and knowledge issues are of normal importance for my company and receive the same attention as they have received over the last several years.

Not Important - Workforce and knowledge issues have a low importance in my company.

No Opinion

70. How do you rate safeguarding your workforce and knowledge assets? (19 Respondents)



Using the following scale:

Very Confident - These issues receive high visibility in the company, and have been addressed in a comprehensive manner. The risks have been quantified, adequate resources have been allocated, and a plan is being implemented according to schedule.

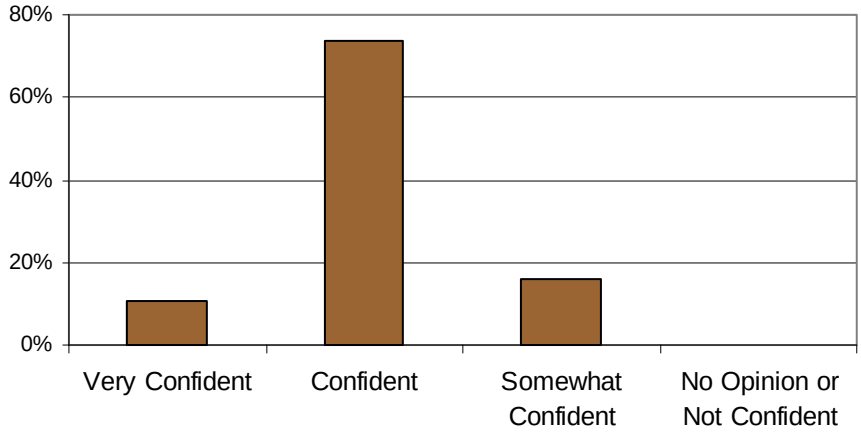
Confident - These issues receive visibility within the company, and have been addressed. The most important risks have been quantified, some resources have been allocated, and necessary steps are being taken to secure the company's knowledge and workforce.

Somewhat Confident - These issues have some visibility in the company, and actions to address them are in the planning stages.

Not Confident – Workforce issues are not being allocated the required resources or manpower.

No Opinion

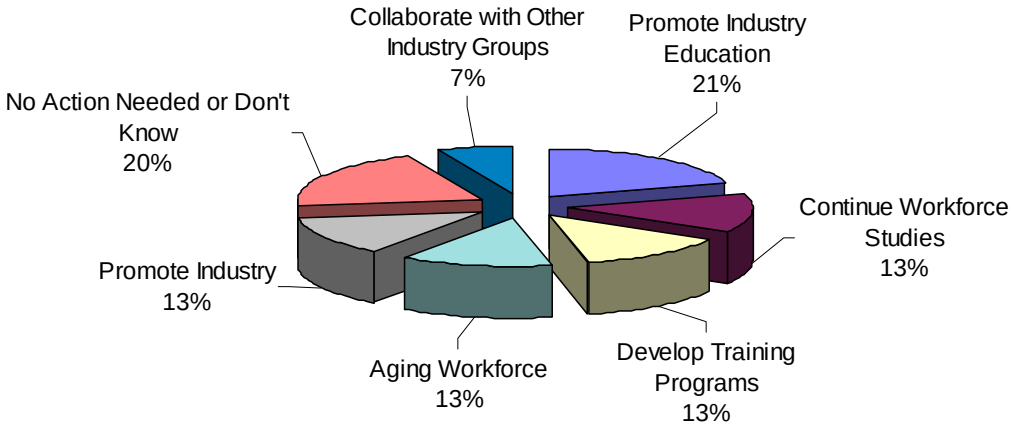
71. Do you feel your company will be able to successfully maintain your workforce and knowledge assets? (19 Respondents)



72. Have workforce issues become more critical to your company's management over the past year? If yes, please comment.

- Yes (10 comments)
  - We have actively worked with senior management to educate them using the INGAA study.
  - Workforce issues have become more critical to our management. Steps have been taken to engage an outside consultant to assist with knowledge transfer and documentation of on-the-job training.
  - We have seen multiple jobs go unfilled due to lack of a qualified candidate.
  - The diminishing skilled workforce is a major concern with my company. The ability to attract and retain highly skillful workforce is a difficulty that we are struggling to achieve.
  - The extreme shortage of resources has prompted management to explore many alternatives to secure additional resources.
  - As we have added more people and have spent the time and money to train those people you want to retain them. There is a shortage of good, quality employees so you want to keep the ones you have.
  - Over the past 3 years -- YES, but 2008 we are seeing the benefits to some of the processes we have implemented in 2006, 2007 and 2008.
  - Actually over the last 3 years.
  - Steps are being taken to retain workforce.
  - Engineering is significant, not critical. Increasing capital budgets combined with higher levels of attrition than in the past have created more pressure on providing adequate training with reduced capacity for one-on-one mentoring.
  - Economic pressures.
- No (3 comments)
- No change (1 comment)

73. What actions should the INGAA Foundation take to help you with your workforce strategy?



- Promote education (3 comments)
  - Work with universities to advise on the future need for engineers in energy businesses.
  - Support of industry specific college research centers.
  - Organize a list of vocation/technical schools that train specifically for our industry. Work to grow that list. Help to set up/incorporate internships with both traditional and vocational schools.
- Workforce studies (2 comment)
  - Continue to survey and publish reports on trends.
  - INGAA should take the input gathered from this survey and compile it into workable and deliverable action item list. This will help companies to view how workforce strategies are being administered and implemented and the urgent changes that are occurring in the pipeline industry. This will help to raise awareness throughout. INGAA should help companies to understand what a successful strategy might entail.
- Develop training programs (2 comments)
  - Develop training for an ever-changing workforce.
  - If there was some sort of INGAA sponsored training program for different crafts, it would help with the training aspect.
- Aging workforce (2 comments)
  - Continue to help focus the industry to the needs of our aging workforce and attracting and mentoring new employees.
  - Lobbying activities for phased-in retirement and removing impediments to hiring foreign workers.
- Promote industry (2 comments)
  - Continue to promote industry knowledge.

  - Public education to increase awareness of our industry.
- No action needed or don't know (3 comments)
  - Current steps have been sufficient.
  - None. Each company has different needs that must be solved by them.
  - Not familiar with the INGAA Foundation or its past contributions.

74. Please add any other comments (1 Respondent)

- INGAA should team with IPLOCA [International Pipeline and Offshore Contractors Association] in an effort to attack and resolve issues that affect the workforce as a whole.

APPENDIX D - CRITICALITY ASSESSMENT

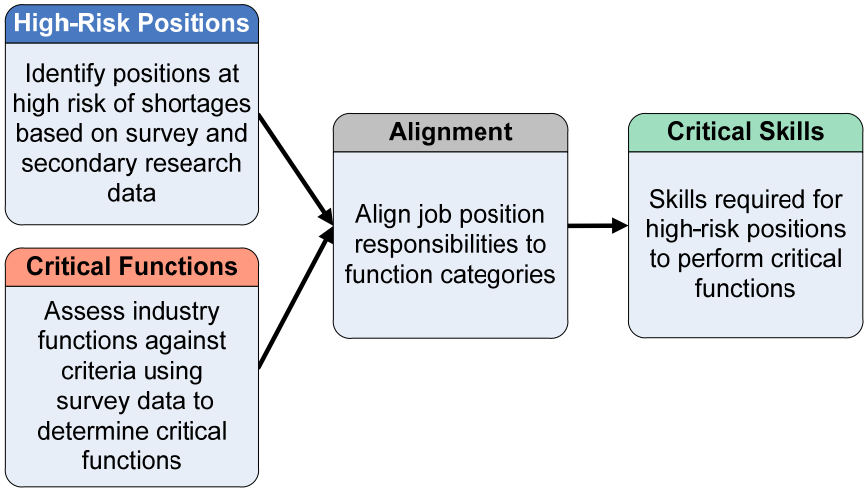
TABLE OF CONTENTS

INTRODUCTION

This document is part of the INGAA Foundation's *Critical Skills Forecast for the Natural Gas Transmission Industry* Project and presents the criticality assessment of job functions, the risk assessment for the supply of skilled employees, and examines the intersection of critical functions and job positions at high risk for labor shortages in the natural gas industry.

The critical intersections are based on:

- Criticality of each function category
- High-risk (i.e., labor shortage) job positions
- Alignment of critical functions to high-risk job positions



Appendix G - Industry Function Model defines the 12 function categories and their 487 functions. *Appendix F - Industry Technical Job Positions* lists the six job categories with their 89 job positions and alternate job titles.

STUDY FINDINGS

The study findings identified the areas of greatest concern for maintaining a capable workforce in the natural gas industry to minimize risk to operational capability and the costs associated with poor performance.

Of the 12 function categories, the critical functions identified by the criticality assessments are:

- System and Facility Design
- Construction Activities
- Project Management
- Pipeline Integrity

The review of overall and natural gas industry employment forecasts and survey data from Human Resources, Management and Technical industry professionals was aggregated to assess

the industry job positions for their risk of shortages. The high-risk job positions are shown with their reference numbers from *Appendix F - Industry Technical Job Positions* in parentheses:

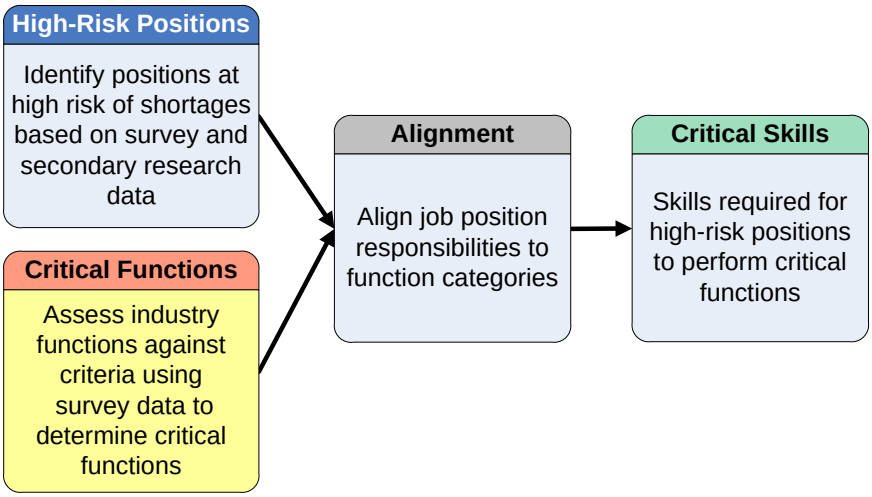
- Pipeline Integrity Engineer (1.2)
- Electrical Engineer (1.3)
- Civil Engineer (1.10)
- Architect (1.11.1)
- Construction Manager (2.2)
- Surveyor, Surveyor Technician, Pipeline Mapper (3.3.1, 3.3.2, 3.3.4)
- Electrician (4.1.1)
- Environmental Compliance Inspector (5.3.1)

The positions and function categories were aligned to identify the critical intersections, which are:

- Project management performed by construction managers, civil engineers, pipeline integrity engineers, or electrical engineers.
- Pipeline design for structural analysis and corrosion control performed by pipeline integrity engineers or civil engineers with assistance from construction managers.
- Pipeline design for compliance performed by pipeline integrity engineers with assistance from environmental compliance inspectors.
- Design of measurement and communication systems performed by electrical engineers.
- Pipeline integrity planning for maintenance, regulatory compliance, risk management and threat identification performed by pipeline integrity engineers with assistance from environmental compliance inspectors and operations managers.
- Drilling/boring planning and performance performed by civil engineers and managed by construction managers with input from environmental compliance inspectors and surveyors.
- Quality inspections for new systems and stations managed by construction managers or civil engineers.
- Management of compliance requirements during construction activities performed by construction managers with input from environmental compliance inspectors.

The methodology and more detailed results are presented in the remainder of this report.

FUNCTION CRITICALITY ASSESSMENT



Two assessment tools were used for determining the function criticality. The first was a detailed criticality assessment and the second was a summary criticality assessment. The detailed criticality assessment used a spreadsheet that presented the 12 function categories and 487 functions identified by the Critical Skills project steering committee and industry subject matter experts.

Respondents were asked to assess the functions' relative criticality to the industry based on twelve measures, grouped into operational impact and cost of quality.

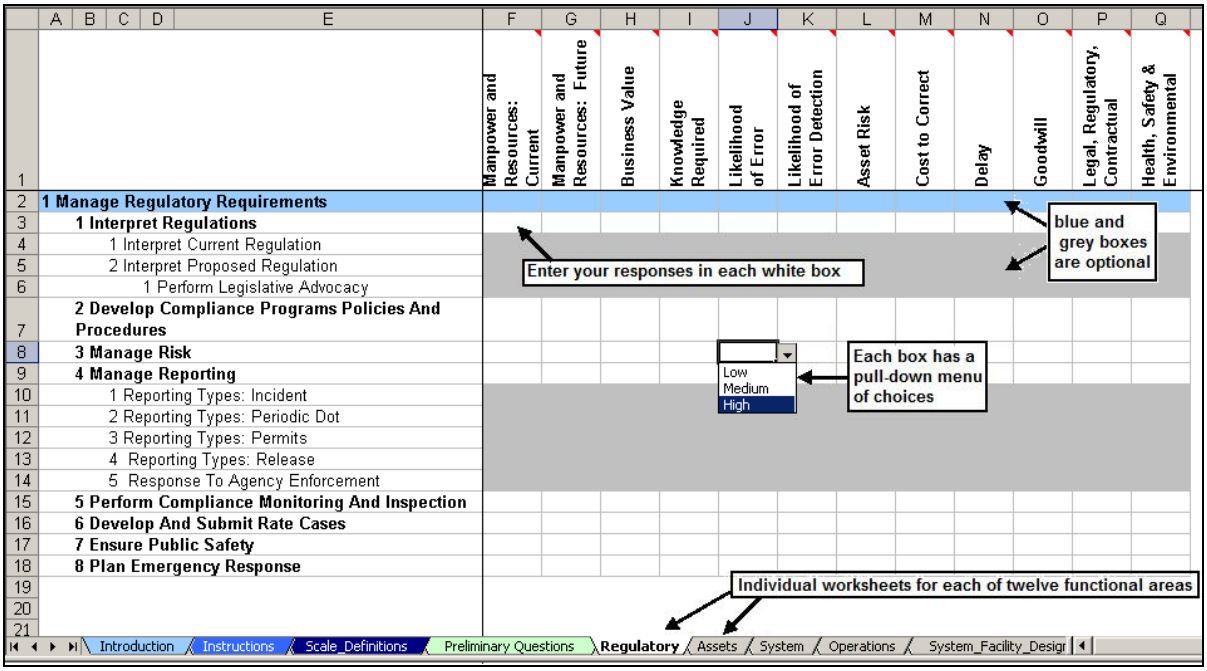
The Operational impact of the functions is measured in terms of:

- Resources and manpower is the proportion of the company business that is involved in completing the function in terms of manpower, equipment, budget and capital.
- Business value is the amount of value derived from performing this function, including expected revenue and profit, as well as whether this is a core function or a function that should be discontinued.
- Knowledge required assesses the level knowledge required to perform this function, and the difficulty and time involved in developing competence in this function. Respondents were asked to consider the level of documentation available, the skill and experience required, whether required knowledge tacit or explicit, and the availability of external training resources.

The Cost of quality assesses the severity of potential errors resulting from the poor performance of a function. The most severe errors will be most likely to occur, difficult to detect, and costly to correct. This is measured in terms of:

- Likelihood of error assesses the probability of making an error when performing this function.
- Likelihood of early detection is the probability that any errors will be detected in time to avoid potential costs.
- Cost of failure is assessed in terms of risk to assets, correction cost, delays, goodwill, legal, regulatory, and contractual, and health, safety and environmental for undetected errors.

The measures and their scale definitions are explained further in the *Detailed Criticality Scale Definitions* section of this document. The following is a picture of the "Regulatory" sheet from the detailed criticality spreadsheet. The blue and grey fields indicate optional assessments.



Respondents were asked to answer questions about their job function and the size and type of their company, and to estimate the overall resources in terms of manpower, equipment, budget and capital assigned to each of the twelve functions. A picture of the input sheet for this information is shown below.

Respondent Demographics

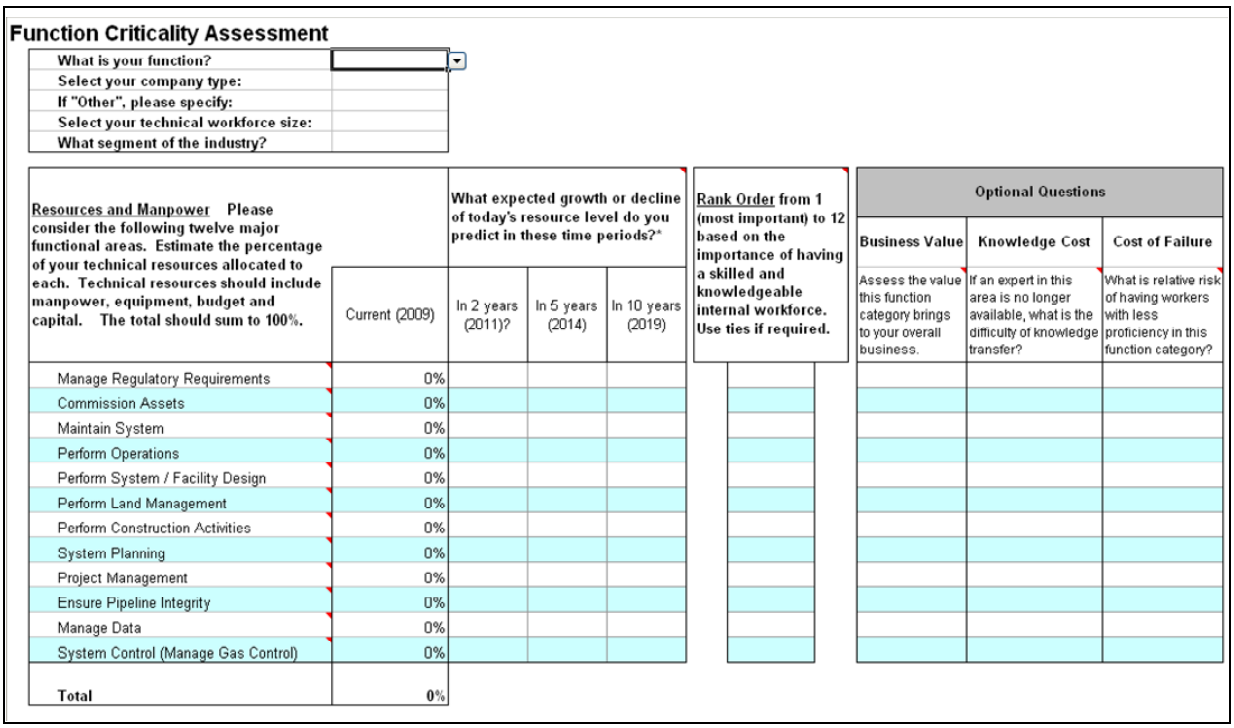
What is your function?	
Select your company type:	
If "Other", please specify:	
Select your technical workforce size:	
What segment of the industry?	

Resources and Manpower Please consider the following twelve major functional areas. Estimate the percentage of your technical resources allocated to each. Technical resources should include manpower, equipment, budget and capital. The total should sum to 100%.	
Manage Regulatory Requirements	0%
Commission Assets	0%
Maintain System	0%
Perform Operations	0%
Perform System / Facility Design	0%
Perform Land Management	0%
Perform Construction Activities	0%
System Planning	0%
Project Management	0%
Ensure Pipeline Integrity	0%
Manage Data	0%
System Control (Manage Gas Control)	0%
Total	0%

The summary criticality assessment was also available for respondents. This was a shortened version of the detailed criticality spreadsheet. For each of the 12 high-level functions, respondents were asked to assess:

- Present resources and manpower
- Forecasts for resource increases or decreases
- Rank order of the 12 function categories in terms of the importance of maintaining a skilled workforce
- Business value of the function category
- Knowledge cost in terms of skill development lead-time
- Cost of failure for poor function performance

A picture of the summary criticality spreadsheet is shown below.



Function Criticality Assessment

What is your function?	
Select your company type:	
If "Other", please specify:	
Select your technical workforce size:	
What segment of the industry?	

Resources and Manpower Please consider the following twelve major functional areas. Estimate the percentage of your technical resources allocated to each. Technical resources should include manpower, equipment, budget and capital. The total should sum to 100%.	Current (2009)	What expected growth or decline of today's resource level do you predict in these time periods?* In 2 years (2011)?	In 5 years (2014)	In 10 years (2019)	Rank Order from 1 (most important) to 12 based on the importance of having a skilled and knowledgeable internal workforce. Use ties if required.	Optional Questions: Business Value — Assess the value this function category brings to your overall business.	Knowledge Cost — If an expert in this area is no longer available, what is the difficulty of knowledge transfer?	Cost of Failure — What is relative risk of having workers with less proficiency in this function category?
Manage Regulatory Requirements	0%							
Commission Assets	0%							
Maintain System	0%							
Perform Operations	0%							
Perform System / Facility Design	0%							
Perform Land Management	0%							
Perform Construction Activities	0%							
System Planning	0%							
Project Management	0%							
Ensure Pipeline Integrity	0%							
Manage Data	0%							
System Control (Manage Gas Control)	0%							
Total	0%							

Scale definitions for the summary criticality spreadsheet are defined in the *Summary Criticality Scale Definitions* section of this document.

ASSESSMENT RESPONSES

The function category assessments from the detailed and summary criticality spreadsheets were rated using the following scale:

Very High	High	Moderate	Low	Very Low

The explanation of the rating mappings and aggregation is given in the *Aggregating Criticality Assessment Responses* section of this document.

The following section gives the summary criticality assessment from companies in the area of consulting, distribution utility, and pipeline.

Consulting

There was one criticality response from a consulting company that identified their most critical function categories as:

- Designing systems and facilities
- Project management

Less critical function categories where the costs of failure or knowledge costs were still high are:

- Business planning
- Managing regulatory requirements
- Construction
- Pipeline integrity

This company did not have any present resources allocated to maintaining systems, operations, system planning, or gas control (SCADA) data management.

The following table shows the summary responses for the criticality assessment.

Function Category	Present Resources	Business Value	Knowledge Cost	Cost of Failure	Overall Criticality
Manage Regulatory Requirements					
Commission Assets					
Maintain System					
Perform Operations					
Perform System / Facility Design					
Perform Land Management					
Perform Construction Activities					
Plan System/ Business Development					
Project Management					
Ensure Pipeline Integrity					
Pipeline Charts & Databases					
Gas Control (SCADA) Data					

The overall criticality was determined by assigning a value of 1 through 5 to the individual assessments of "very low" through "very high." The assessments for each of the four dimensions were summed and a scale was developed for each company type to ensure the "high" and "very high" ratings were limited to an equivalent number. The future forecast was not used to determine criticality, because the limited number of responses could skew the overall criticality based on a single company's business plan.

Distribution Utility

There was one criticality response from a utility company in the distribution segment of the industry.

They identified their most critical function categories as:

- Construction
- Pipeline integrity

System and facility design was also a higher criticality function category. Although there was a high level of present resources in maintenance, this was not rated as a critical function category because of the moderate level of the business value and knowledge cost. Overall, the cost of failure and knowledge costs were considered high for most areas.

The following table shows the responses for the criticality assessment.

Function	Present Resources	Business Value	Knowledge Cost	Cost of Failure	Overall Criticality
Manage Regulatory Requirements					
Commission Assets					
Maintain System					
Perform Operations					
Perform System / Facility Design					
Perform Land Management					
Perform Construction Activities					
System Planning/Business Development					
Project Management					
Ensure Pipeline Integrity					
Manage Pipeline Charts & Databases					
Manage Gas Control (SCADA) Data					

Pipeline

Two pipeline companies completed detailed criticality assessments. These were aggregated using scales shown in the *Aggregating Criticality Assessment Responses* section of this document. These companies rated their highest criticality function category as:

- Perform construction activities

Other critical function categories are:

- Commission assets
- Ensure pipeline integrity
- Control maps, drawings and databases

The following table shows the aggregated responses for the criticality assessment.

Function	Present Resources	Business Value	Knowledge Cost	Cost of Failure	Overall Criticality
Manage Regulatory Requirements					
Commission Assets					
Maintain System					
Perform Operations					
Perform System / Facility Design					
Perform Land Management					
Perform Construction Activities					
System/Business Planning					
Project Management					
Ensure Pipeline Integrity					
Control Maps, Drawings, Databases					
Manage Gas Control (SCADA) Data					

CRITICAL FUNCTION CATEGORIES

There were similarities in the critical function categories for the three company types (consulting, distribution utility, and pipeline).

The critical function category list includes those function categories that were rated as very high by at least one company type:

- Perform system / facility design
- Perform construction activities
- Project management
- Ensure pipeline integrity

The following table shows the overall criticality assessment for each for each company type, with critical function categories highlighted in yellow.

Function Category	Consulting	Distribution Utility	Pipeline
Manage Regulatory Requirements			
Commission Assets			
Maintain System			
Perform Operations			
Perform System / Facility Design			
Perform Land Management			
Perform Construction Activities			
System/Business Planning			
Project Management			
Ensure Pipeline Integrity			
Control Maps, Drawings, Databases			
Manage Gas Control (SCADA) Data			

The full criticality spreadsheet responses were used to identify the critical functions within each category. The formulas for assigning values are given in the *Detailed Criticality Scale Definitions* section of this document. The highest possible criticality score for a function is 100%, and the lowest is 0%. The top four functions were selected for each area, adding any tied functions. The

critical functions are listed below, along with their criticality score in parentheses. The function numbers are based on the numbering system in *Appendix G - Industry Function Model*.

Perform System / Facility Design

- 5.1.4 Perform Structural Analysis – Perform the structural analysis for the pipeline segment, including anticipated in-ground or atmospheric structures. Design system to operate to a specified MAOP level. (65%)
- 5.1.7 Perform Directional Drilling (HDD) – Perform directional drilling as required to route pipe and other transmission components. Maintain compliance with applicable regulation and requirements, including local permits and authorization. (62%)
- 5.2 Design Corrosion Control Systems – Design corrosion control systems, both internal and external, to ensure long-term resistance to corrosion. Corrosion systems may include both active and passive control systems, as appropriate. (61%)
- 5.3.1.2 Specify Compressors - Design the compressor system to be used for gas movement purposes. Identify, analyze and specify the type of compressor to be used based on compression power and sizing requirements as well as other operational performance needs. (61%)
- 5.5 Design Measurement System - Design measurement system to adequately and efficiently control aspects of the system, facility, station, or pipeline. Include specifics of measurement tools design as well as associated communication systems design. (64%)
    - 5.5.1 Plan Meter Design - Design meter to meet storage station requirements. (64%)

Perform Construction Activities

- 7.1.4 Conduct Boring – Bore pipeline as a part of the construction activities. Ensure that boring operations are conducted with approved methods. Verify that boring operations meet all regulatory requirements. (79%)
- 7.1.11 Manage Environmental/Regulatory/Safety Compliance - Manage environmental, regulatory, and safety compliance for the construction project. Monitor and analyze the environmental impact of the project. Identify necessary mitigation measures. Perform notification and reporting activities as required. (71%)
- 7.1.13 Perform Quality Inspection – Perform quality inspection to ensure that approved construction techniques have been employed and documented. Verify and document the use of approved materials. Identify and resolve construction issues or discrepancies, as needed. Issue and file an inspection report. (74%)
    - 7.1.13.1 Inspect Welding – Inspect welding for gas transportation station. (79%)
- 7.2.1 Construct Station – Plan and construct the gas transportation station. Inspect all construction-related activities and materials. Complete project documentation. Complete management role up to the commissioning of the station. (69%)
    - 7.2.1.8 Manage Environmental/Regulatory/Safety Compliance (71%)
    - 7.2.1.10 Perform Quality Inspection (74%)

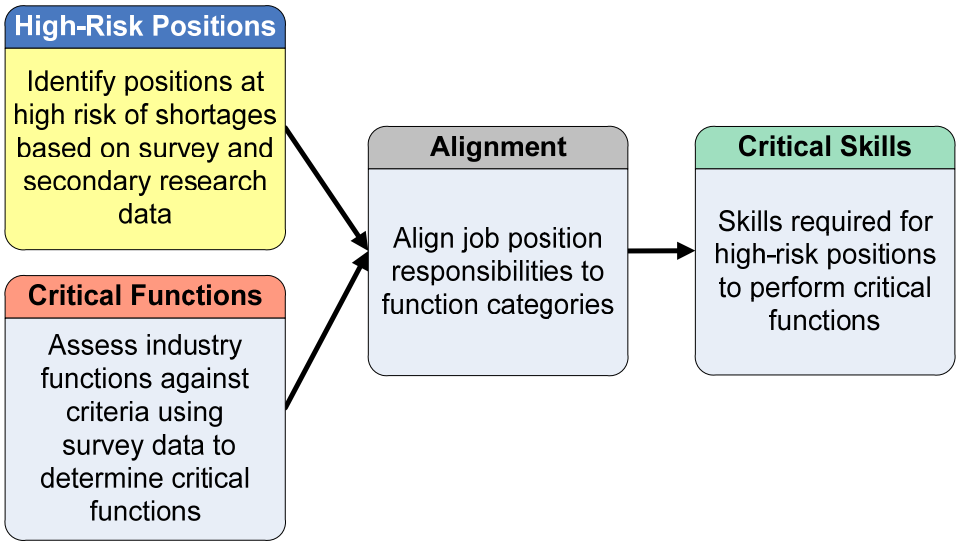
Project Management

- 9.1.5 Perform Change Management - Manage change for the project, including design revisions. Coordinate project changes and modifications with technical experts and project leaders. (77%)
- 9.1.6 Provide Scope Management - Manage the scope of the project so that adequate focus and resources are employed. Ensure the project's definition is clearly defined and accepted. Manage the impact of scope changes with project participants and leaders. Communicate changes in project related to estimated cost and other factors to project sponsor. (79%)
- 9.2.1 Perform Preliminary Project Development – Develop a preliminary plan for a project. Estimate initial cost and schedule. Assess and identify major obstacles or issues that must be resolved in order to complete project. Identify major project phases and milestones. Establish project tracking system. Obtain appropriate approvals to proceed to next project phase. (84%)
- 9.2.2 Perform Detailed Project Development – Develop a detailed plan for a project. Estimate specific costs and schedules. Identify and define project phases along with specific project milestones for each element of the plan. Maintain and mature the project tracking system. Obtain appropriate approvals to proceed to next project phase. (88%)

Ensure Pipeline Integrity

- 10.1 Manage Inspection/Maintenance Planning – Manage inspection to ensure pipeline integrity. Conduct all required regulatory testing and pipeline surveys, including assessments and evaluations. Manage risk in conjunction with all regulatory and organizational requirements. (76%)
    - 10.1.5 Manage Compliance Requirements – Manage compliance requirements for pipeline integrity. Ensure that all regulatory requirements are fully addressed and completed as required. Monitor and track compliance activities to ensure timely completion. Identify and manage to resolution any potential compliance issues. (62%)
    - 10.1.9 Manage Risk - Analyze the results of the physical assessment and determine if actions are required to mitigate findings from assessment. Determine urgency and effect immediate repair/replacement or schedule repair/replacement, other mitigating action, or reassessment interval. (56%)
- 10.2 Perform Threat Identification – Integrate and analyze data on pipeline segments to identify threats and conditions, length of service, inspection interval, experience on pipeline segments with similar characteristics or other factors related to the probability of future conditions. Conduct risk assessment for all pipeline segments and develop a near-term (annual) and long-term plan to assess high-risk segments and HCA's. (65%)

JOB POSITION ASSESSMENT



Eighty-nine job positions were identified in five main job categories for the technical workforce. The job categories along with their job descriptions and alternative titles are presented in the *Appendix F - Industry Technical Job Positions* document. The following table shows the main job categories and percent of the technical workforce in each category, based on data from the Human Resources Survey.

Job Position Category	Pipeline	Services, Construction and Other
1. Engineering, Architecture and Computer Science	16%	53%
2. Management	6%	8%
3. Operations	59%	8%
4. Skilled Trades	15%	13%
5. Quality Control, Regulatory, and Compliance	4%	18%

The data from the Human Resources Survey and the Technical and Management Survey were used along with the secondary research forecasts to assess the risk factor for job positions.

- Difficult to hire is the proportion of respondents from the Human Resources Survey that reported that this job position has been difficult to fill in the recent past.
- Percent of workforce is the percent of the technical workforce in the overall category, and the proportion of the category in each job position, based on the Human Resources Survey data. For example, the Engineering, Architecture and Computer Science category comprises 16% of the total technical workforce for pipeline companies, and mechanical engineers make up 28% of the category, or 4% of the total technical workforce.
- Forecast employment change is the Department of Labor's forecast for the total increase or decrease in the job position from 2006 to 2016. Much of the influence on this percentage is the overall population growth, along with the forecasts for industries that

hire from this category. For example, job positions that are common in construction are expected to have a larger growth in employment because of expected increases in that industry and job positions more common to manufacturing are expected to continue losing employment because of forecasted manufacturing decreases.

- Risk is the possibility of a shortage of this job position (or job position category) based on the other criticality measures. If a job position falls into several risk categories, the highest risk category is assigned.

Some job positions were grouped, and the final listing contains 41 job positions or groups of job positions from the original list of 89 job positions. For instance, electrical engineering technicians (4.1.4) and electronics technicians (4.1.5) were grouped together into one job position group.

HIGH-RISK JOB POSITIONS

The highest risk category was assigned to those job positions that are:

- Very difficult to hire for 80-100% of Human Resources Survey respondents
- Comprise a significant proportion of the workforce: at least 1% of the total workforce or 5% of any category
- Are expected to grow in employment by 2016

Or are:

- Difficult to hire for 60%-80% or respondents
- Comprise a significant proportion of the workforce
- Are expected to have large employment increases of over 15% by 2016

The high-risk job positions and their corresponding reference number from the *Appendix F Job Positions* document are:

- Pipeline Integrity Engineer (1.2)
- Electrical Engineer (1.3)
- Civil Engineer (1.10)
- Architect (1.11.1)
- Construction Manager (2.2)
- Surveyor, Surveyor Technician, Pipeline Mapper (3.3.1, 3.3.2, 3.3.4)
- Electrician (4.1.1)
- Environmental Compliance Inspector (5.3.1)

Medium-high risk was assigned to job positions that are difficult or very difficult to hire, are not expected to have declining employment and comprise a significant proportion of the workforce, or where the Department of Labor is predicting shortages. The medium-high risk job positions are:

- Mechanical Engineer (1.1)
- Gas compressor or gas pumping station operator (3.1.1)
- Gas plant operator (3.1.3)

- LNG or Pipeline Technician (3.1.4, 3.1.5)
- Gas controller (3.2.1)
- Electrical Engineering/Electronics Technician (4.1.4, 4.1.5)
- Instrument and Control Technician (4.1.6)
- Operating Engineer (4.5.1)
- Construction/building inspector (5.1)

The next section presents the job position assessments used to identity the risk levels.

ASSESSMENT FINDINGS

The following scale shows the risk categories that defined in the *Job Position Rating Scale* section of the report.

Engineering, Architecture and Computer Science

Overall, this category is assessed as a high risk due to the present difficulty of finding new-hires, the significant numbers of employees in the natural gas industry, and the growth in employment expected by the Department of Labor.

Particular job positions at highest risk are: pipeline integrity engineers, electrical engineers, civil engineers and architects.

Job Positions	Natural Gas Industry			Forecast Employ-ment Change	Risk
	Difficult to Fill	Percent of Workforce			
		Pipeline	Services, Construction & Other		
1. Engineering, Architecture And Computer Science	83%	16%	53%	18%	
1.1 Mechanical Engineer	78%	28%	21%	4%	
1.2 Pipeline Integrity Engineer	80%	14%	4%	4%	
1.3 Electrical Engineer	86%	5%	19%	6%	
1.4 Environmental Engineer	0%	5%	2%	39%	
1.5 Petroleum Engineer	75%	1%	4%	4%	
1.6 Industrial Engineer	33%	1%	0%	18%	

Job Positions	Natural Gas Industry			Forecast Employ-ment Change	Risk
	Difficult to Fill	Percent of Workforce			
		Pipeline	Services, Construction & Other		
1.7 Geoscientist	100%	0%	0%	29%	
1.8 Chemical Engineer	60%	5%	4%	8%	
1.9 Materials Engineer	60%	0%	9%	3%	
1.10 Civil Engineer	67%	16%	25%	25%	
1.11.1 Architect	67%	5%	0%	22%	
1.12 Computer Programmer	29%	13%	5%	1%	
1.13 Computer Software Engineer	43%	7%	4%	50%	

Management

Overall, the management category has a medium-low risk. The Department of Labor expects these job categories are to grow at a slower than average rate over the next ten years and at present there is only moderate difficulty in finding new-hires.

Job Positions	Natural Gas Industry			Forecast Employ-ment Change	Risk
	Limited Supply	Percent of Workforce			
		Pipeline	Services, Construction & Other		
2 Management	55%	6%	8%	2%	
2.1 Operations Manager	57%	70%	9%	-4%	
2.2 Construction Manager	63%	2%	37%	18%	
2.3 Engineering Manager	50%	16%	47%	8%	

Job Positions	Natural Gas Industry			Forecast Employ-ment Change	Risk
	Limited Supply	Percent of Workforce			
		Pipeline	Services, Construction & Other		
2.4 Purchasing Manager	20%	9%	2%	1%	
2.5 Training and Development Manager	20%	2%	4%	17%	

The one exception is construction managers that are expected to be in high demand in the future. Most Technical and Management survey respondents mentioned project managers, construction managers, or superintendents as difficult to fill positions, and many reported that these are difficult skills to develop. Further limiting the pool, 73% of Human Resources respondents reported that management candidates should have experience in the natural gas industry.

Operations

Operations job categories are expected to grow more slowly than overall employment, with several categories losing significant numbers of employees. The Department of Labor cites automation and mergers in the natural gas industry as reasons for the reduction in operators that are unique to this industry (e.g., gas compressor/gas pumping station operator, gas plant operator, and gas controller).

However, the Department of Labor cites retirement attrition without suitable replacement candidates as a significant motivation for increasing automation in the natural gas industry. Whether increasing automation and efficiencies can keep up with impending attrition and speed of replacement will determine whether these operations become high risk in the future.

One exception to the expected declining employment is the LNG or pipeline technicians who are expecting a modest growth rate of 5% in employment. They are at present difficult to hire for 60% of Human Resources survey respondents. This category is assigned a medium-high risk of shortages, along with the other declining operations positions.

Overall operations are assessed as a medium-high risk for supply shortages.

Job Positions	Natural Gas Industry			Forecast Employ-ment Change	Risk
	Limited Supply	Percent of Workforce			
		Pipeline	Services, Construction & Other		
3 Operations	29%	59%	8%	1%	
3.1.1 Gas Compressor or Gas Pumping Station Operator	67%	2%	0%	-20%	
3.1.2 Measurement Technician	25%	1%	13%	-4%	
3.1.3 Gas Plant Operator	50%	0%	40%	-11%	
3.1.4-5 LNG or Pipeline Technician	60%	84%	32%	5%	
3.2.1 Gas Controller	40%	6%	4%	-11%	
3.2.2 Natural Gas Trader	100%	0%	4%	0%	
3.2.3 Natural Gas Accountant	0%	4%	0%	22%	
3.3.1 Surveyor	75%	1%	5%	24%	
3.3.3 Land Agent	67%	1%	0%	11%	

The only high-risk job position in this category is the surveyor category which includes surveyors (3.3.1), survey technicians (3.3.2) and pipeline mappers (3.3.4). Significant growth in employment (24%) is expected due to increases in the construction industry. At present this job category is difficult to hire for 75% of survey respondents.

Skilled Trades

Overall the skilled trades category is assessed as a low risk. This is mainly due to declining employment in the manufacturing industry, which has been a major employer. Human Resources survey respondents report moderate (44%) difficulty in finding qualified new-hires in the skilled trades job positions.

One exception in the skilled trades category is for electricians. They are at present very difficult to hire and are expected to experience moderate growth in employment. Construction and the

electric power industry are expected to increase employment for this position, offsetting expected losses in employment in the manufacturing industry.

Medium-high risk was assigned to electrical engineering/electronic technicians and instrument and control technicians because they are at present very difficult to hire. These job positions are not rated as a high risk because they are not expected to have any significant employment growth. Operating engineers are expected to have employment growth, but are not as difficult to hire and were also rated as a medium-high risk.

Job Positions	Natural Gas Industry			Forecast Employ-ment Change	Risk
	Limited Supply	Percent of Workforce			
		Pipeline	Services, Construction & Other		
4 Skilled Trades	44%	15%	13%	5%	
4.1.1-3 Electrician	100%	0%	10%	7%	
4.1.4-5 Electrical Engineering / Electronics Technician	100%	4%	6%	0%	
4.1.6 Instrument and Control Technician	75%	17%	6%	0%	
4.2.1 SCADA Engineer	50%	9%	2%	1%	
4.2.2 Automation and Control System Programmer	100%	5%	2%	-3%	
4.3 Pipelayers, Pipefitters, Pipeliners	0%	13%	34%	11%	
4.4 Welding	33%	5%	8%	3%	
4.5.1 Operating Engineer	67%	18%	14%	9%	
4.6 Equipment Maintenance	0%	29%	17%	8%	

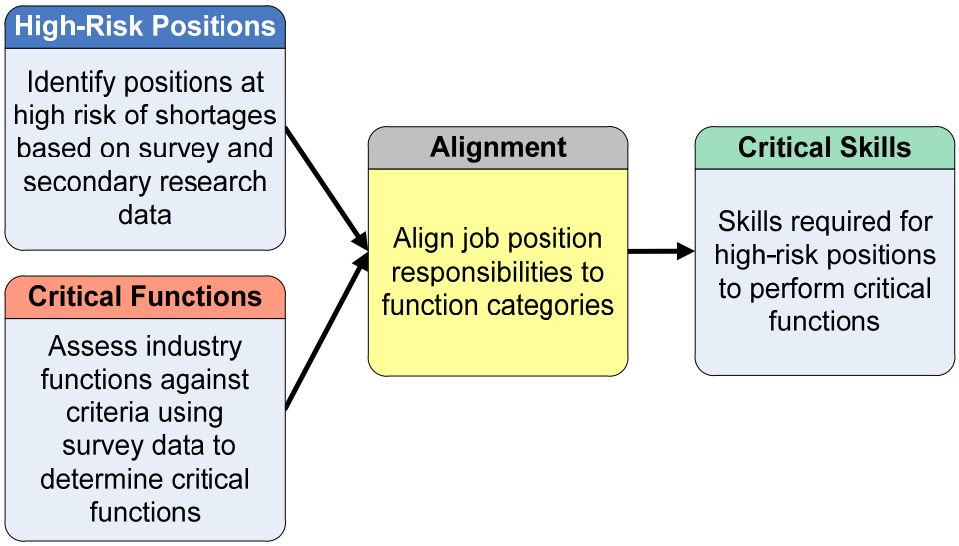
Quality Control, Regulatory and Compliance

Total employment for quality control, regulatory and compliance job positions is expected to fall by 6% by 2016, mainly due to decreases in employment for quality inspectors and specialists in the manufacturing industry.

Increases in construction are expected to increase employment for construction/building inspectors by 34%, making this a medium-high risk job position because they are at present not very difficult to hire. Although increases in employment for environmental compliance inspectors is expected to be smaller (20% increase), they are assessed as a high risk because they were rated as difficult to hire by all of the survey respondents.

Job Positions	Natural Gas Industry			Forecast Employ-ment Change	Risk
	Limited Supply	Percent of Workforce			
		Pipeline	Services, Construction & Other		
5 Quality Control, Regulatory, And Compliance	33%	4%	18%	-6%	
5.1 Construction/Building Inspector	50%	34%	19%	34%	
5.2 Quality Inspector	67%	7%	41%	-13%	
5.2.1 Quality Specialist	100%	2%	20%	-13%	
5.3.1 Environmental Compliance Inspector	100%	31%	20%	20%	
5.3.2 Regulatory Specialist	40%	26%	1%	20%	

ALIGNMENT OF FUNCTION CATEGORIES TO JOB POSITIONS



The relationship of function categories to job positions is shown in the alignment matrix. The types of relationships are:

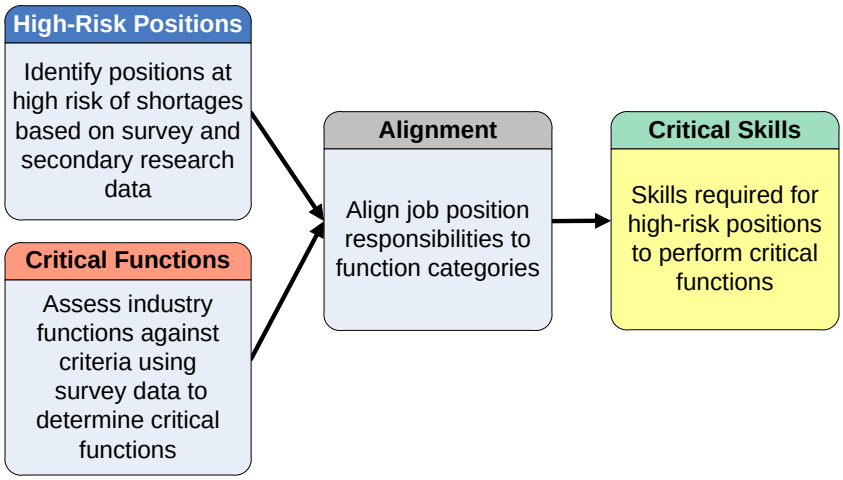
- P = Primary performer of function category
- A = Assists with function category
- M = Manages other performers in this function category
- Blank = Not involved in function category, or in a limited manner
- Yellow highlighting indicates critical function category, in-demand job positions, and the intersections of these positions and function categories

The intersections indicate where critical skills will be found.

Alignment Matrix

Job Position	1. Manage Regulatory Requirements	2. Commission Assets	3. Maintain System	4. Perform Operations	5. Perform System / Facility Design	6. Perform Land Management	7. Perform Construction Activities	8. Business/System Planning	9. Project Management	10. Ensure Pipeline Integrity	11. Manage Maps and Databases	12. Gas Control (SCADA) Data
1. Engineering, Architecture and Computer Science												
1.1 Mechanical Engineer		A	A	A	P		A	P	A	A		
1.2 Pipeline Integrity Engineer	A	A	A	A	P		A		A	P		
1.3 Electrical Engineer		A	A	A	A		A		A	A		A
1.4 Environmental Engineer	A	A	A	A	A	A	A		A	A		
1.5 Petroleum Engineer		A		A	P		A		A			
1.6 Industrial Engineer	A	A	A	A	A				A	A		
1.7 Geoscientist	A	A			P		A		A	A		
1.8 Chemical Engineer	A	A	A	A	P				A	A		
1.9 Materials Engineer	A	A	A	A	P		A		A	A		
1.10 Civil Engineer	A	A			P		P		A			
1.11 Architect	A	A			P		A		A			
1.12 Computer Programmer/Engineer	A			A	A		A		A	A	A	P
2 Management												
2.1 Operations Manager	M	A	M	M	A					M	M	M
2.2 Construction Manager	A	M			A		M		M	A		
2.3 Engineering Manager	A	A	A	A	M			M	A	M		
2.4 Purchasing Manager					A	M	A		A			
2.5 Training and Development Manager	A	A	A	A	A	A	A	A	A	A	A	A
3 Operations												
3.1 Natural Gas Operations				P						A		A
3.2 Scheduling and Accounting				P								A
3.3 Surveying and Land Management			A		A	P	A				P	
4 Skilled Trades												
4.1 Electrical Equipment			P	A			P			A		A
4.2 Computer Control			P	A			P			A		P
4.3 Pipe Installation			P				P					
4.4 Welding			P				P					
4.5 Equipment Operation			P	A			P					
4.6 Equipment Maintenance			P	A			A					
5 Quality Control, Regulatory, and Compliance												
5.1 Construction/Building Inspector		P			A		P		A			
5.2 Quality Inspector		P		A			P		A			
5.3 Regulatory and Environmental	P	P	A	A	A	A	A		A	A		

CRITICAL SKILLS



Critical skills are required for the intersections of critical functions and high-risk job positions. The critical skills are explained in this section along with the function numbers from the *Appendix G - Industry Function Model*.

Project Management (9.1.5, 9.1.6, 9.2.1, 9.2.2) was very critical for pipeline and services companies. Performing the preliminary and detailed project development includes:

- Managing the project scope.
- Performing change management.
- Estimating initial cost and schedule.
- Assessing and identifying major obstacles or issues that must be resolved in order to complete project.
- Identifying major project phases and milestones.
- Establishing project tracking system.
- Obtaining appropriate approvals to proceed to next project phase.

Project management can be performed by several of the critical job positions: construction managers, civil engineers or pipeline integrity engineers. Additionally, industry experience was considered a requirement for job applicants in this area.

Pipeline integrity engineers will also be involved in critical functions for new system and facility design. They are needed to design new pipeline systems, including the structural analysis (5.1.4) and corrosion control systems (5.2). Other critical functions for pipeline integrity engineers are in the pipeline integrity category: managing the inspection and maintenance planning (10.1) and performing threat identification (10.2).

Electrical engineers may develop the design for the pipeline measurement system (5.5) including the meters (5.5.1) and communication systems. Electrical engineers may also have project management responsibilities (9.1.5, 9.1.6, 9.2.1, 9.2.2).

Civil engineers may also be involved in the structural analysis for new pipelines (5.1.4), developing drilling/boring specifications (5.1.7) and overseeing the drilling/boring (7.1.4) during construction.

The planning and drilling/boring may have job duties for an environmental compliance inspector (5.1.7, 7.1.4) as these functions include compliance with regulatory requirements. In addition the inspectors can be involved in managing compliance requirements for ensuring pipeline integrity (10.1.5), and during the construction process (7.1.11, 7.2.1.8).

Construction managers will be responsible for managing all of the critical construction functions for conducting boring (7.1.4), performance of quality inspections for new pipeline construction (7.1.13.1) and station construction (7.2.1.10). Construction managers may also have input into planning for directional drilling (5.1.7), and project management (9.1.5, 9.1.6, 9.2.1, 9.2.2) responsibilities.

The surveyors' work product is an input to the planning and drilling/boring activities (5.1.7, 7, 1.4).

SCALE DEFINITIONS AND MAPPING FUNCTIONS

This section defines the criticality scales and the method for aggregating the responses.

DETAILED CRITICALITY SCALE DEFINITIONS

The criticality functions were determined by the sum of the criticality measures from the detailed criticality spreadsheet. Each of the twelve assessments was assigned a proportion of the total value for the assessment, and this weighting was applied to the individual responses. The maximum value any function can be assigned is 100% and the minimum is 0%.

The weighting is as follows:

- Operational Impact – 80% of total criticality value
    - Current Manpower and Resources – 20% of total criticality value
    - Future Resources – 20% of total criticality value
    - Business Value – 20% of total criticality value
    - Knowledge Required – 20% of total criticality value
- Cost of Quality – 20% of total criticality value
    - Likelihood of Error – 33% of cost of quality measure
    - Likelihood of Error Detection – 33% of cost of quality measure
    - Cost of Error – 33% of cost of quality measure
        - Asset Risk – 17% of cost of error measure
        - Cost to Correct – 17% of cost of error measure
        - Delay – 17% of cost of error measure
        - Goodwill – 17% of cost of error measure
        - Legal, Regulatory, Contractual – 17% of cost of error measure
        - Health, Safety & Environmental – 17% of cost of error measure

The possible responses for each rating type are given below, along with the response's value to the criticality score.

Operational Impact

- **Resources and Manpower –** Rate each indicated function on the following scale for the resources and manpower required. (20%)
    - Majority – This function uses a majority of the resources and manpower in this category. (100%)
    - High – This function uses a large proportion of the resources and manpower in this category. (75%)
    - Medium –This function uses an average amount of the resources and manpower considering all functions in this category. (50%)
    - Low – This function uses a small amount of the resources and manpower in this category. (10%)
    - Rarely/Do not perform –This function is rarely performed or not performed at all. (0%)
- **Future Resources** - Estimate the expected change in the amount of resources and manpower that will be allocated to this function in 5 years.
    - Large Decrease – Greater than 50% decrease in resources and manpower allocated to this function. (0%)
    - Moderate Decrease – 25% to 50% decrease in resources and manpower allocated to this function. (10%)
    - Little or No Change – Up to 25% increase or decrease in resources and manpower allocated to this function. (50%)
    - Moderate Increase – 25% to 50% increase in resources and manpower allocated to this function. (75%)
    - Large Increase – Greater than 50% increase in resources and manpower allocated to this function. (100%)
- **Business Value –** Assess the value that performing this function brings to the overall business.
    - Minimal – Interruptible, this function can be interrupted for periods of time without disrupting company business, and makes little or no contribution to core of business. (0%)
    - Low – Interruptible, this function can be interrupted for periods of time without disrupting company business, but when performed supports core business. (25%)
    - Moderate – Interruptible, this function can be interrupted for a period of time without disrupting company business, but when performed contributes to growth of business. (50%)
    - High – Uninterruptible, this function cannot be interrupted for any period of time without disrupting company core business, but does not contribute to growth of business. (75%)

  - Very High – Uninterruptible, this function cannot be interrupted for any period of time without disrupting company core business and when performed, contributes to growth of business. (100%)

- **Knowledge –** If an expert in this area is no longer available, assess the difficulty of knowledge transfer to another employee. (20%) Consider:
  - Level of documentation available
  - Skill and experience required
  - Whether required knowledge tacit or explicit
  - Availability of external training resources

  Given that, assess the amount of time a new employee needs to develop the skills to perform this function at the acceptable standard level.

    - Minimal – Transferring this knowledge takes less than 1 month (0%)
    - Low – Transferring this knowledge takes 2-6 months (25%)
    - Moderate – Transferring this knowledge takes 6-12 months (50%)
    - High – Transferring this knowledge takes 1-2 years (75%)
    - Very High – Transferring this knowledge takes over 2 years (100%)

Cost of Quality

- **Likelihood of Error**

  Assess the probability that this function will be performed poorly or incorrectly, assuming the performer is qualified to do this function and has an average skill and experience level. (7%)

  - Low – The likelihood of error is considered as having a remote or slight chance of occurrence when performing this function. (0%)
  - Medium – The likelihood of error is considered more than remote, reasonably possible, but less than likely when performing this function. (50%)
  - High - The likelihood of an error is considered probable or likely to occur when performing this function. (100%)

- **Likelihood of Early Detection**

  When errors do occur, assess how likely is it that they will be caught and corrected before other activities are impacted or assets are placed at risk. (7%)

  - Low – There is a remote or slight chance of detecting errors in performance of this function before they have an impact. (100%)
  - Medium – There is a more than remote, reasonably possible, but less than likely, chance of detecting errors in performance of this function before they have an impact. (50%)
  - High – It is probable or likely that errors in performance of this function will be detected before they have an impact. (0%)

- **Cost of Failure**

  If errors occur with no early detection, assess the impact. Consider asset risk, correction costs, schedule delays, client goodwill, legal, environmental impact and other risks. The cost of failure assessment is a sum of the six failure costs that follow. (7%)

  Significance of Asset Risk

  When this function is performed poorly or incorrectly, how likely is it that assets will be placed at risk? (17%)

  - Low – There is a low risk to assets if this function is not performed properly. (0%)
  - Moderate – There is a moderate risk to assets if this function is not performed properly. (50%)
  - High – There is a high risk to assets if this function is not performed properly. (100%)

  Significance of Cost to Correct

  How much would correcting the poor quality performance cost in comparison to the total cost of performing the function in terms of manpower and materials? That is, does the average error require a small correction, complete replication, or does it have wide-ranging effects that can cost many times the cost of performing the original function? (17%)

  - Low – There is a low cost associated with correcting the average error. (0%)
  - Moderate – There is a moderate cost associated with correcting the average error. (50%)
  - High – There is a high cost associated with correcting the average error. (100%)

  Delay

  How much would correcting the poor-quality performance delay the completion of this function and affect other functions subsequently performed? That is, is this a bottleneck function having all or many subsequent functions relying on it, and any delays will affect all deadlines, or is this performed in parallel to other functions or not mandatory, and time delays will not have a significant effect? (17%)

  - Low – The average error would result in a small delay in completing this or subsequent functions. (0%)
  - Moderate – The average error would result in a moderate delay in completing this or subsequent functions. (50%)
  - High – The average error would result in a large delay in completing this or subsequent functions. (100%)

  Goodwill

  Does an error or poor performance of this function risk present or future business with your customer? (17%)

- Low – There is a low likelihood with only a remote or slight chance that impact of this error would cause an average client to reduce their business. (0%)
- Medium– The chance is considered more than remote, reasonably possible, but less than likely, that impact of this error would cause an average client to reduce their business. (50%)
- High– It is considered probable or likely that impact of this error would cause an average client to reduce their business. (100%)

Legal, Regulatory, Contractual

Does an error or poor performance of this function carry potential legal, regulatory or contractual penalties? (17%)

- Low – There is a low likelihood with only a remote or slight chance that an error in this function will have a legal, regulatory or contractual impact. (0%)
- Medium – The chance is considered more than remote, reasonably possible, but less than likely, that an error in this function will have a legal, regulatory or contractual impact. (50%)
- High – It is considered probable or likely that an error in this function will have a legal, regulatory or contractual impact. (100%)

Health, Safety and Environmental

Does an error or poor performance of this function pose health, safety or environmental risks? (17%)

- Low – There is a low likelihood with only a remote or slight chance that an error in this function will have a health, safety, or environmental impact. (0%)
- Medium – The chance is considered more than remote, reasonably possible, but less than likely, that an error in this function will have a health, safety, or environmental impact. (50%)
- High – It is considered probable or likely that an error in this function will have a health, safety, or environmental impact. (100%)

An example of the criticality calculation is shown in the following table.

Measure	Response	Value	Multiplier	Section Value
Current Manpower and Resources	Medium	50%	20%	10%
Future Manpower and Resources	Hi Increase	100%	20%	20%
Business Value	High	75%	20%	15%
Knowledge Required	High	75%	20%	15%
Cost of Quality				
Likelihood of Error	Medium	50%	20%*33%	3%
Likelihood of Error Detection	Medium	50%	20%*33%	3%
Cost of Failure				

Measure	Response	Value	Multiplier	Section Value
Asset Risk	Moderate	50%	20%*33%*17%	1%
Cost to Correct	Moderate	50%	20%*33%*17%	1%
Delay	Moderate	50%	20%*33%*17%	1%
Goodwill	Medium	50%	20%*33%*17%	1%
Legal, Regulatory, Contractual	Medium	50%	20%*33%*17%	1%
Health, Safety & Environmental	Low	0%	20%*33%*17%	0%
Function Value				69%

SUMMARY CRITICALITY SCALE DEFINITIONS

Resources and Manpower - Assess the proportion of the company's technical resources that are involved in performing each function including: manpower, equipment, budget and capital. The 12 function categories should sum to 100%.

Estimate the Expected Change in the amount of resources and manpower that will be allocated to this function in 2, 5, and 10 years.

- Hi Decrease – greater than 50% decrease in resources allocated to this function.
- Med Decrease – 25% to 50% decrease in resources allocated to this function.
- No Change – up to 25% increase or decrease in resources allocated to this function.
- Med Increase – 25% to 50% increase in resources allocated to this function.
- Hi Increase – greater than 50% increase in resources allocated to this function.

Rank Order from 1 (most important) to 12 based on the importance of having an internal workforce with the proper skills and knowledge. To determine which of these are most or least critical, it may be helpful to consider these factors of criticality:

- Can this function be contracted out?
- Can the skills used in this function be obtained through standardized training?
- What are the potential costs of errors? Does an error or poor performance of this function:
    - Pose health, safety or environmental risks
    - Carry potential legal, regulatory or contractual penalties
    - Risk present or future business with your customer
    - Require a small correction, complete replication, or have wide-ranging effects
    - Cause time delays that affect the core business
- What is the likelihood of errors in this function category?
- What is the likelihood of early detection of errors in this function category?

Business Value – Assess the value that performing this function brings to your overall business.

- Minimal – Interruptible, this function can be interrupted for periods of time without disrupting company business, and/or is not a part of the core of our business.
- Low – Interruptible, this function can be interrupted for periods of time without disrupting company business although it is a part of our core business.
- Moderate – Uninterruptible, this function cannot be interrupted for periods of time without disrupting company business, but can be acquired from external sources (e.g., contracted out) if internal technical resources are not sufficient.
- High – Uninterruptible, this function cannot be interrupted for any period of time without disrupting company core business and cannot be acquired externally (e.g., contracted out) if internal technical resources were not sufficient.

Knowledge Cost – If an expert in this area is no longer available, what is the difficulty of knowledge transfer to another employee? Consider:

- Level of documentation available
- Amount of skill and experience required
- Whether required knowledge is tacit or explicit
- Availability of external training resources

How much time does the average new employee need to develop the skills to perform this function at the acceptable standard level?

- Low – Transferring this knowledge takes up to six months
- Moderate – Transferring this knowledge takes six to twelve months
- High – Transferring this knowledge takes over one year

Cost of Failure – What is relative risk of having workers with less proficiency in this function category?

If errors occur, assess the impact. Consider asset risk, correction costs, probability of early detection, schedule delays, client goodwill, legal, environmental impact and other risks.

Consider the relative risks associated with failures that are more likely to be caused by having less proficiency in workers performing functions in this category.

- Low – There is a low likelihood, with only a remote or slight chance, that an error in this function will have a health, safety, environmental impact, regulatory or legal consequences, significant detriment to client goodwill, or significant cost in assets or business-critical scheduling.
- Moderate – The chance is considered more than remote, reasonably possible, but less than likely, that an error in this function will have a health, safety, environmental impact, regulatory or legal consequences, significant detriment to client goodwill, or significant cost in assets or business-critical scheduling.
- High – It is considered probable or likely that an error in this function will have a health, safety, environmental impact, regulatory or legal consequences, significant detriment to client goodwill, or significant cost in assets or business-critical scheduling.

AGGREGATING CRITICALITY ASSESSMENT RESPONSES

The function assessments in the detailed and summary criticality spreadsheets are rated using the following scale:

Very High is assigned to:

- Present resources of 25% or greater for this function, or the highest percentage (if less than 25%) in any category including tied values.
- Business value for functions rated high for summary criticality a ranking of 1 to 3, where 1 is the most important rank and 12 is the least important rank. For the detailed spreadsheet, it is assigned where the median ranking is very high for the business value of all functions.
- Knowledge costs that are assigned a high value for the summary criticality, or very high as the knowledge cost median rating for all functions on the detailed criticality spreadsheet.
- Failure costs that are assigned a high value for the summary criticality, or over 25% of the weighted function assessments are high for the detailed criticality spreadsheet. Failure cost measures were aggregated by assigning weights to their component assessments as follows:
    - Likelihood of error (weight = 6)
    - Likelihood of error detection (weight = 6)
    - Cost of error (sum of asset risk + cost to correct + delay + goodwill + legal, regulatory, and contractual + health, safety and environmental)

High is assigned to:

- Present resources of 9-24% for this function, excluding any functions rated as very high.
- Business value for functions rated high for summary criticality with a ranking of 4 through 12, or with high as the median rating for all functions on the detailed criticality spreadsheet.
- Knowledge costs that are rated as high for the median rating for all functions on the detailed criticality spreadsheet.
- Failure costs are rated as high for 20-25% of all weighted function ratings on the detailed criticality spreadsheet. See very high definition for weightings.

Moderate is assigned to:

- Present resources of 5 - 8% for this function.
- Business value for functions rated moderate for summary criticality. For the detailed spreadsheet, it is assigned where the median ranking is moderate for the business value of all functions.
- Knowledge costs that are assigned a moderate value for the summary criticality, or moderate as the knowledge cost median rating for all functions on the detailed criticality spreadsheet.

- Failure costs that are assigned a moderate value for the summary criticality, or 10-20% are rated as high for all weighted function assessments on the detailed criticality spreadsheet. See very high definition for weightings

 Low is assigned to:

- Present resources of 2 - 4% for this function.
- Business value for functions rated low for summary criticality. For the detailed spreadsheet, it is assigned where the median ranking is low for the business value of all functions.
- Knowledge costs that are assigned a low value for the summary criticality, or low as the knowledge cost median rating for all functions on the detailed criticality spreadsheet.
- Failure costs that are assigned a low value for the summary criticality, or only 5-10% of the weighted functions are rated as high on the detailed criticality spreadsheet. See very high definition for weightings.

 Very Low is assigned to:

- Present resources of less than 2% for this function.
- Business value for functions rated minimal for summary criticality. For the detailed spreadsheet, it is assigned when the median ranking is minimal for the business value of all functions.
- Knowledge costs with a minimal value as the median rating for all functions on the detailed criticality spreadsheet.
- Failure costs that are assigned a high rating for less than 5% of the weighted functions on the detailed criticality spreadsheet. See very high definition for weightings.

JOB POSITION RATING SCALE

This is the overall assessment of the job position (or job position categories) based on the other criticality measures. If a job position falls into several categories, the highest risk category is assigned.

- Difficulty to hire is the assessment by Human Resources professionals in the industry about their recent ability to find qualified candidates for the job position. Job position ratings are based on percentage of respondents that reported the position as "difficult to hire". The categories are:
  - Very difficult - 80-100%
  - Difficult - 60-80%
  - Somewhat difficult - 50-60%
  - Not difficult - 0-50%
- Percent of industry is the percent of the technical workforce in the overall category, and the proportion of the category in each job position. For example, the Engineering, Architecture and Computer Science category comprises 16% of the total technical workforce for pipeline companies, and Mechanical Engineers make up 28% of the category, or 4% of the total technical workforce.

  - Significant proportion of the workforce is any job position that is at least 1% of the total workforce or 5% of any category.
  - Small proportion of the workforce is any job position that is less than 1% of the total workforce or 5% of any category.

- Forecast Employment Change is the Department of Labor's forecast for the total increase or decrease in the job position from 2006 to 2016. Much of the influence on this percentage is the overall population growth, along with the forecasts for industries that hire from this category. For example, job positions that are common in construction are expected to have a larger growth in employment because of expected increases in that industry and job positions more common to manufacturing are expected to continue losing employment because of expected manufacturing decreases.
  - Very large employment increases are those over 25% by 2016.
  - Large employment increases are those over 15% by 2016.
  - Moderate employment increases are those over 10% by 2016.
- Risk is the possibility of a shortage of this job position (or job position category) based on the other criticality measures. If a job position falls into several risk categories, the highest risk category is assigned.

The risk categories are assigned to job positions with the following characteristics:

 High Risk is assigned to:

- Job positions that are very difficult to hire, comprise a significant proportion of the workforce, and are expecting growth in employment.
- Job positions that are difficult to hire, comprise a significant proportion of the workforce, and are expected to have large employment increases.

 Medium-High Risk is assigned to:

- Job positions that are difficult or very difficult to hire, are not expected to have declining employment, and comprise a significant proportion of the workforce.
- Job positions that are difficult or very difficult to hire, and are expected to have declining employment due to lack of qualified candidates.

 Medium Risk is assigned to:

- Job positions that are at present difficult or very difficult to hire, but are expected to have declining employment.
- Job positions that are at present difficult to hire, and are a small proportion of the workforce.
- Job positions that had significant mentions as difficult to hire in technical and management surveys, although not for human resources survey respondents.
- Job positions that are expected to have large employment increases.


Medium-Low Risk is assigned to:

- Job positions that are somewhat difficult to hire and are not expected to have declining employment.
- Job positions that are expected to have moderate employment increases.


Low Risk is assigned to:

- Job positions that are not generally difficult to hire and do not expect to have very large employment increases.

The findings from the criticality assessment analysis along with conclusions, recommendations and next steps are discussed in the main project report *Critical Skills Forecast for the Natural Gas Industry*.

APPENDIX E- SECONDARY RESEARCH

TABLE OF CONTENTS

INTRODUCTION

This document presents the employment forecasts for technical job positions in the natural gas industry. These forecasts are based on the US government census data, Department of Labor studies, web-based job posting statistics from Monster.com, and assessment of recruitment difficulty by the staffing company Manpower Inc.

The prosperity of other industries and their subsequent workforce needs directly impact the natural gas industry's workforce. When other industries are growing, they can more easily attract workers from the natural gas industry, impacting its ability to retain employees. New entrants to the workplace may also be drawn to other industries with strong growth forecasts. While individual companies may have had success hiring from within the existing natural gas industry employee pool, even they will feel the impact if the pool of experienced workers declines.

Therefore, knowing which industries employ the same types of workers and how those industries are expected to fare can help managers and HR personnel in the natural gas industry to focus their efforts on the positions most likely to be in short supply based on the forecasted employment climate.

The two largest industries that have common workforce needs with the natural gas industry are the construction industry and the manufacturing industry; a smaller factor is the electric power industry. Overall, government forecasts expect the manufacturing industry to continue to reduce employment and the construction industry and electric power industry to continue their growth during the period from 2006 through 2016.

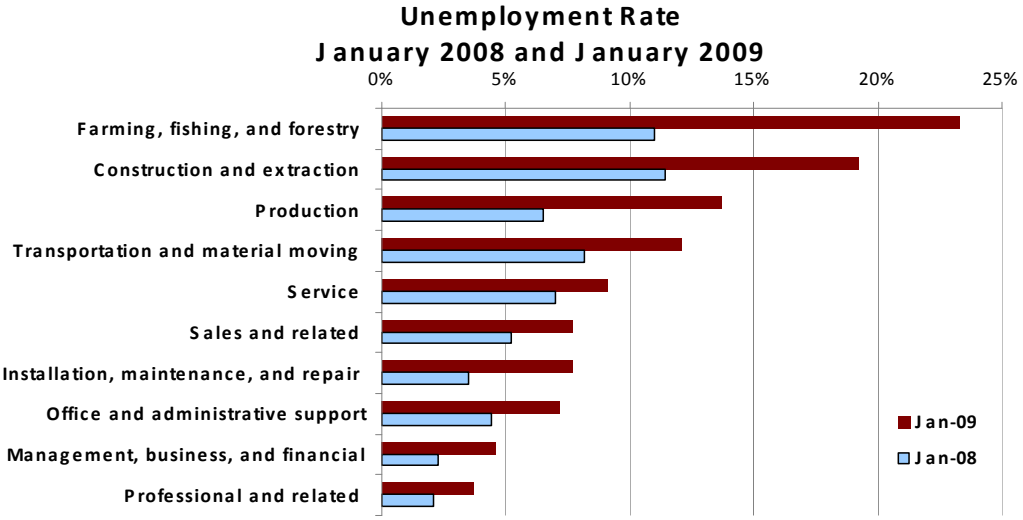
The effect is that many construction-related job positions (e.g., civil engineering, architecture, construction managers and surveyors) will increase their total employment over the next decade. Job positions that have significant manufacturing employment (e.g., quality inspectors, first-line supervisors and machinists) will continue to have declining employment. Some workers employed by both industries (e.g., welders, purchasing managers, and industrial machinery mechanics) are expected to have little change in total employment.

Specific to the natural gas industry, the Department of Labor predicts declining employment for operations job positions (e.g., gas control operators and gas pumping station operators) due to mergers and continuing efficiency improvements such as automation.

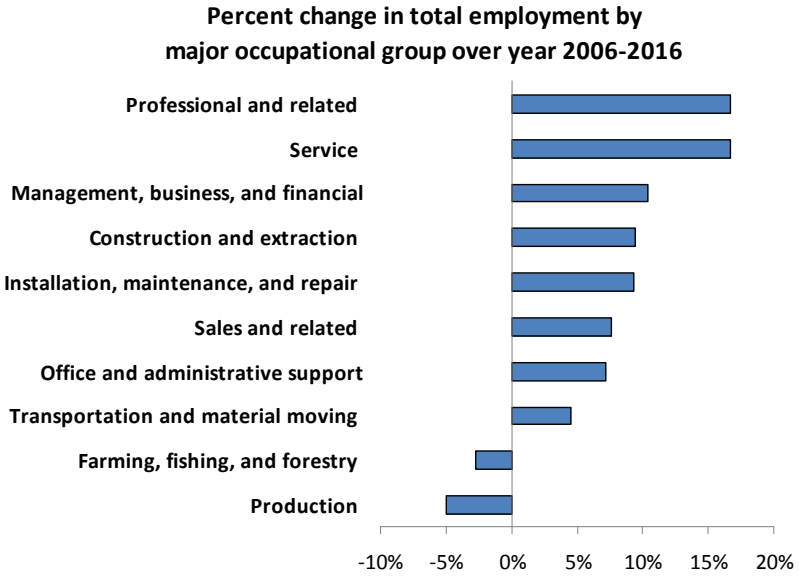
OVERALL EMPLOYMENT FORECASTS

The United States Department of Labor collects data annually on US employment over a diverse set of industries. The Department of Labor combines this data with other analyses to forecast expected employment changes over ten-year periods and publishes these forecasts every two years. The most recent forecast was published in November 2007 for the period 2006-2016. This report was published before the sharp rise and fall of energy prices in 2008, the 2008-2009 credit crisis, and the present economic downturn. Therefore, many of their forecasts may be less accurate for the short term, yet the premises on which the forecasts are based are still valid for the long term.

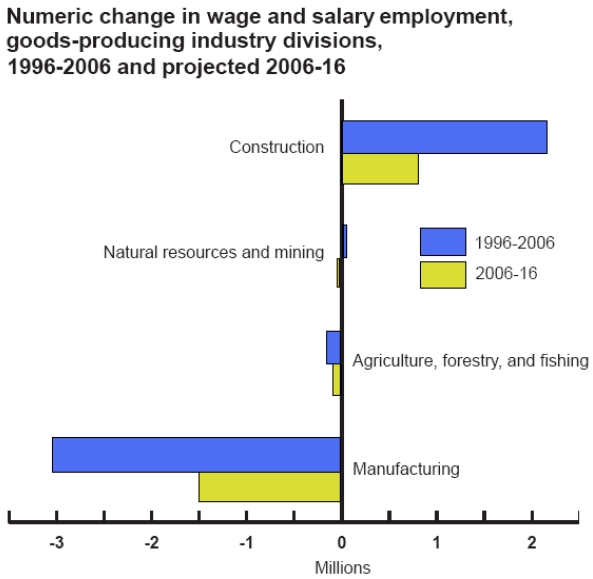
As an example of the short-term changes, the following chart shows the unemployment rates for January 2008 and January 2009:



The Department of Labor has based its employment forecast largely on the demographics of the growing US population. The 55 to 64 age group is expected to increase 30.3% by 2016. This amounts to a disproportionate additional 9.5 million persons in this category. Meanwhile, the US population is expected to grow by 21.8 million, and the workforce is expected to grow by 12.8 million. Many of these new workers will be employed in occupations serving the needs and consumer demands of the aging population. Additionally, the Department of Labor is expecting continuation of the trend away from a goods-producing economy to a service-providing economy. Construction will continue to increase as the aging population requires increases in health care facilities, retirement living facilities, and other infrastructure. Management, scientific, and technical services are expected to grow due to increasing adoption of computers and other technologies and the increasing complexity of business activities. The following chart shows the expected change in the major industries from 2006 to 2016.



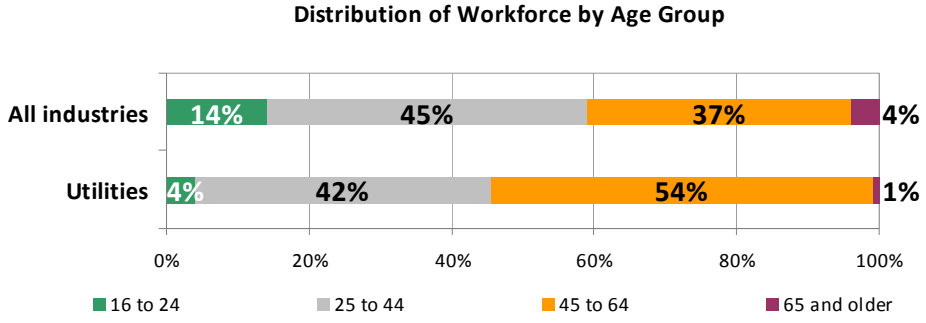
Among the goods-producing industries, construction has had the most growth in recent history, and is expected to continue to grow through 2016.



For the utilities portion of the natural gas industry, employment is expected to decrease by 18% over the decade leading to 2016. This is due to technology improvements allowing increases in productivity as well as efficiencies encouraged by the Energy Policy Act of 2005 leading to decreased demand. The Bureau of Labor Statistics also cites workers lost to retirement as a cause of declining employment for this industry.

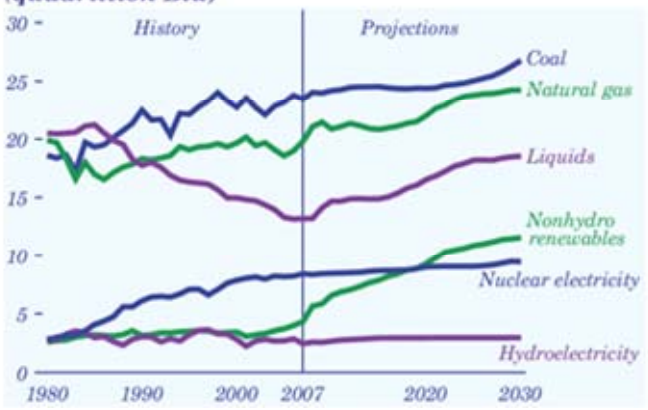
> *"Although electric power, natural gas and water continue to be essential to everyday life, employment declines will result from the retirement of much of the industry's workforce. While utilities are doing what they can to replace these workers, the wide variety of careers open to people with technical skills will make it difficult for companies to find enough applicants to fill these openings. Utilities will be forced to further automate their systems, negotiate part-time status with retirees and contract with employment services to make up for the difference between the desired number of employees and the number of workers actually available."*

The utility portion of the natural gas industry is at significant risk from retirement attrition, due to the older workforce and relatively young retirement ages. The following chart shows the differences in workforce age between utilities and the entire working population.



Therefore, the Department of Labor expects an energy industry that will be increasing output with a shrinking workforce. During the period of the Department of Labor's predictions, through 2016, the Department of Energy predicts natural gas production levels will be stable. From 2016 through 2030, natural gas production is expected to rise by 16%. The following chart shows the Department of Energy's forecasts for production of fuel by type.

Figure 6. Energy production by fuel, 1980-2030 (quadrillion Btu)

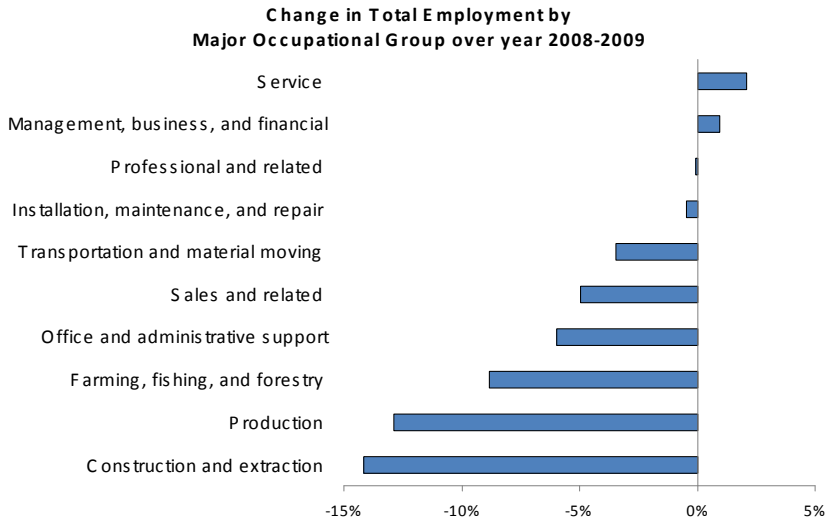


The forecasted decline in a key competing industry of manufacturing may provide some relief for natural gas employers.

EFFECT OF CURRENT ECONOMY

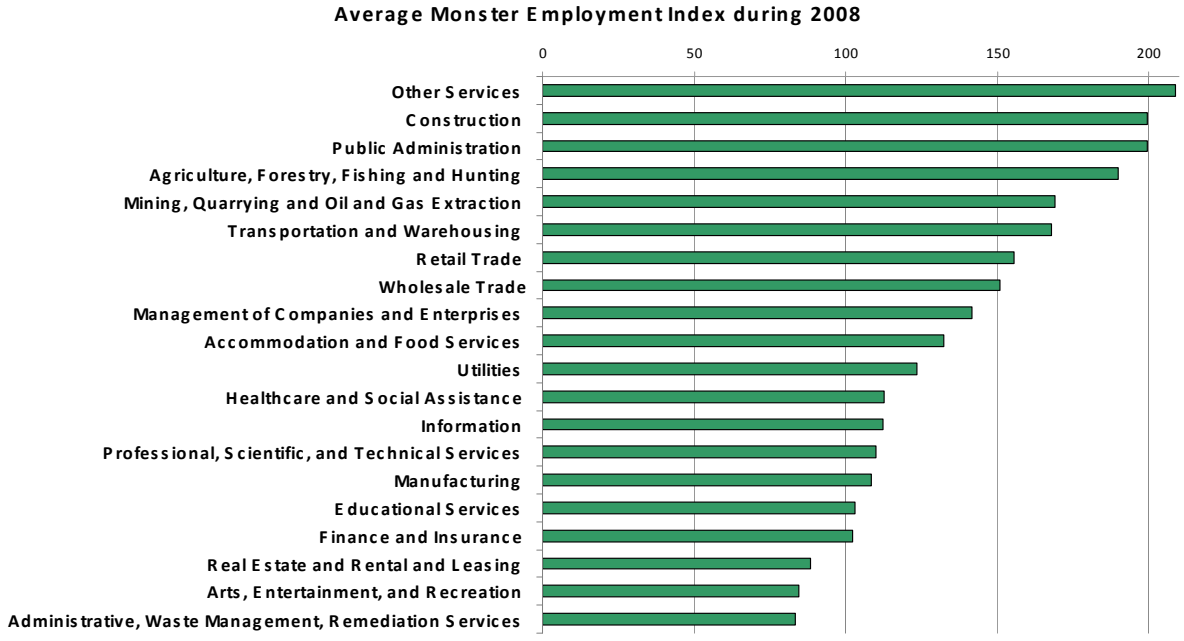
The forecasted growth in construction activities is one of the more significant predictions in terms of potential impact on the natural gas industry. The construction workforce employs many of the same professions as the natural gas pipeline industry: engineers, architects, project managers, equipment operators, and many skilled trades and laborers. In the 2007 outlook statement, the Bureau of Labor Statistics forecasted that over the following ten-year period construction activity would be strong with 10% growth in construction employment to support the needs of the growing and aging population. The housing and credit crises of 2008 have the potential to slow the construction industry in the short term; however the American Recovery and Reinvestment Act of 2009 has the potential to keep the industry strong and in competition with the natural gas industry for workforce. The underlying assumptions for the ten-year growth pattern are expected to still be valid when the economy recovers.

So far during this recession, the change in employment generally follows the trend expected by the Department of Labor for forecasted industry growth. That is, the industries expected to grow over the forecasted period have shown the least declines in employment over the last year as the economy weakened. Construction showed the greatest deviation from this trend, apparently more greatly affected by the current downturn than other industries.



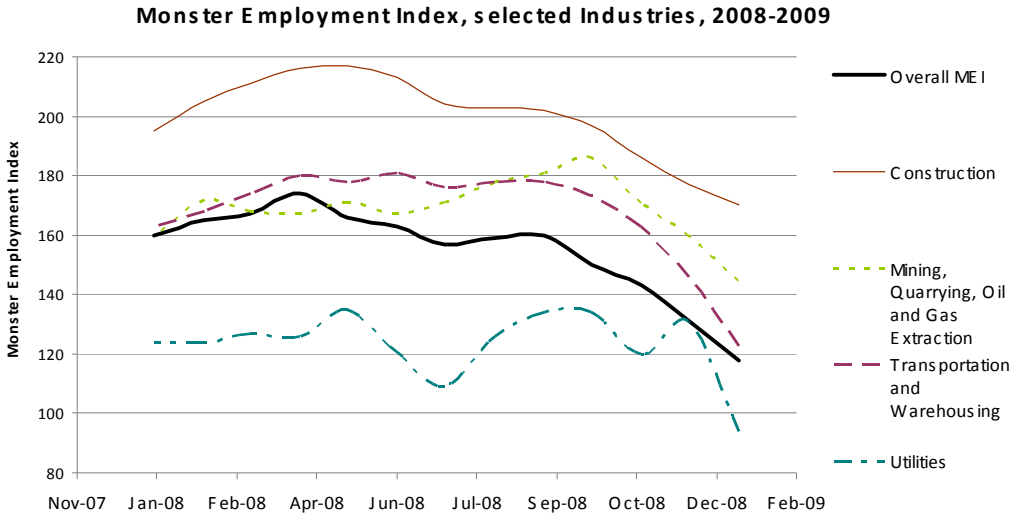
EMPLOYMENT AND JOB POSTING TRENDS

The Monster Employment Index (MEI) is a monthly assessment of U.S. online job demand based on reviews of job postings from a large representative selection of corporate career web sites and job boards, including Monster.com. In the MEI, Construction and Oil and Gas Extraction were fairly active in hiring in 2008 compared to other industries. The following chart shows the average MEI during 2008 by industry.

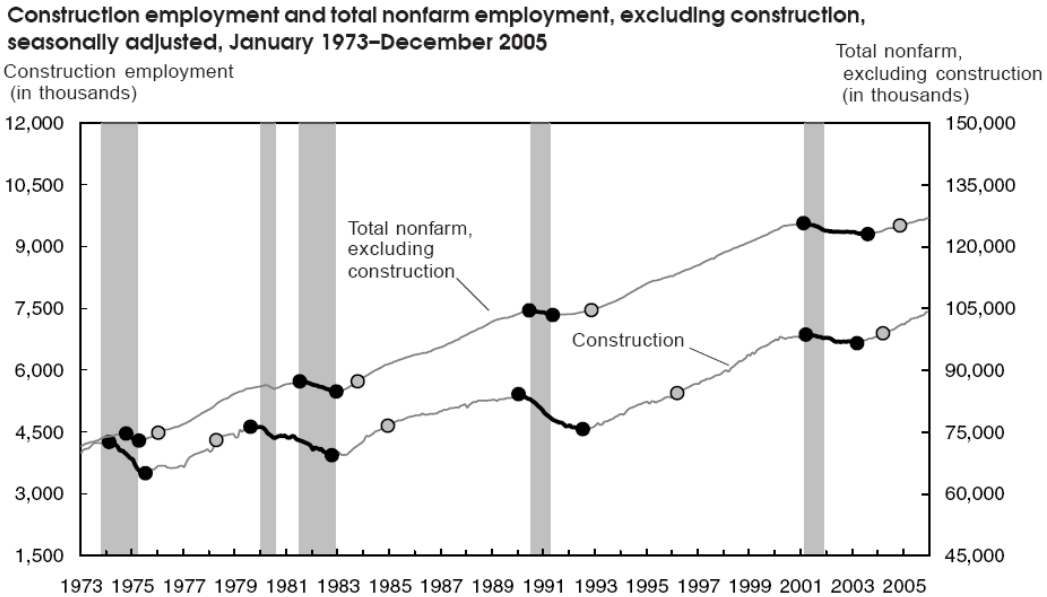


Alternatively, the January 2009 Monster.com Employment Index reported that though construction reduced hiring in each of the eighteen preceding months, it had a mild decline relative to the MEI as a whole. Even with the declining economy and reduced employment, construction was one of the most active industries in advertising for new employees. As expected

with the current economic downturn, most sectors have had reduced hiring activities. Construction hiring slowed after peaking with the overall index in April 2008. Energy-associated industries showed their significant declines later in 2008.



Construction typically has longer and larger employment losses than other industries, averaging 16% losses during and after a recession and lasting two to three times as long. This compares to an average of 2% declines for all other types of non-farm employment. On average, other non-farm employment recovers in about 25 months and construction employment averages about 60 months for recovery. In our current recession, construction decreased by 111,000 jobs in January 2009 and 104,000 in February 2009 contributing to a drop of about 1.1 million jobs in this industry since its last total employment peak in January 2007.



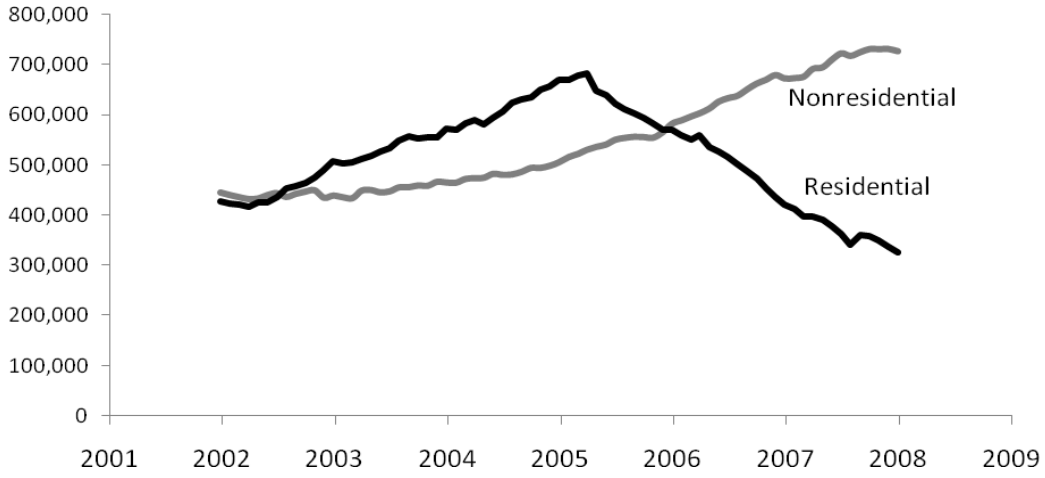
NOTE: Shaded bars denote recession. Black dots represent employment peaks and troughs. Grey dots represent return to employment level of previous peak. Bolded black portions of data series represent periods of recessionary job loss.

The Department of Labor also cites aging industrial plants as contributing to construction demand. However, the economic decline, particularly in manufacturing throughout 2008 and into 2009, may reduce industrial construction needs during this time.

The Department of Labor construction employment statistics show that residential construction employment began exceeding nonresidential construction during the 2001 and then continued to greatly surpass it through 2006. More recent Census Bureau data show that the value of spending on construction reflects the employment trend and also shows that the segments activities were reversed in 2007 with residential construction falling greatly and nonresidential spending on the rise.

Therefore, while it may appear that the overall decline in total construction may provide less competition for many of the workers needed by the natural gas transmission industry, the strong nonresidential construction activity may likely still provide competition for the engineers, project managers, and skilled trades common to both industries.

Value of Construction Put in Place in the United States, Seasonally Adjusted Annual Rate
(Millions of dollars. Details may not add to totals due to rounding.)



FORECASTS BY JOB CATEGORY

ENGINEERING, ARCHITECTURE AND COMPUTER SCIENCE

Kelly Engineering Resources, when interviewed by Monster.com, reported that all engineering disciplines were hard to fill and had a shortage of new graduates. They reported strong demand for civil and petrochemical engineers. The staffing firm Manpower Inc. places engineers at the top of their list for positions hardest to fill.

The following table shows the present employment and Department of Labor forecasts for specific engineering disciplines.

Job Category: Engineering, Architecture and Computer Science	Total Employment 2006	Forecasted Change 2006-2016
Computer software engineers, applications	287,584	50%
Environmental engineers	33,927	39%
Geoscientists, except hydrologists and geographers	23,269	29%
Civil engineers	165,336	25%
Architects, except landscape and naval	97,960	22%
Industrial engineers	171,159	18%
Chemical engineers	24,013	8%
Architectural and civil drafters	102,264	7%
Electrical engineers	122,697	6%
Chemical technicians	54,283	6%
Petroleum engineers	12,971	4%
Drafters or mechanical drafters	61,337	4%
Mechanical engineers	183,286	4%
Materials engineers	16,192	3%
Computer programmers	227,504	1%

The expected decline in the manufacturing industry should affect the employment growth for mechanical engineers and result in lower than average growth of only 4% by 2016.

Recruitment prospects are good for electrical and electronics engineers with employment growth slower than other specialties largely due to easy off-shoring of many of these jobs. This may increase the available supply of these engineers for domestic industries. One large employer of electrical engineering employees is the declining manufacturing industry, which may be less appealing to recent graduates than the natural gas industry. However, another large employer for electrical engineers is the electric power generation industry. The NERC 2008 *Long-term Reliability Assessment 2008-2017* forecasts that by 2017, peak demand for electricity in the US will rise by 17%, but the amount of additional generation power expected to come online will add just 8% to the present capacity. This may lead to the need for additional infrastructure investment and the corresponding demands for electrical engineers and other professions that the natural gas industry has in common with the electric power generation industry. The annual Black & Veatch *Strategic Directions Survey* also forecasts additional investment needs for retrofitting existing facilities to meet the expected new environmental regulations.

Civil engineers may be in higher demand from construction industries and architectural, engineering and related services to support building needs related to population growth and aging infrastructure. Demand for civil engineers is expected to grow faster than that of other occupations. However, declines in construction will likely result in lower employment at least in the short term.

The Department of Labor predicts that employment opportunities for petroleum engineers will grow more slowly than the average engineering discipline due to the diminishing petroleum reserves of the United States. However, the number of job openings is expected to exceed the relatively small number of graduates, so petroleum engineers will likely remain difficult to recruit.

Chemical engineering employment is expected to nearly keep pace with overall growth with a focus shifting to research in energy and the developing fields of biotechnology and nanotechnology.

Employment of materials engineers is expected to decline, except for those with specialties in nanomaterials or biomaterials. As manufacturing firms contract for their materials engineering needs, the competition for workers will come mainly from the category of Professional, Scientific and Technical Services.

The employment of computer programmers in the US is expected to have minimal growth over the next decade. Many functions formerly performed by computer programmers are shifting to computer software engineers, a field that is expecting large growth over the next decade. Also, many computer programming jobs are likely to be exported to countries with lower prevailing wages. Computer software engineering positions are less likely to be sent overseas. Forecasters at Monster.com predict that even with off-shoring, there will still be demand for entry-level programmers and other IT workers. The staffing firm Manpower also considers IT positions among their hardest to fill.

The aging baby boomers are expected to drive need for more housing communities and institutions to serve this changing demographic, increasing employment of architects. Although it is expected that more students will pursue architectural degrees, and there is some off-shoring of lower-level architectural work, demand is still expected to be high.

The Department of Labor predicts geoscientists will be growing in employment to address increasing energy and environmental concerns. Many (18%) geoscientists work in oil and gas extraction, and these activities can be expected to grow in light of the higher prices expected in the future. The recession may lead to layoffs of some geoscientists, particularly consultants. Masters degrees are needed for most positions, and relatively few students pursue these, thus a shortage of new geoscientists is expected.

Department of Labor predicts industrial and environmental engineers will be in higher demand in the future. Environmental engineering is expected to show growth much faster than other fields due to increasing environmental concerns, concentration on preservation, and the associated demands of population growth. Hiring prospects may be improved by signs of greater interest by students pursuing these degrees. Industrial engineers are expected to be in increasing demand to support efforts to help businesses reduce costs and increase productivity.

MANAGEMENT

Similar to architects and civil engineers, anticipated growth in construction associated with the aging population is expected to increase demand for construction managers, subject to variations in the economy and effect of government intervention. Significant retirements of experienced professionals are also expected in this field.

Employment of engineering managers is expected to grow about as fast as overall employment, with many jobs coming from the scientific research and development services industry and the architectural, engineering, and related services industry. Other large employers are federal, state, and local government agencies.

Demand for operations managers varies by industry. Employment growth is expected in professional, scientific and technical services, while a decrease is expected for manufacturing.

Technology is helping purchasing managers become more productive and therefore less in demand. Production occupations in general are expected to suffer declines associated with the anticipated decline in domestic manufacturing.

The following table shows the present employment and Department of Labor forecasts for specific management disciplines.

Job Category: Management	Total Employment 2006	Forecasted Change 2006-2016
Construction managers	189,019	18%
Training and development manager	239,220	17%
Engineering managers	154,753	8%
Purchasing managers	37,756	1%
General and operations managers and pipeline supervisors	666,222	0%
First-line supervisors/managers of production and operating workers	500,450	-10%

OPERATIONS

The following table shows the present employment and Department of Labor forecasts for specific operations disciplines.

Job Category: Operations	Total Employment 2006	Forecasted Change 2006-2016
Surveyors	50,515	26%
Surveying and mapping technicians	58,244	23%
Accountants and auditors	612,143	22%
Pipeline technician / maintenance and repair workers, general	476,859	5%
Power plant operators	25,100	1%
Measurement technician / control and valve installers and repairers	27,042	-4%

Job Category: Operations	Total Employment 2006	Forecasted Change 2006-2016
Gas plant operators / gas controller	11,551	-11%
Chemical plant and system operators	51,272	-16%
Pump operators, except wellhead pumpers	4,735	-17%
Gas compressor and gas pumping station operators	2,780	-25%

Surveyors and pipeline mapping and survey technicians are expected to have higher employment growth. If construction activity returns to levels predicted by the Department of Labor, this will likely be a difficult position to fill in the future as new entrants to this work could be recruited by other industries. Also, increased interest and applications of geographic data is expected to increase growth in surveying employment. Advances in technology make surveying technicians less required than professional surveyors so this position may be easier to fill and retain in the future.

Gas compressor and pumping station operators are not likely to have recruitment competition from other industries. The Department of Labor expects employment in this field to decline 25% by 2016.

The Department of Labor predicts little or no change in employment of power plant operators over the next decade due to the competing factors of more power plants but also more efficient and technologically advanced facilities requiring fewer operators. However, they acknowledge that job prospects for these workers are very good due to level of expected retirements in the utilities workforce over the next ten years. They note that many utilities companies have set up new education programs at community colleges and high schools.

Accountants are expected to be in high demand with employment growth much larger than average due to projected growth in the number of businesses, and because of new and changing regulations increasing the quantity and nature of accounting for most businesses, especially publicly traded companies. The business growth expectation may need to be tempered somewhat in an economic downturn, but the impacts of the new regulations cannot be discounted. Monster.com's research, based on interviews with employment firms and large employers, reports that accountants are in high demand in 2008 and should be into the foreseeable future. The staffing firm Manpower also places accountants on their list of top ten hardest to fill positions. As a small subset of the accounting profession, natural gas accountants are likely to be in demand as well.

SKILLED TRADES

The following table shows the present employment and Department of Labor forecasts for skilled trades disciplines.

Job Category: Skilled Trades	Total Employment 2006	Forecasted Change 2006-2016
Heating, air conditioning, and refrigeration mechanics and installers	191,570	12%
Plumbers, pipefitters, and steamfitters	396,019	11%
Mobile heavy equipment mechanics, except engines	57,788	9%
Operating engineers and other construction equipment operators	314,484	9%
Pipelayers	46,604	8%
Electricians	559,540	7%
Millwrights	38,536	6%
Electrical power-line installers and repairers	87,228	6%
Industrial machinery mechanics	183,379	5%
Maintenance and repair workers, general	476,859	5%
Welders, cutters, solderers, and brazers	336,024	3%
Computer programmers / SCADA Technicians	227,504	1%
Welding, soldering, and brazing machine setters, operators, and tenders	44,296	0%
Electrical and electronic engineering technicians	97,592	0%
Computer-controlled machine tool operators, metal and plastic	134,906	-3%
Machinists	312,106	-8%

A growing population and the associated growth in construction and business are expected to increase the need for electricians. Modern technologies in business and home automation systems also require electricians for installation of upgraded wiring. The potential increase in power plant production should also result in higher employment for electricians, electrical power-line installers and electrical and electronic technicians. The Department of Labor predicts that the electric utilities will increasingly turn to contract power-line installers to answer the increasing demand for new electrical service with increasing population. Retirements in these fields are expected to be high over the next eight years.

For operating engineers, new technologies have created improvements in productivity to perform an increasing workload without large increases in employment. The competition may be less for recruiting these positions.

Several other positions in this category, such as electrical engineering technicians and automation programmers, should not receive much hiring pressure from outside industries as there will not be much growth in those occupations. Foreign competition in design and

manufacturing will also limit growth for these job types. However, the staffing firm Manpower counts technicians as among the top ten hardest to fill positions. A slow decline in employment is expected for CNC operators; however there are few entrants to training programs so employers are expected to have difficulty finding qualified workers.

Employment for industrial machinery mechanics is expected to have average growth. The demand for workers in this field is increased by increasing automation and decreased by advances in automation technology producing more reliable machines that need less maintenance. Many experienced workers in this field are expected to retire and there is a currently a shortage of newer workers with advanced skills. These positions are not likely to be affected greatly by economic downturns as they can be used to overhaul equipment during down cycles.

Maintenance mechanics are employed in a wide variety of industries. Therefore employment is widely distributed and expected to grow at about the average rate for all industries. Retirements may limit the available supply.

Machinists face slightly reduced employment opportunities as productivity increases and many jobs head to countries with lower manufacturing costs. On the other hand, insufficient supply into the ranks is expected to make machinists hard to find. Machinists not involved in facility maintenance can be expected to become more available in manufacturing downturns. The staffing firm Manpower reports that machinist positions are one of the top ten most difficult to fill positions.

Employment for millwrights is expected to grow more slowly than average, largely due to their heavy concentration in manufacturing. Millwrights are, however, important to many industries and thus can switch industries to others more stable in the event of a downturn. There is also the potential for some machinery mechanics to move into millwright positions or take on some of their functions. Many retirements are expected among millwrights, increasing competition for these workers.

Demand for welders and solderers is expected to remain flat due to the opposing effects of the construction industry and the manufacturing industry. Although they are more heavily concentrated in manufacturing, they will not be as greatly affected as other professions that can more easily replaced by automation. These workers are also finding increasing employment in construction and utility industries. Retirements and growth in energy industries are expected to keep these workers in high demand. The Department of Labor reports that many welders laid off from the auto industry have been able to transition to the oil and gas industries.

Pipelayers, plumbers, and pipefitters are expected to be in demand for construction associated with population and business growth and also maintenance and additions to water and sewer infrastructure. Retirement of experienced workers is expected. These positions are considered to be less sensitive to the economy than other construction jobs.

The natural gas industry requires refrigeration and heating mechanics for station construction and maintenance activities. This profession is expected to continue to be needed around the country as heating and air conditioning are very important in the U.S. With new equipment needed every 10-15 years, even fairly recent installations may need replacement. Environmental and energy efficiency concerns and possible incentive legislation may lead to a surge in replacements of

older inefficient heating and cooling systems. Many retirements are also expected in this job category.

QUALITY CONTROL, REGULATORY, AND COMPLIANCE

In the category of Quality Control, Regulatory, and Compliance, the position of construction and building inspector can be expected to provide the most hiring competition for the natural gas industry once the economy recovers and construction activity rises to meet anticipated demand.

Inspection automation and transfer of inspections to earlier in the manufacturing process is leading to a smaller need for quality inspectors. Overall losses of U.S. manufacturing employment will also reduce the employment of quality inspectors.

The following table shows the present employment and Department of Labor forecasts for Quality Control, Regulatory, and Compliance employment.

Job Category: Quality Control, Regulatory, And Compliance	Total Employment 2006	Forecasted Change 2006-2016
Construction and building inspectors	39,775	34%
Compliance officers, except agriculture, construction, health and safety, and transportation	30,907	20%
Quality Inspectors, testers, sorters, samplers, and weighers	361,136	-13%

LABOR

With many construction laborers available for temporary hire, employment is expected to grow about as fast as average employment growth, dependent on the economy and the construction industry. Improved extraction techniques in oil and gas extraction are expected to decrease the overall number of roustabouts needed, even as production climbs slightly.

The following table shows the present employment and Department of Labor forecasts for the unskilled labor job category.

Job Category: Labor	Total Employment 2006	Forecasted Change 2006-2016
Construction laborers	867,294	11%
Roustabouts, oil and gas	42,179	-5%

BIBLIOGRAPHY

Black & Veatch. "Third Annual Strategic Directions in the Electric Utility Industry Survey." 2008. <http://www.bv.com>.

Bureau of Labor Statistics. U.S. Department of Labor, Occupational Outlook Handbook. 2008-09 Edition. <http://www.bls.gov/oco>.

Bureau of Labor Statistics. "U.S. Department of Labor, An overview of BLS projections to 2016." 2007. <http://www.bls.gov/opub/mlr/2007>.

Davis, Michael, Linnet Holland and John Tremblay. US Census Bureau News. February 2, 2009: CB09-18.

Manpower Inc. "Manpower Employment Outlook Survey Reveals Majority of U.S. Employers Holding Staff Steady for Q1 2009." December 2008. < http://www.manpower.com/investors/releasedetail.cfm?releaseid=353241>.

Mullins, John P. "Recent Employment Trends in Residential and Nonresidential Construction." Monthly Labor Review, October 2006 http://www.bls.gov/opub/mlr/2006/10/art1full.pdf.

Sylven, Steve and Murty, Deepika. “Monster Employment Index.” January 2009. <http://corporate.monster.com/Press_Room/MEI_US.asp>.

Tubb, Rita. “Nation’s Pipeline Construction Boom Brings.” Pipeline & Gas Journal, June 2008. <www.pgjonline.com>.

Tubb, Rita. “Record Oil & Gas Development Spending, Minimal Reserve Growth, Profits Flat Despite Rising Prices.” Pipeline & Gas Journal. October 2008. <www.pgjonline.com>.

U.S. Census Bureau. “Manufacturing, Mining, and Construction Statistics.” Manufacturing and Construction Division Information Services Center. February 2, 2009. <http://www.census.gov/const/>.

U.S. Census Bureau. U.S. Census Bureau News. January 2009. <http://www.census.gov/>.

The Whitehouse. "Energy and the Environment." February 2009. <http://www.whitehouse.gov/agenda/energy_and_environment>.

APPENDIX F - INDUSTRY POSITIONS

TABLE OF CONTENTS

INTRODUCTION

This document defines job classifications for the technical workforce in the transmission segment of the natural gas industry that is responsible for design, construction, operation and maintenance of pipelines.

The major job categories are:

- Engineering, Architecture and Computer Science
- Management
- Operations
- Skilled Trades
- Quality Control, Regulatory, and Compliance
- Labor

Each job classification has associated job responsibilities, alternative job titles, and standard occupational codes (SOC). Some job titles used in the industry do not have designated SOC codes. When this occurs, SOC numbers are assigned using a base SOC code from a similar job classification with a .9x suffix.

1. ENGINEERING, ARCHITECTURE AND COMPUTER SCIENCE

1.1 MECHANICAL ENGINEER

Job Responsibilities: Design machinery and production equipment. Design and analyze compressors, engines, pumps, heaters, fans, drilling equipment, pipelines, and rotating equipment. Perform engineering duties in planning and designing tools, engines, machines, and other mechanically functioning equipment. Oversee installation, operation, maintenance, and repair of such equipment as centralized heat, gas, water, and steam systems.

Alternate Job Titles: Equipment Engineer, Product Engineer, Mechanical Design Engineer, Fluid Mechanics Engineer, Hydraulics Engineer, Mechanical Design Engineer, Mechanical Maintenance Engineer, Piping Engineer, Project Engineer/Manager, Reliability Engineer, Rotating Equipment Engineer, Field Engineer

SOC Code: 17-2141.00

1.2 PIPELINE INTEGRITY ENGINEER

Job Responsibilities: Design, construction, operation, and sustainability (integrity) of pipeline systems, including pipelines, manifolds, and pumping and compressor stations. Analyze, test, validate, and plan inspections and repairs to ensure the safety and reliability of the pipeline system. Calculate MOP/MAOP and set points for pumps, compressors. Determine required hydrostatic test pressures. Evaluate defects and recommend appropriate repairs.

Alternate Job Titles: Pipeline Engineer, Pipeline Specialist, Pipeline Corrosion Engineer, Pipeline Mechanical Engineer, Pipeline Project Engineer, Integrity Specialist

SOC Code: 17-2141.99

1.3 ELECTRICAL ENGINEER

Job Responsibilities: Design, develop, test, or supervise the manufacturing and installation of electrical equipment, components, or systems for commercial or industrial use. Troubleshoot electrical problems and issues, develop alternatives, and propose and implement solutions for long-term reliability. Provide design review and evaluation of electrical portion of major capital projects.

Alternate Job Titles: Electrical Design Engineer, Broadcast Engineer, Test Engineer, Electrical and Instrumentation Engineer, Instrument Electrical Engineer, Field Engineer

SOC Code: 17-2071.00

1.4 ENVIRONMENTAL ENGINEER

Job Responsibilities: Design, plan, or perform engineering duties in the prevention, control, and remediation of environmental health hazards utilizing various engineering disciplines. Create systems and processes to make natural gas production and transportation cleaner and to dispose of potentially dangerous materials. Clean up spills, leaks or accidents.

Alternate Job Titles: Environmental Engineer, Environmental Analyst, Hazardous Substances Engineer, Environmental Remediation Specialist, Air Pollution Control Engineer, Hydrologist, Land Drainage Engineer, Pollution Control Engineer, Reclamation Engineer, Water Management Engineer

SOC Code: 17-2081.00

1.4.1 ENVIRONMENTAL MANAGER

Job Responsibilities: Prevent, identify, and eliminate sources of industrial pollutants. Analyze and test air, water, soil, and other source samples to determine how best to clean and preserve the environment. Preserve water supplies and reclaim contaminated land and water.

Alternate Job Titles: Environmental Advisor, Environmental Scientist, Environmental Technician, Hazardous Waste Management Advisor

SOC Code: 17-2081.99

1.5 PETROLEUM ENGINEER

Job Responsibilities: Devise methods to improve oil and gas well production and determine the need for new or modified tool designs. Oversee drilling and offer technical advice to achieve economical and satisfactory progress.

Alternate Job Titles: Petroleum Engineer, Reservoir Engineer, Drilling Engineer, Completion Engineer, Drilling Manager, Operations Manager, Project Production Engineer, Project Reservoir Engineer, Completion Engineer, Operations Engineer

SOC Code: 17-2171.00

1.6 INDUSTRIAL ENGINEER

Job Responsibilities: Design, develop, test, and evaluate integrated systems for managing industrial production processes including: human work factors, quality control, inventory control, logistics and material flow, cost analysis, and production coordination.

Alternate Job Titles: Manufacturing Engineer, Operations Engineer, Manufacturing Specialist, Tool Engineer, Production Engineer

SOC Code: 17-2112.00

1.6.1 RELIABILITY ENGINEER

Job Responsibilities: Identify and support the implementation of predictive technology, evaluate data. Develop equipment maintenance plans. Develop preventive maintenance procedures to provide effective and efficient solutions to improve reliability. Participate in regulatory preventive maintenance system audits as deemed necessary by management. Participate in the project management and engineering processes to ensure reliability concerns are addressed and supported. Lead root cause failure analysis effort to determine failure modes. Inspect new installations and equipment at vendor sites to identify and remedy possible reliability issues.

Alternate Job Titles: Quality Engineer

SOC Code: 17-2112.99

1.6.2 COST CONTROL ENGINEER

Job Responsibilities: Analyze technical and financial elements of capital projects including budgeting, estimating and project control functions.

Alternate Job Titles: Cost Estimating Engineer, Cost Control Engineer, Project Engineer, Project Manager

SOC Code: 17-2112.99

1.6.3 COST ESTIMATOR

Job Responsibilities: Prepare cost estimates for product manufacturing, construction projects, or services to aid management in bidding on or determining price of products or services.

Alternate Job Titles: Estimator, Estimator Project Manager, Project Manager, Construction Estimator, Design Consultant, Operations Manager, Sales Engineer

SOC Code: 13-1051.00

1.7 GEOSCIENTIST

Job Responsibilities: Study the composition, structure, and other physical aspects of the earth. Use geological, physics, and mathematics knowledge in exploration for oil, gas, minerals, or underground water, or in waste disposal, land reclamation, or other environmental problems. Study the earth's internal composition, atmospheres, oceans, and its magnetic, electrical, and gravitational forces.

Alternate Job Titles**:** Geologist, Project Geologist, Mine Geologist, Exploration Geologist, Geophysicist, Geoscientist, Petroleum Geologist, Project Geophysicist, Development Geologist, Environmental Field Office Manager

SOC Code: 19-2042.00

1.7.1 GEOLOGICAL SAMPLE TEST TECHNICIAN

Job Responsibilities: Test and analyze geological samples, crude oil, or petroleum products to detect presence of petroleum, gas, or mineral deposits indicating potential for exploration and production, or to determine physical and chemical properties to ensure that products meet quality standards.

Alternate Job Titles: Materials Technician, Core Inspector, Electron Microprobe Operator, Environmental Field Services Technician, Environmental Sampling Technician, Geological Sample Tester

SOC Code: 19-4041.00

1.8 CHEMICAL ENGINEER

Design plant equipment and devise processes for manufacturing by applying principles and technology of chemistry, physics, and engineering.

1.8.1 CHEMICAL ENGINEER

Job Responsibilities: Design, modify and sometimes operate plants, equipment and processes that refine and transport natural gas products. Develop safety procedures to be employed by workers operating equipment or working in close proximity to on-going chemical reactions. Prepare estimate of production costs and production progress reports for management. Develop processes to separate components of liquids or gases or generate electrical currents using controlled chemical processes. Design and plan layout of equipment.

Alternate Job Titles: Scientist, Development Engineer, Engineering Scientist

SOC Code: 17-2041.00

1.8.2 PROCESS ENGINEER

Job Responsibilities: Perform process design calculations, develop or review process flow diagrams and piping and instrumentation diagram. Identify overpressure scenarios for various types of processing equipment. Calculate relief loads for all types of overpressure scenarios. Evaluate pressure relief device capacities. Design equipment, understand reactions taking place, install control systems, and start, run and upgrade the processes.

Alternate Job Titles: Process Control Engineer, Process Development Engineer, Refinery Process Engineer, Chemical Process Engineer

SOC Code: 17-2041.98

1.8.3 CORROSION ENGINEER

Job Responsibilities: Manage the overall development, standardization and implementation of corrosion monitoring, protection, and remediation processes. Implement and manage systems to

monitor and analyze corrosion data including coupon data, corrosion inhibitor rates, NDE test results, and rectifier readings. Develop recommendations based on data. Develop and report on key corrosion metrics including but not limited to failure rate, failure cost, corrosion related spills, and corrosion related lost production.

Alternate Job Titles: Corrosion Coordinator, Corrosion Technician, Corrosion and Materials Engineer, Corrosion Control Mechanic

SOC Code: 17-2041.99

1.8.4 GAS ENGINEER

Job Responsibilities: Perform modeling and optimization of product recovery, including cost minimization, analysis and trending of plant performance, troubleshooting problems and performance issues, developing plans for gas and LNG product treatment to maintain specification compliance, and debottlenecking of existing plant systems for overall cost and capacity utilization.

Alternate Job Titles: Gas Processing Engineer

SOC Code: 17-2041.98

1.8.5 CHEMICAL TECHNICIAN

Job Responsibilities: Provide technical laboratory support and assistance in chemical engineering, chemical analysis, industrial chemistry, chemical quality control and environmental protection. Conduct chemical and physical laboratory tests to assist scientists in making qualitative and quantitative analyses of solids, liquids, and gaseous materials for purposes such as: research and development of new products or processes, quality control, maintenance of environmental standards, and other work involving experimental, theoretical, or practical application of chemistry and related sciences.

Alternate Job Titles: Laboratory Technician, Research Technician, Laboratory Tester, Research and Development Technician, Chemical Technician, Laboratory Analyst, Chemical Engineering Technician, Dehydration Technician, Formulation Technician

SOC Code: 19-4031.00

1.9 MATERIALS ENGINEER

Job Responsibilities: Evaluate materials and develop machinery and processes to manufacture materials for use in products that must meet specialized design and performance specifications. Develop new uses for known materials. Includes those working with composite materials or specializing in one type of material, such as graphite, metal and metal alloys, ceramics and glass, plastics and polymers, and naturally occurring materials.

Alternate Job Titles: Materials Engineer, Manufacturing Engineer, Materials Research Engineer, Metallurgist, Process Engineer, Research Engineer, Test Engineer, Materials and Processes Manager, Materials Branch Chief, Materials Development Engineer, Mettalurgist

SOC Code: 17-2131.00

1.10 CIVIL ENGINEER

Job Responsibilities: Perform engineering duties in planning, designing, and overseeing construction and maintenance of building structures, and facilities. Optimize processes and operations at existing facilities. Manage all aspects of construction projects, such as the installation of oil, gas and water production, separation and injection facilities and transportation systems.

Alternate Job Titles: Structural Engineer, Design Engineer, Applications Engineer, Facilities Engineer

SOC Code: 17-2051.00

1.11 ARCHITECT

1.11.1 ARCHITECT

Job Responsibilities: Plan and design structures, prepare information regarding design, structure specifications, materials, color, equipment, estimated costs, or construction time. Integrate engineering elements into a unified design.

Alternate Job Titles: Designer, Project Architect

SOC Code: 17-1011.00

1.11.2 ARCHITECTURAL OR CIVIL DRAFTER

Job Responsibilities: Prepare detailed drawings of architectural designs and plans for buildings and structures according to specifications provided by architect. Prepare drawings used in the layout, construction, and operation of oil and gas fields, refineries, chemical plants, and process piping systems.

Alternate Job Titles: Drafter, Draftsman, Architectural Drafter

SOC Code: 17-3011.00

1.11.3 DRAFTER

Job Responsibilities: Prepare, reproduce and distribute drawings, maps, graphics, displays and other related documents. Establish, maintain, store and file drawings and maps in an orderly, systematic filing and data base mapping systems. Prepare detailed working diagrams of machinery and mechanical devices, including dimensions, fastening methods, and other engineering information.

Alternate Job Titles: Drafter, Mechanical Drafter, CAD (Computer-Aided Design) Operator, Design Drafter, CAD Designer, CAD Drafter, Computer Draftsman Mechanical, Computer-Aided Design and Computer-Aided Manufacturing (CAD/CAM) Programmer, Design Technician

SOC Code: 17-3013.00

1.12 COMPUTER PROGRAMMER

Job Responsibilities: Convert project specifications and statements of problems and procedures to detailed logical flow charts for coding into computer language. Develop and write computer programs to store, locate, and retrieve specific documents, data, and information.

Alternate Job Titles: Programmer Analyst, Programmer, Computer Programmer, Software Developer, Internet Programmer, Web Programmer

SOC Code: 15-1021.00

1.13 COMPUTER SOFTWARE ENGINEER

Job Responsibilities: Develop, create, and modify general computer applications software or specialized utility programs. Analyze user needs and develop software solutions. Design software or customize software for client use with the aim of optimizing operational efficiency. May analyze and design databases within an application area, working individually or coordinating database development as part of a team. Research, design, develop, and test operating systems-level software, compilers, and network distribution software. Set operational specifications and formulate and analyze software requirements. Apply principles and techniques of computer science, engineering, and mathematical analysis.

Alternate Job Titles: Software Engineer

SOC Code: 15-1031.00/15-1032.00

2 MANAGEMENT

2.1 OPERATIONS MANAGER

Job Responsibilities: Manage multiple operations and capital projects directly involved with scheduling, resource planning, and procurement. Supervise project managers and contractors and ensure timely execution of project goals associated with both. Utilize expertise in design and construction management, resource planning and procurement, estimating work breakdown structures and project scoping.

Alternate Job Titles: Senior Field Engineer

SOC Code: 11-1021.00

2.1.1 PIPELINE SUPERVISOR

Job Responsibilities: Oversee the day-to-day operations of pipeline facility operations and ensure that they are safely operating according to industry standards and regulations. Implement corporate policies and examining and confirming the accuracy of the systems operating in the pipeline facility.

Alternate Job Titles: Supervisor, Shift Supervisor, Team Leader

SOC Code: 11-1021.99

2.1.2 FIRST-LINE SUPERVISOR

Job Responsibilities: Supervise and coordinate the activities of operations, maintenance and/or construction workers.

Alternate Job Titles: Production Supervisor, Shift Supervisor, Team Leader, Production Manager, Department Manager

SOC Code: 51-1011.00

2.1.3 PRODUCTION MANAGER

Job Responsibilities: Plan, direct, or coordinate the work activities and resources necessary for manufacturing products in accordance with cost, quality, and quantity specifications.

Alternate Job Titles: Supervisor, Shift Supervisor, Team Leader

SOC Code: 11-3051.00

2.2 CONSTRUCTION MANAGER

Job Responsibilities: Plan, direct, coordinate, or budget, usually through subordinate supervisory personnel, activities concerned with the construction and maintenance of structures, facilities, and systems. Participate in the conceptual development of a construction project and oversee its organization, scheduling, and implementation.

Alternate Job Titles: Project Manager, Construction Manager, Construction Superintendent, Construction Area Manager, Construction Foreman, General Contractor, Job Superintendent, Project Superintendent

SOC Code: 11-9021.00

2.3 ENGINEERING MANAGER

Job Responsibilities: Plan, direct, or coordinate activities in such fields as architecture and engineering or manage research and development in these fields.

Alternate Job Titles: Capital Projects Engineering Manager

SOC Code: 11-9041.00

2.4 PURCHASING MANAGER

Job Responsibilities: Plan, direct, or coordinate the activities of buyers, purchasing officers, and related workers involved in purchasing materials, products, and services.

Alternate Job Titles: Purchasing Manager, Director of Purchasing, Materials Manager, Commodity Manager, Director of Materials, Director of Strategic Sourcing, Procurement Manager, Purchasing Supervisor, Supply Chain Manager

SOC Code: 11-3061.00

2.4.1 LAND MANAGER

Job Responsibilities: Plan, direct, or coordinate selling, buying, leasing, or governance activities of commercial or industrial real estate properties.

Alternate Job Titles: Lease Administration Supervisor, Leasing Manager

SOC Code: 11-9141.00

2.5 TRAINING AND DEVELOPMENT MANAGER

Job Responsibilities: Plan, direct, or coordinate the training and development activities and staff of an organization.

Alternate Job Titles: Education and Development Manager, Manager of Staff Training and Development, Training and Development Coordinator

SOC Code: 11-3042.00

3 OPERATIONS

3.1 NATURAL GAS OPERATIONS

3.1.1 GAS COMPRESSOR OR GAS PUMPING STATION OPERATOR

Job Responsibilities: Distribute or process gas for utility companies and others by controlling compressors to maintain specified pressures on main pipelines. Operate steam, gas, electric motor, or internal combustion engine driven compressors. Transmit, compress, or recover gases, such as butane, nitrogen, hydrogen, and natural gas.

Alternate Job Titles: Compressor Station Operator, Engine Room Operator, Gas System Operator, Bulk Plant Operator, Gas Compressor Operator, Gas Processing Compressor Operator, Gauger, Panel Operator, Tank Farm/Terminal Operator

SOC Code: 53-7071.00

3.1.2 MEASUREMENT TECHNICIAN

Job Responsibilities: Calibrate, test, operate, install, repair, and maintain regulating and controlling devices, such as electric meters, gas regulators, thermostats, safety and flow valves, and other mechanical governors related to measurement and regulating facilities, corrosion equipment, and control and monitoring equipment. Take gas samples to ensure proper volume calculations. Insure gas measurement field devices and related equipment types are in working condition. Pipeline operations work (operating valves, launching pigs) may also be required. Report abnormal and safety related operating conditions, report accidents and near misses. Perform emergency response procedures, regulatory compliance procedures, and repair procedures. Pipeline and measurement facilities may include buried pipelines, buried valves, above ground piping assemblies, cathodic protection equipment right of ways, signage, positive meters, orifice meters, ultrasonic meters, gravitometers, flow computers, samplers, communications devices, valves, and actuators.

Alternate Job Titles: Meter Technician, Electric Meter Technician, Valve Technician, Control Valve Technician, Maintenance Technician

SOC Code: 49-9012.99

3.1.3 GAS PLANT OPERATOR

Job Responsibilities: Operate, control and monitor vital process control systems in areas like plant settings, onshore and offshore natural gas processing facilities, pumping stations and other pipeline facilities, distribution terminals, storage and offshore production facilities.

Alternate Job Titles: Plant Operator, Gas Plant Operator, Gas Recovery Operator

SOC Code: 51-8092.00

3.1.4 LIQUIFIED NATURAL GAS TECHNICIAN

Job Responsibilities: Operate, control and monitor vital process control systems in areas like plant settings, onshore and offshore liquid natural gas processing facilities, pumping stations and other pipeline facilities, distribution terminals, storage and offshore production facilities.

Alternate Job Titles: Liquid Natural Gas Plant Operator (LNG Plant Operator), Liquified Natural Gas Specialist

SOC Code: 51-8092.97

3.1.5 PIPELINE TECHNICIAN

Job Responsibilities: Locate pipelines, oversee excavations, check facility stations, and maintain equipment. Gather samples and process results, gauge tanks, prove meters, witness sampling, and monitor inbound/outbound pipeline shipments.

Alternate Job Titles: Production Technician, Pipeline Systems Operator, Terminal Operator

SOC Code: 49-9042.99

3.1.6 PUMP OPERATOR

Job Responsibilities: Tend, control, or operate power-driven, stationary, or portable pumps and manifold systems to transfer gases, oil, other liquids to and from various vessels and processes.

Alternate Job Titles: Pumper, Outside Operator, Pipeline Operator, Day Light Relief Operator, Pump Station Operator

SOC Code: 53-7072.00

3.1.7 CHEMICAL OPERATOR

Job Responsibilities: Control or operate an entire chemical process or system of machines.

Alternate Job Titles: Operator, Process Technician, Process Operator, Purification Operator, Operations Technician, Process Development Associate, Chemical Plant Operations Technician, Continuous Operator, Control Room Operator, Process Development Technician

SOC Code: 51-8091.00

3.2 SCHEDULING AND ACCOUNTING

3.2.1 GAS CONTROLLER

Job Responsibilities: Provide project controls and project management services, including scheduling and cost control, requirements identification, solution design, configuration and training. Understands regulatory requirements.

Alternate Job Titles: Gas Dispatcher, Gas Scheduler, Gas Supplier, Gas Utility Operator

SOC Code: 51-8092.99

3.2.2 NATURAL GAS TRADER

Job Responsibilities: Trade and manage the physical and financial natural gas supply, demand, pipeline flows, weather, power plant outages, and competing fuels. Work with trading financial instruments such as swing swaps, basis swaps, index swaps, and calendar spreads for a trading team.

Alternate Job Titles: Gas Trader, Natural Gas Market Analyst, Energy Trader

SOC Code: 13-1022.99

3.2.3 NATURAL GAS ACCOUNTANT

Job Responsibilities: Perform accounting duties including pipeline actualization and balancing, verifying transportation invoices, and reconciling accounts, customer invoices, and transaction reports.

Alternate Job Titles: Accountant, Gas Gathering Accountant, NGL Volume Accountant, Gas Accountant

SOC Code: 13-2011.01

3.3 SURVEYING AND LAND MANAGEMENT

3.3.1 SURVEYOR

Job Responsibilities: Make exact measurements and determine property boundaries. Provide data relevant to the shape, contour, gravitation, location, elevation, or dimension of land or land features on or near the earth's surface for engineering, mapmaking, mining, land evaluation, construction, and other purposes.

Alternate Job Titles: Surveyor, Survey Party Chief, Engineer, Land Surveyor, County Surveyor, Engineering Technician, Geodesist, Licensed Land Surveyor, Mine Surveyor, Professional Land Surveyor

SOC Code: 17-1022.00

3.3.2 SURVEY TECHNICIAN

Job Responsibilities: Adjust and operate surveying instruments, such as electronic distance-measuring equipment, and compile notes, make sketches and enter data into computers. Perform deed research for both on-line and in land record offices, prepare property mosaics, perform boundary computations, develop topographic base maps, prepare boundary, or right-of-way plats, and prepare legal descriptions.

Alternate Job Titles: Survey Technician, Survey Crew Chief, Survey Party Chief, Instrument Man (I-Man), Chainman, Rodman, Instrument Operator, Engineering Technician, Engineering Assistant, Field Crew Chief

SOC Code: 17-3031.01

3.3.3 LAND AGENT

Job Responsibilities: Acquire land surface and mineral rights needed by gas companies. Negotiate agreements and contracts regarding leasing or land purchase with stakeholders such as farmers, ranchers, aboriginal groups and governments. Obtain permits from various government agencies and manage the agreements with these stakeholders. Negotiate right-of-way access for pipeline construction and maintenance, and ensure appropriate reclamation.

Alternate Job Titles: Right-of-way Claim Agent, Land Agent, Land Use Technician, Lease Contract Negotiator, Reclamation Coordinator, Right-of-Way Agent/Planner, Contract Analyst, Land Administrator

SOC Code: 41-9022.99

3.3.4 PIPELINE MAPPER

Job Responsibilities: Perform topographical pipeline mapping and as it applies to maintenance and expansion projects. Coordinate the layout of the pipeline. Skills involve using survey data, metes and bounds, property plats, plotting deeds, alignment sheets, permit drawings, aerial photography, geo-referenced data, deeds and titles.

Alternate Job Titles: Mapper, Civil Drafter

SOC Code: 17-1022.98

3.4 POWER PLANT OPERATOR

Job Responsibilities: Control, operate or maintain machinery to generate electric power. Maintain proper pressures and flow rates and bring additional boilers on line as required. Make scheduled rounds within the plant, record all required data in proper logs and coordinates with fuel delivery personnel.

Alternate Job Titles: Auxiliary Operator, Control Operator, Control Center Operator, Plant Control Operator, Control Room Operator, Operations and Maintenance Technician (O & M Technician), Unit Operator, Power Plant Operator, Boiler Operator, Operations and Maintenance Gas Turbine Technician

SOC Code: 51-8013.00

4 SKILLED TRADES

4.1 ELECTRICAL EQUIPMENT

4.1.1 ELECTRICIAN

Job Responsibilities: Install, maintain, test and repair industrial electrical equipment and associated electrical and electronic controls. These include wiring and lighting systems, cathodic protection systems, seismic restraint systems, high/low voltage power distribution systems, climate/environment control systems, building automation and emergency and standby systems.

Alternate Job Titles: Journeyman Electrician, Maintenance Electrician, Apparatus Electrician, High Voltage Electrician, Industrial Electrician, Pipeline Electrical Maintenance Technician

Apprenticeship Specialties: Protective-Signal Repairer, Electrician (Water Transportation), Electrician (Construction), Protective-Signal Installer, Street-Light Servicer, Electrician, Maintenance, Neon-Sign Servicer, Electrician (Ship-Boat Manufacturing), Residential Wireman

SOC Code: 47-2111.00

4.1.2 ELECTRICAL POWER-LINE INSTALLERS AND REPAIRERS

Job Responsibilities: Install or repair cables or wires used in electrical power or distribution systems.

Alternate Job Titles: Lineman, Journeyman Lineman, Electrical Lineworker, Lineworker, Power Lineman

Apprenticeship Specialties: Cable Installer-Repairer, Cable Splicer, Line Erector, Line Maintainer, Line Repairer, Trouble Shooter II

SOC Code: 49-9051.00

4.1.3 SUBSTATION ELECTRICIAN

Job Responsibilities: Inspect, test, repair, or maintain electrical equipment in generating stations, substations, and in-service relays. Repair, test, adjust, or install electronic equipment, such as industrial controls, transmitters, and antennas.

Alternate Job Titles: Relay Technician, Substation Electrician, Substation Technician, Substation Mechanic, Wireman, Meter / Relay Technician, Apparatus Lineman

SOC Code: 49-2095.00

4.1.4 ELECTRICAL ENGINEERING TECHNICIAN

Job Responsibilities: Apply electrical theory and related knowledge to test and modify developmental or operational electrical machinery and electrical control equipment and circuitry in industrial or commercial plants and laboratories.

Alternate Job Titles: Electronic Engineer Technician, Electronics Technician, Engineering Technician, Engineering Assistant, Test Technician, Electrical Design Technician, Electrical Engineering Technician, Electrical Technician, Engineering Lab Coordinator, Engineering Lab Technician, Equipment Engineering Technician

SOC Code: 17-3023.00

4.1.5 ELECTRONICS TECHNICIAN

Job Responsibilities: Maintain, install, remove and repair electrical equipment including electrical motors, generators, industrial storage batteries, and hydraulic and pneumatic electrical control systems.

Alternate Job Titles: Test Technician, Electrical Design Technician, Electrical Engineering Technician, Electrical Technician, Engineering Lab Coordinator, Engineering Technician, Engineering Lab Technician, Equipment Engineering Technician

SOC Code: 17-3023.01

4.1.6 INSTRUMENT AND CONTROL TECHNICIAN

Job Responsibilities: Troubleshoot and maintain all plant instrumentation, control valves, high and low voltage switchgear, transformers, motors and electrical controls equipment. Calibrate, maintain, and repair hydraulic, pneumatic, mechanical, electrical/electronic instruments and/or ambient, meteorological and associated air monitoring instruments. Install, test, repair and calibrate recording and indicating instrumentation and circuitry. Remove, dismantle, clean, maintain and assemble instruments and replace defective components. Connect instruments to simulated equipment standard testing devices. Test and install gas, steam, and water instruments and apparatus.

Alternate Job Titles: Instrument and Electrical Technician, Electrical Repairman, Electronic Mechanic, Electrical Instrument Mechanic, Electrical Technician, Electronic Instrumentation Technician, Instrument Technician, Instrument and Controls Technician, Instrument, Control and Electrical Technician, Instrumentation Engineer, Instrumentation Specialist

SOC Code: 49-2095.99

4.2 COMPUTER CONTROL

4.2.1 SCADA ENGINEER

Job Responsibilities: Monitor pipeline automation and control systems (fiber optic and microwave), along with ultrasonic flowmeters, smart pressure transmitters, flow and temperature transmitters, smart pressure and level switches, and other field instrumentation associated with automated pipeline monitoring.

Alternate Job Titles: Controls Engineer, Substation Engineer

SOC Code: 15-1021.99

4.2.2 CNC OPERATOR, AUTOMATION AND CONTROL SYSTEM PROGRAMMER

Job Responsibilities: Set-up and operate special purpose equipment, conventional (lathe and/or mill), and/or numerical control (NC) machines and machining centers for fabrication of metallic and nonmetallic parts. Read and interpret blueprints, sketches, drawings, manuals, specifications, or sample parts to determine dimensions and tolerances of finished work pieces, sequence of operations and setup requirements.

Alternate Job Titles: Computer Numerical Control (CNC) Operator, CNC Machinist, Machine Operator, CNC Lathe Operator, CNC Machine Operator, CNC Mill Operator, Production Worker, Brake Press Operator, CNC Set Up Technician, CNC Set-Up Operator

SOC Code: 51-4011.00

4.3 PIPE INSTALLATION

4.3.1 PIPE LAYERS

Job Responsibilities: Perform any combination of the following tasks: grade trenches or culverts, position pipe, or seal joints. Organize sections of pipeline in preparation for welding. Guide tractor drivers to ensure proper placement of the pipeline sections.

Alternate Job Titles: Pipelayer

SOC Code: 47-2151.00

4.3.2 PIPEFITTER

Job Responsibilities: Assemble, install, alter, and repair pipelines or pipe systems that carry water, steam, air, or other liquids or gases. May install heating and cooling equipment and mechanical control systems. Build and maintain piping systems used to produce oil and gas. Assemble, check, and help plan that carry liquids or gases through processes at wellsites and gas plants. Install and repair both high-pressure and low-pressure pipe systems used in manufacturing, in the generation of electricity, and in the heating and cooling of buildings.

Alternate Job Titles: Pipe Fitter, Journeyman Pipe Fitter Equipment Service Associate (ESA)

SOC Code: 47-2152.01

4.3.3 PLUMBER

Job Responsibilities: Install and repair water, waste disposal, drainage, and gas systems in commercial and industrial buildings.

Alternate Job Titles: Journeyman Plumber, Drain Technician, Plumber Gasfitter, Service Plumber

SOC Code: 47-2152.02

4.3.4 PIPELINER

Job Responsibilities: Apply insulation materials to pipelines, plumbing, air-handling units, heating, cooling and refrigeration systems, piping equipment and pressure vessels, and walls, floors and ceilings of buildings and other structures to prevent or reduce the passage of heat, cold, sound or fire.

Alternate Job Titles: Cryogenic Insulator, Pipeline Insulator

SOC Code: 47-2152.99

4.4 WELDING

4.4.1 WELDER

Job Responsibilities: Perform specialized (both gas and electric) welds on pipelines and gas mains. Fabricate high pressure piping, structural equipment, riser clamps, stairs and rails, ladders, scaffolding, and other components of both onshore and offshore pipeline stations and facilities.

Alternate Job Titles: Welder, Welder-Fitter, Fabricator, Maintenance Welder

SOC Code: 51-4121.06

4.4.2 WELDING OPERATOR

Job Responsibilities: Set up, operate, or tend welding, soldering, or brazing machines or robots that weld, braze, solder, or heat treat metal products, components, or assemblies.

Alternate Job Titles: Fabricator, Finishing Technician, Fitter-Welder, Robot Operator, Braze Operator, Machine Operator, Spot Welder, Technical Associate (TA)

SOC Code: 51-4122.00

4.4.3 MIG WELDER

Job Responsibilities: Perform specified welds, such as arc welding, heli-arc, oxyacetylene, and brazing processes.

Alternate Job Titles: Sub Arc Operator, B-Pressure Welders, Pipeline Arc Welder

SOC Code: 51-4121.99

4.4.4 SOLDERER

Job Responsibilities: Operate electric, gas, or oil-fired furnace to braze (bond) or solder metal components, as specified by work orders, sketches, and charts.

Alternate Job Titles: Brazer, Solderer, Electronic Assembler, Wirer, Assembly Line Brazer, Connector, Electronic Technician, Fabricator, Production Technician, Electrical Assembler

SOC Code: 51-4121.07

4.5 EQUIPMENT OPERATION

4.5.1 OPERATING ENGINEER

Job Responsibilities: Operate one or several types of power construction equipment, such as motor graders, bulldozers, scrapers, compressors, pumps, derricks, shovels, tractors, or front-end loaders to excavate, move, and grade earth, erect structures, or pour concrete or other hard surface pavement.

Alternate Job Titles: Equipment Operator, Heavy Equipment Operator, Operating Engineer, Back Hoe Operator, Loader Operator, Machine Operator, Motor Grader Operator, Track Hoe Operator, Excavator Operator, Grader Operator

SOC Code: 47-2073.00

4.5.2 DRILLING AND BORING TOOLSETTER

Job Responsibilities: Set up, operate, or tend drilling machines to drill, bore, ream, mill, or countersink metal or plastic work pieces.

Alternate Job Titles: Directional Driller, Horizontal Driller, Machine Operator, Drill Operator, Drill Setup Operator, Computer Numerical Control Set-Up Operator, Drill Press Operator, Radial Drill Operator, Assembler, Bore Mill Operator, Computer Numerical Control Drilling Operator, Computer Numerical Control Machine Operator

SOC Code: 51-4032.00

4.6 EQUIPMENT MAINTENANCE

4.6.1 MOBILE HEAVY EQUIPMENT MECHANIC

Job Responsibilities: Diagnose, adjust, repair, or overhaul mobile mechanical, hydraulic, and pneumatic equipment, such as cranes, bulldozers, graders, and conveyors. Usually requires several years of work-related experience, on-the-job training, and/or vocational training.

Alternate Job Titles: Construction Equipment Mechanic, Forklift Technician, Field Service Technician, Field Mechanic, Heavy Equipment Mechanic, Mobile Heavy Equipment Mechanic, Heavy Duty Mechanic, Diesel Engine Mechanic, Heavy Duty Equipment Technician, Heavy Duty Mechanic.

SOC Code: 49-3042.00

4.6.2 MILLWRIGHT

Job Responsibilities: Install, replace, dismantle, and repair machinery and heavy equipment. Inspect, examine, install, align, dismantle and move stationary industrial machinery and mechanical equipment, including pumps, hydraulic and pneumatic systems, and turbines, compressors and associated controls.

Alternate Job Titles: Compressor Station Maintenance Mechanic, Derrick Mechanic, Gas Plant Maintenance Mechanic, Mechanical Technician, Oilfield Mechanic, Pipeline Mechanic, Pipeline Station Mechanic Pump Mechanic

SOC Code: 49-9044.00

4.6.3 INDUSTRIAL MACHINERY MECHANIC

Job Responsibilities: Repair, install, adjust, or maintain industrial production and processing machinery or refinery and pipeline distribution systems. Troubleshoot and repair conveyer systems, hydraulics, and fabrication. Perform mechanical and electrical maintenance.

Alternate Job Titles: Maintenance Mechanic, Maintenance Technician, Mechanic, Industrial Mechanic, Engineering Technician, Master Mechanic, Industrial Machinery Mechanic, Overhauler, Machine Adjuster

SOC Code: 49-9041.00

4.6.4 MACHINIST

Job Responsibilities: Set up and operate a variety of machine tools to produce precision parts and instruments. Includes precision instrument makers who fabricate, modify, or repair mechanical instruments. May also fabricate and modify parts to make or repair machine tools or maintain industrial machines, applying knowledge of mechanics, shop mathematics, metal properties, layout, and machining procedures.

Alternate Job Titles: Machinist, Machine Operator, Machinist Tool and Die, Maintenance Specialist, Set-Up Machinist, Utility Operator, Maintenance Machinist, Production Machinist, Maintenance Technician, Mold Tooling Designer (MTD)

SOC Code: 51-4041.00

4.6.5 Heating, Air Conditioning, and Refrigeration Mechanic

Job Responsibilities: Inspect, repair and maintain heating ventilation and air conditioning systems including, gas, oil and propane boilers and furnaces, central air conditioning, heat pumps and packaged roof top systems.

Alternate Job Titles: HVAC (Heating, Ventilation, and Air Conditioning) Specialist, HVAC Technician, HVAC Installer

SOC Code: 49-9021.00

4.6.6 Maintenance Mechanic and Repair Worker, General

Job Responsibilities: Perform work involving the skills of two or more maintenance or craft occupations to keep machines, mechanical equipment, or the structure of an establishment in repair. Duties may involve: pipe fitting, boiler making, insulating, welding, machining, carpentry, repairing electrical or mechanical equipment, installing, aligning, and balancing new equipment, and repairing buildings, floors, or stairs.

Alternate Job Titles: Maintenance Technician, Maintenance Mechanic, Maintenance Supervisor, Maintenance Engineer, Building Maintenance Mechanic, Building Mechanic

SOC Code: 49-9042.00

5 Quality Control, Regulatory, and Compliance

5.1 Construction/Building Inspector

Job Responsibilities: Inspect structures using engineering skills to determine structural soundness and compliance with specifications, building codes, and other regulations.

Alternate Job Titles: Building Inspector, Construction Inspector, Engineer, Associate Architect, Construction Project Supervisor, Integrity Inspector, Inspector, Plumbing Inspector, Building Code Administrator

SOC Code: 47-4011.00

5.2 QUALITY INSPECTOR

Job Responsibilities: Inspect, test, sort, sample, or weigh nonagricultural raw materials or processed, machined, fabricated, or assembled parts or products for defects, wear, and deviations from specifications.

Alternate Job Titles: Inspector, Quality Inspector, Quality Technician, Quality Assurance Inspector, Quality Control Inspector, Quality Auditor, Picker / Packer, Quality Assurance Auditor, Quality Control Supervisor, Quality Control Technician, General Mechanical Inspectors

SOC Code: 51-9061.00

5.2.1 QUALITY SPECIALIST

Job Responsibilities: Carry out nondestructive testing, calibration analyses, and audits and inspections on plants, structures, and drilling/well equipment using a variety of highly technical processes such as radiographic, infra-red, and ultrasonic inspections. Audits and inspections ensure compliance with engineering design specifications, standards and procedures, and environmental and safety compliance.

Alternate Job Titles: Gas Measurement Analyst, Pressure Equipment Integrity Coordinator, Coatings Inspector, ISO Inspector, Non-Destructive Examination (NDE) Inspector/Technician, Non-Destructive Testing (NDT) Technician, Quality Specialist, Quality Assurance/Quality Control Inspectors, Thread Inspector, Tubular/Drill Pipe Inspector, Welding Inspector

SOC Code: 51-9061.99

5.3 REGULATORY AND ENVIRONMENTAL

5.3.1 ENVIRONMENTAL COMPLIANCE INSPECTOR

Job Responsibilities: Inspect and investigate sources of pollution to protect the public and environment and ensure conformance with Federal, State, and local regulations and ordinances.

Alternate Job Titles: Enforcement Officer, Environmental Scientist, Environmental Specialist, Resource Conservation and Recovery Act Enforcement Officer (RCRA Enforcement Officer), Compliance Investigator, Environmental Quality Analyst, Environmental Protection Specialist, Inspector, Toxics Program Officer, Waste Management Specialist

SOC Code: 13-1041.01

5.3.2 REGULATORY SPECIALIST

Job Responsibilities: Coordinate regulatory submissions related to cost of service, capital expansion programs, and rate change applications to provincial, territorial and federal bodies.

Alternate Job Titles: Regulatory Advisor

SOC Code: 13-1041.99

6 LABOR

6.1 CONSTRUCTION LABORER

Job Responsibilities: Perform tasks involving physical labor at construction projects, tunnel and shaft excavations, and demolition sites. May operate hand and power tools of all types: air hammers, earth tampers, cement mixers, small mechanical hoists, surveying and measuring equipment, and a variety of other equipment and instruments. May clean and prepare sites, dig trenches, set braces to support the sides of excavations, erect scaffolding, clean up rubble and debris, and remove asbestos, lead, and other hazardous waste materials. May assist other craft workers.

Alternate Job Titles: Laborer, Construction Laborer, Cement Finisher, Construction Worker, Groundsman

SOC Code: 47-2061.00

6.2 ROUSTABOUT, OIL AND GAS

Job Responsibilities: Assemble or repair oil field equipment using hand and power tools. Assist in the operation of the right equipment when drilling, completing, or maintaining a well including connecting and disconnecting pipes, handling, sorting and moving drill pipe or tubing, setting up and taking down the rig equipment and general clean-up of the rig area and lease site.

Alternate Job Titles: Roustabout, Roustabout Pusher, Roustabout Hand, Floor Hand, Oil Field Roustabout, Roustabout Crew Leader, Roustabout Crew Pusher, Roughneck

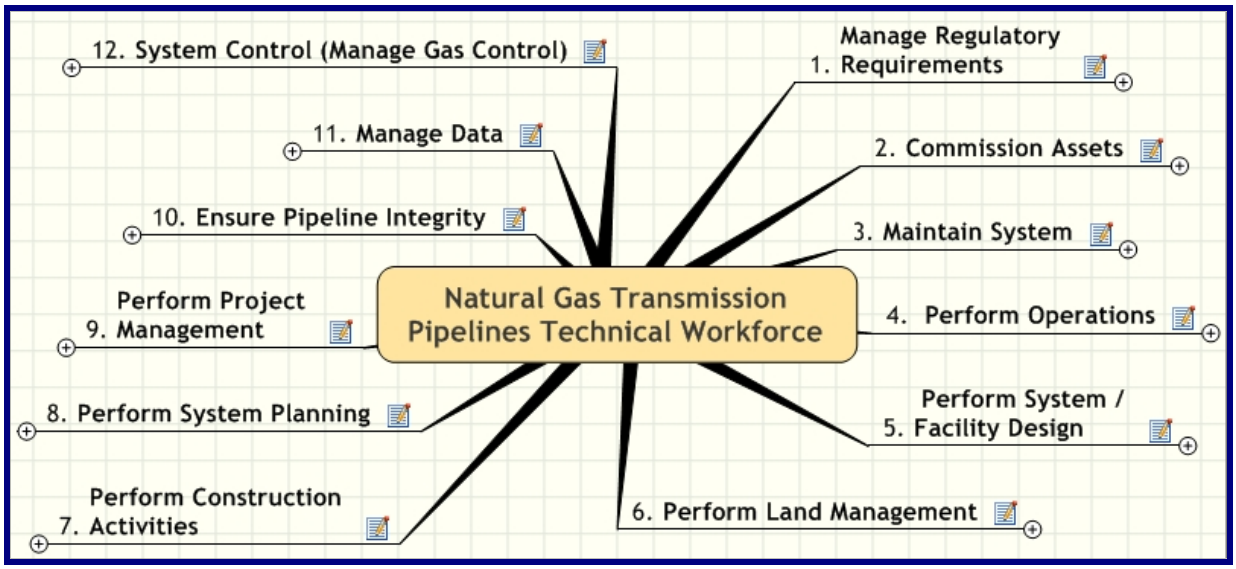
SOC Code: 47-5071.00

APPENDIX G - INDUSTRY FUNCTION MODEL

TABLE OF CONTENTS

Introduction

This document presents a function model for the natural gas transmission's technical workforce. A function is a key activity performed by the organization to achieve its objectives. Employees use their *knowledge* and *skills* to accomplish a function. The top level function map is shown below with the 12 highest level functions.

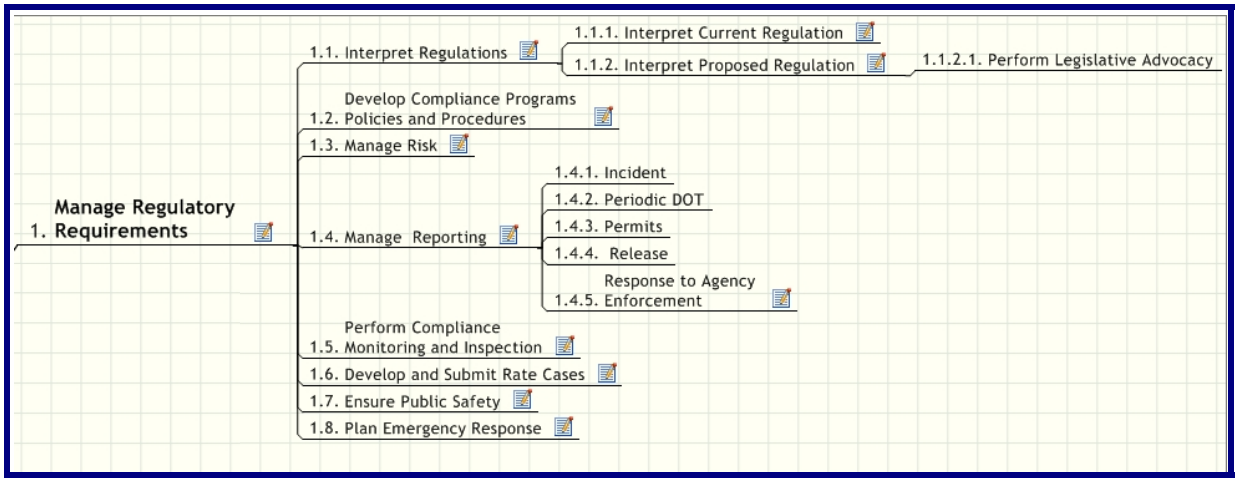


Each major function is accompanied by sub-functions. For example, “1. Manage Regulatory Requirements” has sub-functions 1.1 through 1.8.

Function Model

1 MANAGE REGULATORY REQUIREMENTS

Manage the regulatory requirements for risk, compliance, reporting and other regulatory aspects that impact the organization and its stakeholders.



1.1 INTERPRET REGULATIONS

Interpret proposed and actual regulation that may impact gas transportation system. Conduct Federal Register review to assess both direct and indirect impacts on operations, personnel, and stakeholders. Develop a regulatory interpretation specific to the industry. Formulate an impact analysis and potential responses.

1.1.1 INTERPRET CURRENT REGULATION

Provide consistent communication of strategy, approach and results to internal and external constituencies. Interpret current regulation(s) and keep abreast of current industry and regulatory status. Find opportunities to interact and provide feedback on the impact, effectiveness and ease of implementation of the existing regulation.

1.1.2 INTERPRET PROPOSED REGULATION

Provide consistent communication of strategy, approach and results to internal and external constituencies. Interpret proposed(s) regulation and keep abreast of industry and regulatory activity. Find opportunities to interact and provide feedback on the impact, effectiveness and ease of implementation for the proposed regulation.

1.1.2.1 Perform Legislative Advocacy

Advocate legislatively by creating opportunities to interact and provide feedback on the impact, effectiveness and ease of implementation for the proposed regulation. Develop Compliance Programs, Policies and Procedures

Develop and deploy compliance programs, policies and procedures to respond to gaps identified in meeting regulatory requirements.

1.2 DEVELOP COMPLIANCE PROGRAMS POLICIES AND PROCEDURES

1.3 MANAGE RISK

Analyze the current situation and identify potential situations which might impact compliance. Perform evaluation of cost/benefit analysis, trade-offs, risks, potential liabilities, etc. Manage and pursue the strategies that provide the optimum approach to managing risk.

1.4 MANAGE REPORTING

Determine reporting requirements and secure required permits and authorizations. Manage the frequency and detail level of reporting and communication in compliance with requirements.

1.4.1 REPORTING TYPES: INCIDENT

Report incidents using incident reporting procedures and forms. Inform organization representatives and other applicable regulatory agencies as required.

1.4.2 REPORTING TYPES: PERIODIC DOT

Report to PHMSA using PHMSA reporting procedures and forms (e.g., EPA, DOT Driver, DEQ, OSHA, FERC, etc.) Inform organization representatives and other applicable regulatory agencies as required.

1.4.3 REPORTING TYPES: PERMITS

Report as required by permits using appropriate reporting procedures and forms. Inform organization representatives and applicable regulatory agencies as required.

1.4.4 REPORTING TYPES: RELEASE

Report gas and other releases of materials as required using release reporting procedures and forms. Inform organization representatives and other applicable regulatory and local agencies as required.

1.4.5 RESPONSE TO AGENCY ENFORCEMENT

Analyze audit findings and reports of agency enforcement to determine root cause of non-conformance. Evaluate alternatives in terms of effectiveness, sustainability, cost of implementation, etc. Select optimum approach, plan and schedule the implementation of action to mitigate the occurrence and prevent reoccurrence in the future.

1.5 Perform Compliance Monitoring and Inspection

Monitor results to validate compliance levels and to identify potential problem areas. Develop protocols and conduct audits and inspections of facilities, equipment, personnel, and procedures to ensure compliance with regulations. Identify gaps, institute corrective action and perform ongoing monitoring to ensure compliance.

1.6 Develop and Submit Rate Cases

Assess current and projected rate structures. Develop new rate case proposals. Compile and initiate new rate cases as appropriate.

1.7 Ensure Public Safety

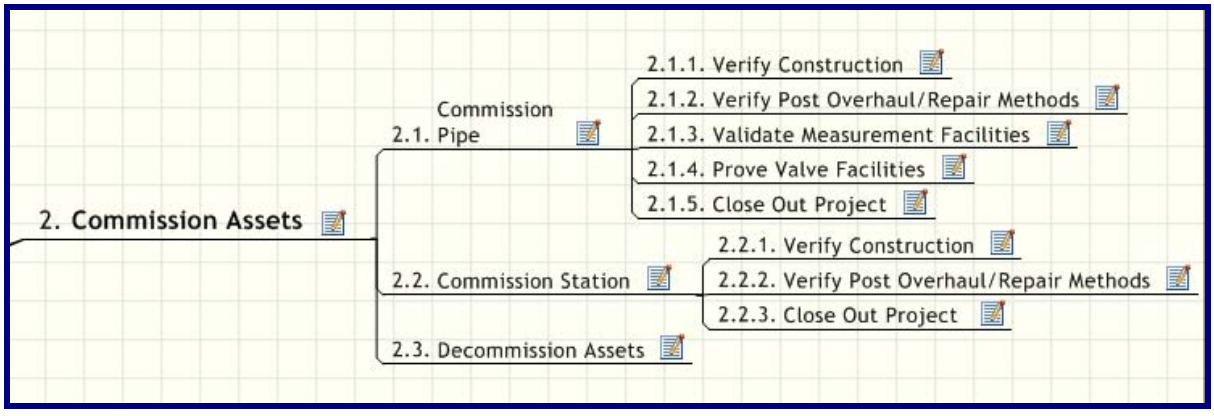
Monitor and review regulatory requirements affecting public safety. Identify application to specific industry elements. Assess current compliance and approaches to identify possible or actual gaps. Identify and initiate countermeasures to ensure compliance and promote public safety.

1.8 Plan Emergency Response

Review all applicable regulatory requirements for emergency response. Develop emergency response policies and procedures that meet or exceed applicable regulatory requirements. Plan drills.

2 Commission Assets

Develop a systematic approach to ensure that facilities and projects brought on line meet design requirements and system and performance objectives, and that they use appropriate methods for construction/overhaul.



2.1 Commission Pipe

Verify that the pipeline (and any associated assets) being brought on line fully meet the design, construction and performance requirements for the project. Identify any gaps in execution and performance. Coordinate countermeasures to address and rectify any deficiencies.

2.1.1 VERIFY CONSTRUCTION

Review plans and as-built condition. Identify any material differences and determine if variances are significant and need to be rectified. Develop test plan for ensuring proper performance and operation. Oversee completion of any needed corrections.

2.1.2 VERIFY POST OVERHAUL/REPAIR METHODS

Review procedures for the overhaul and / or repair of the asset to ensure the appropriate methods were employed. Develop test plan for ensuring proper performance and operation. Identify any discrepancies and determine if variances are significant and need to be rectified. Oversee completion of any needed corrections.

2.1.3 VALIDATE MEASUREMENT FACILITIES

Review measurement system plans and as-built condition. Identify any material differences and determine if variances are significant and need to be rectified. Develop test plan for ensuring proper performance and operation. Validate system operation. Oversee completion of any needed corrections.

2.1.4 PROVE VALVE FACILITIES

Review plans, design and as-built condition. Develop test plan for ensuring proper performance and operation. Identify any material differences and determine if variances are significant and need to be rectified. Oversee completion of any needed corrections.

2.1.5 CLOSE OUT PROJECT

Conduct post-job reviews. Prepare any needed post-job reports, conduct surveys and completion checklists, if applicable.

2.2 COMMISSION STATION

Verify that the station being brought on line fully meets the design, construction and performance compliance requirements for the project. Identify any gaps in execution and performance. Coordinate countermeasures to address and rectify any deficiencies.

2.2.1 VERIFY CONSTRUCTION

Review plans and as-built condition. Identify any material differences and determine if variances are significant and need to be rectified. Develop test plan for ensuring proper performance and operation. Oversee completion of any needed corrections.

2.2.2 VERIFY POST OVERHAUL/REPAIR METHODS

Review procedures for the overhaul and / or repair of the asset to ensure the appropriate methods were employed. Develop test plan for ensuring proper performance and operation. Identify any discrepancies and determine if variances are significant and need to be rectified. Oversee completion of any needed corrections.

2.2.3 CLOSE OUT PROJECT

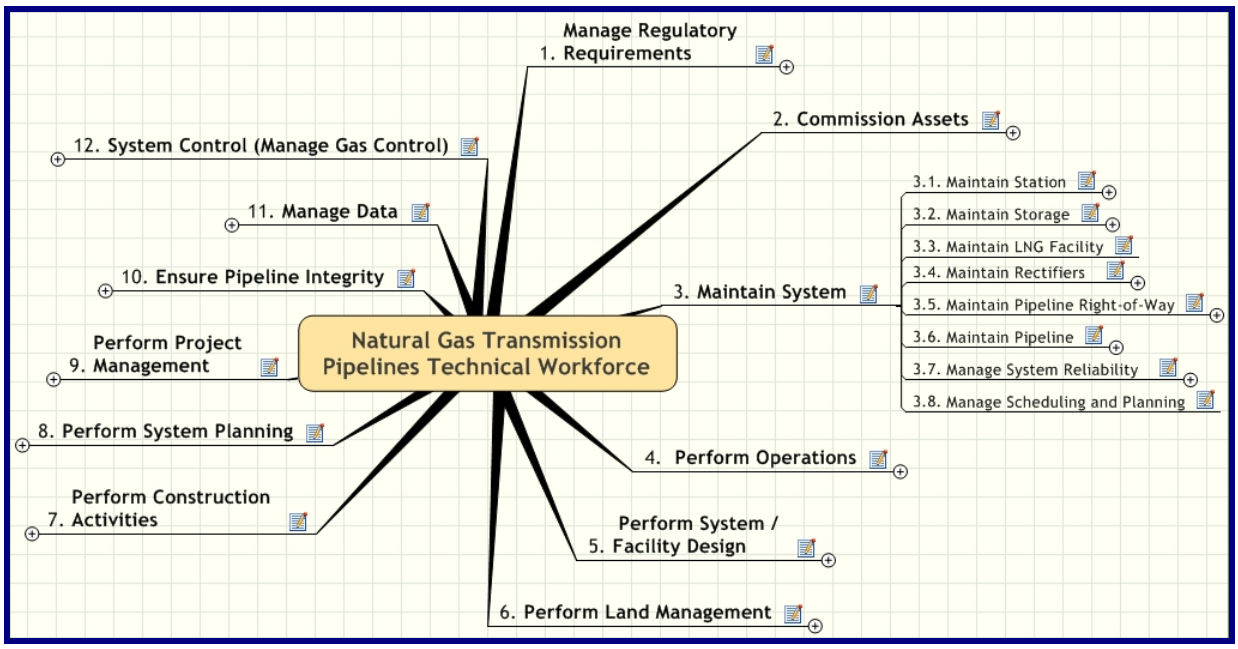
Conduct post-job reviews. Prepare any needed post-job reports, conduct surveys and completion checklists, if applicable.

2.3 DECOMMISSION ASSETS

Provide for a systematic approach to remove an asset from service. Identify key objectives for the decommissioning process; plan and execute the decommissioning process, including sale or transfer of surplus assets and demolition and restoration functions, as necessary.

3 MAINTAIN SYSTEM

Maintain overall system assets. including station, storage, transport, etc.

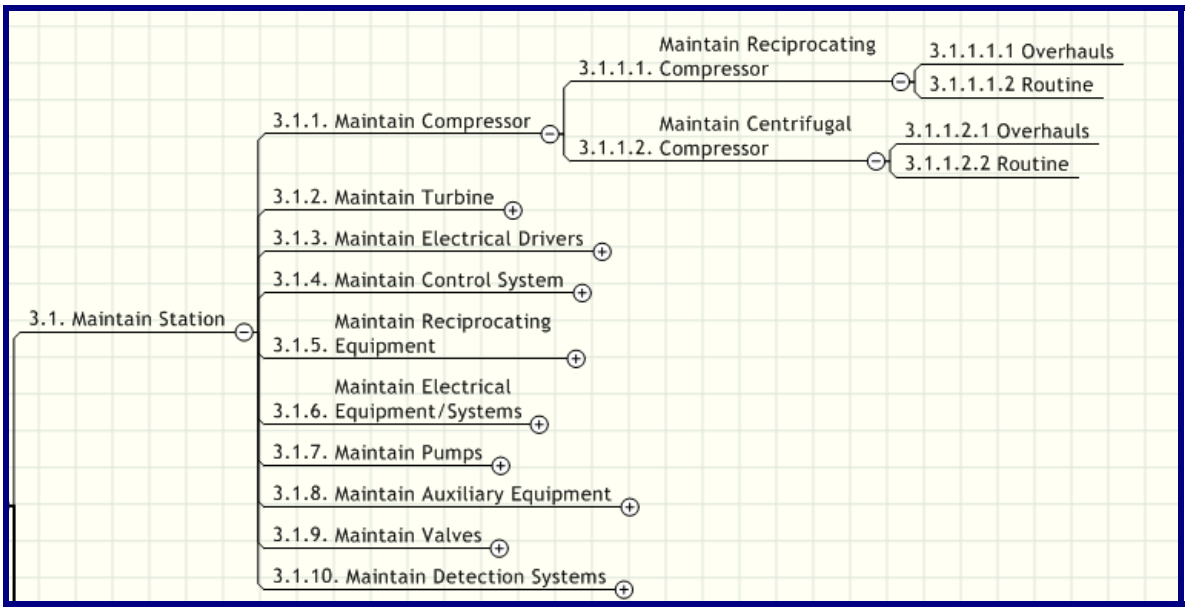


3.1 MAINTAIN STATION

Maintain station assets to ensure the ability to operate effectively and efficiently to meet station requirements.

3.1.1 MAINTAIN COMPRESSOR

Maintain compressor to meet station requirements. Develop routine and periodic maintenance plans and schedules appropriate to specific compressor types. Ensure data collection and analysis for predictive maintenance where employed.



3.1.1.1 Maintain Reciprocating Compressor

Maintain reciprocating compressor per established procedures and standards. Conduct operations for routine and periodic maintenance per schedule. Perform analysis for predictive maintenance where employed. Update and maintain maintenance records.

3.1.1.1.1 Maintenance Type: Overhauls

3.1.1.1.2 Maintenance Type: Routine

3.1.1.2 Maintain Centrifugal Compressor

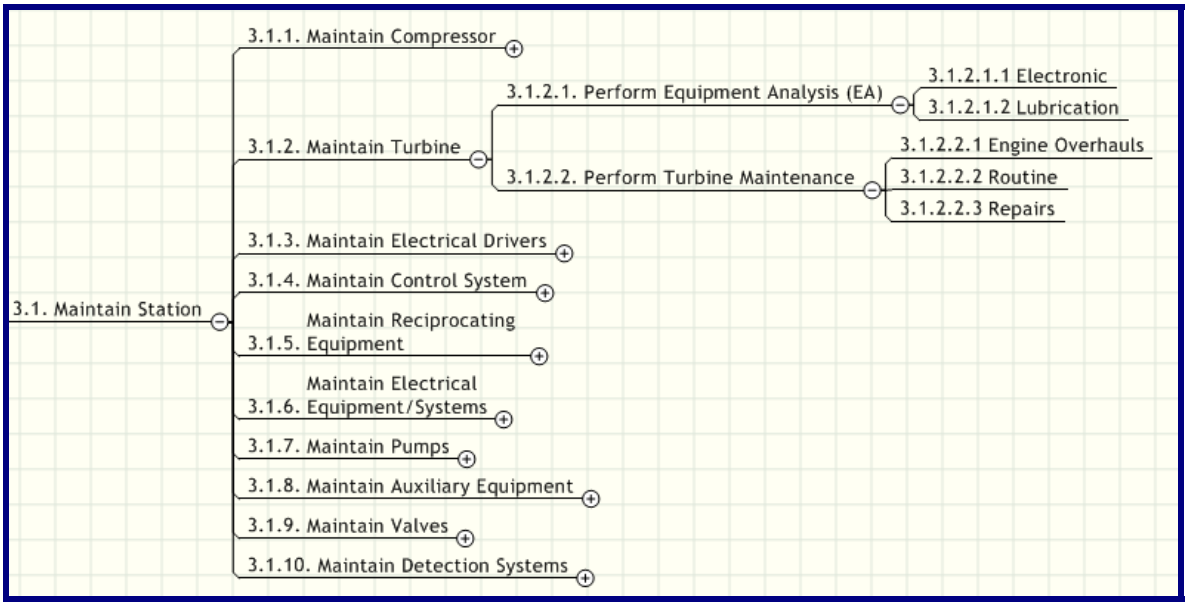
Maintain centrifugal compressor per established procedures and standards. Conduct operations for routine and periodic maintenance per schedule. Perform analysis for predictive maintenance where employed. Update and maintain maintenance records.

3.1.1.2.1 Maintenance Type: Overhauls

3.1.1.2.2 Maintenance Type: Routine

3.1.2 MAINTAIN TURBINE

Maintain turbine equipment to ensure the ability to operate effectively and efficiently to meet station requirements. Develop routine and periodic maintenance plans and schedules appropriate to specific equipment types. Ensure data collection and analysis for predictive maintenance where employed.



3.1.2.1 Perform Equipment Analysis (EA)

Monitor and review equipment performance data. Perform Equipment Analysis (EA). Identify and assess equipment issues through analysis of results. Determine appropriate actions to address equipment issues. Modify future maintenance schedules and procedures to incorporate improved practices.

3.1.2.1.1 EA Type: Electronic

3.1.2.1.2 EA Type: Lubrication

3.1.2.2 Perform Turbine Maintenance

Maintain station per established schedules and procedures. Perform routine and periodic maintenance plans and schedules appropriate to specific station equipment. Utilize data collection and analysis for predictive maintenance where employed. Modify future maintenance schedules and procedures to incorporate improved practices. Update and maintain maintenance records.

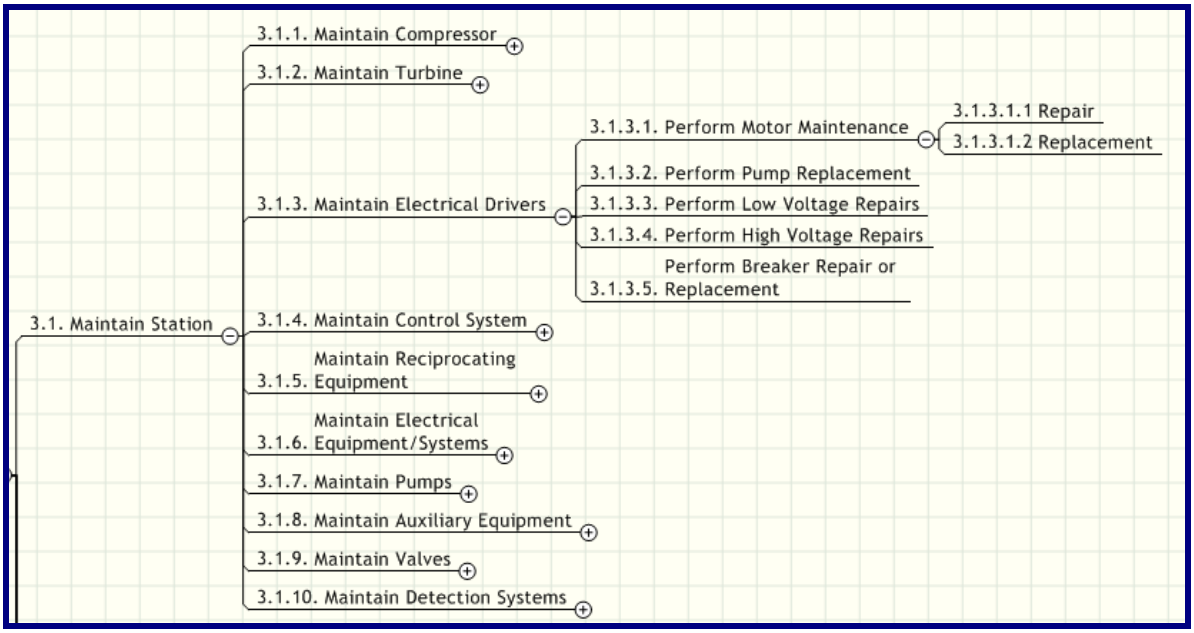
3.1.2.2.1 Maintenance Type: Engine Overhauls

3.1.2.2.2 Maintenance Type: Routine

3.1.2.2.3 Maintenance Type: Repairs

3.1.3 MAINTAIN ELECTRICAL DRIVERS

Maintain electric-based compressors to ensure the ability of the station and equipment to operate effectively and efficiently. Develop routine and periodic maintenance plans and schedules appropriate to specific electrical system types (i.e., thermal analysis of breakers, etc.). Ensure data collection and analysis for predictive maintenance where employed.



3.1.3.1 Perform Motor Maintenance

Maintain motor per established procedures. Assess condition of motor and determine if repair or replacement is the preferred option.

3.1.3.1.1 Repair

Repair electrical motors per specific unit and manufacturer's guidelines. Disconnect and reconnect mechanical and electrical attachments. Perform and verify motor alignment. Verify proper operation and return to service. Prepare repair log and record appropriate data.

3.1.3.1.2 Replacement

Replace electrical motors per specific unit and manufacturer's guidelines. Disconnect and reconnect mechanical and electrical attachments. Perform and verify motor alignment. Verify proper operation and return to service. Prepare repair log and record appropriate data.

3.1.3.2 Perform Pump Replacement

Replace electrical pumps per specific unit and manufacturer's guidelines. Disconnect and reconnect mechanical and electrical attachments. Perform and verify motor/pump alignment. Verify proper operation and return to service. Prepare repair log and record appropriate data.

3.1.3.3 Perform Low Voltage Repairs

Make low voltage electrical repairs per applicable standards and codes. Utilize appropriate lock-out and safety practices. Document repairs and modifications. Prepare appropriate documentation. Safely return affected equipment to service.

3.1.3.4 Perform High Voltage Repairs

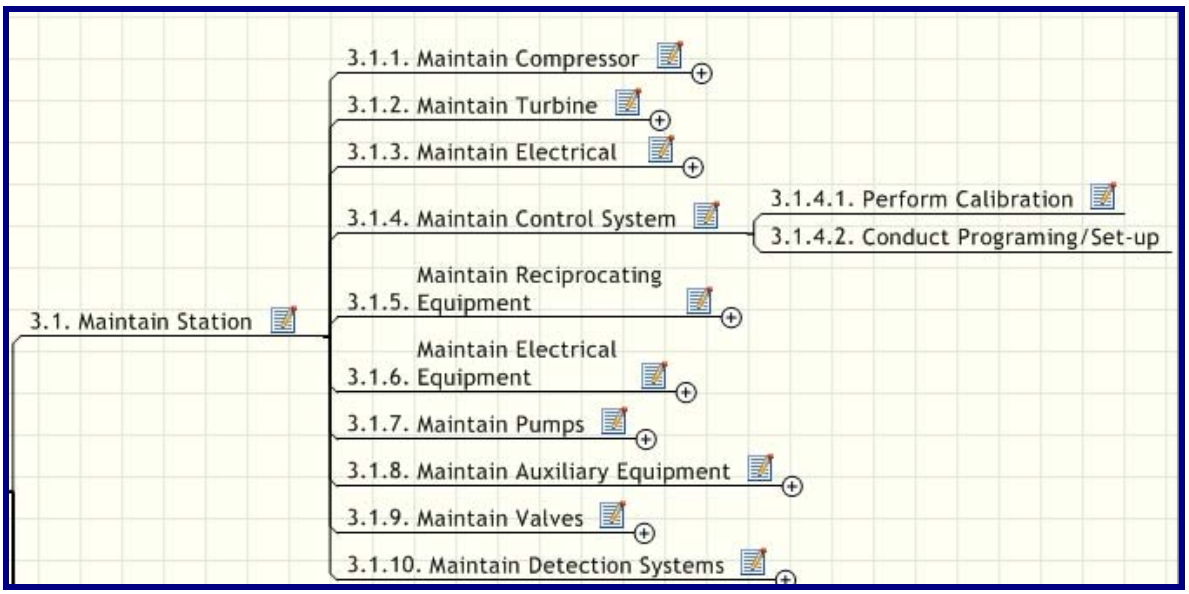
Make high voltage electrical repairs per applicable standards and codes. Utilize appropriate lock-out and safety practices. Document repairs and modifications. Prepare appropriate documentation. Safely return affected equipment to service.

3.1.3.5 Perform Breaker Repair / Replacement

Make breaker repairs or replacement per applicable standards and codes. Utilize appropriate lock-out and safety practices. Document repairs and modifications. Complete appropriate documentation. Safely return affected equipment to service.

3.1.4 MAINTAIN CONTROL SYSTEM

Maintain control system to ensure the ability of the station and equipment to operate effectively and efficiently. Develop routine and periodic maintenance plans and schedules appropriate to specific control system. Ensure data collection and analysis for predictive maintenance where employed.



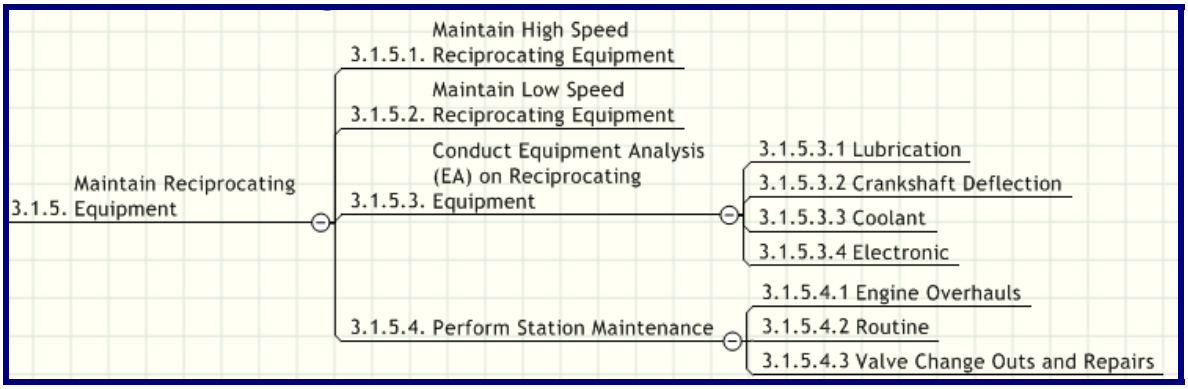
3.1.4.1 Perform Calibration

Calibrate the control system to ensure accurate and reliable operations.

3.1.4.2 Conduct Programming/Set-up

3.1.5 MAINTAIN RECIPROCATING EQUIPMENT

Maintain reciprocating equipment to ensure the ability of the station and equipment to operate effectively and efficiently. Develop routine and periodic maintenance plans and schedules appropriate to specific reciprocating equipment. Ensure data collection and analysis for predictive maintenance where employed.



3.1.5.1 Maintain High Speed Reciprocating Equipment

Maintain high speed reciprocating equipment per established schedules and procedures. Perform routine and periodic maintenance plans and schedules appropriate to specific reciprocating equipment. Utilize data collection and analysis for predictive maintenance where employed. Modify future maintenance schedules and procedures to incorporate improved practices. Update and maintain maintenance records.

3.1.5.2 Maintain Low Speed Reciprocating Equipment

Maintain low speed reciprocating equipment per established schedules and procedures. Perform routine and periodic maintenance plans and schedules appropriate to specific reciprocating equipment. Utilize data collection and analysis for predictive maintenance where employed. Modify future maintenance schedules and procedures to incorporate improved practices. Update and maintain maintenance records.

3.1.5.3 Conduct Equipment Analysis (EA) on Reciprocating Equipment

Monitor and review equipment performance data. Perform EA, including electronic, lubrication, coolant, balancing, crankshaft deflection and others. Identify and assess equipment issues through analysis of results. Determine appropriate actions to address equipment issues. Modify future maintenance schedules and procedures to incorporate improved practices.

3.1.5.3.1 EA Type: Lubrication

3.1.5.3.2 EA Type: Crankshaft deflection

3.1.5.3.3 EA Type: Coolant

3.1.5.3.4 EA Type: Electronic

3.1.5.4 Perform Station Maintenance

Maintain station per established schedules and procedures. Perform routine and periodic maintenance plans and schedules appropriate to specific station equipment. Utilize data collection and analysis for predictive maintenance where employed. Modify future maintenance schedules and procedures to incorporate improved practices. Update and maintain maintenance records.

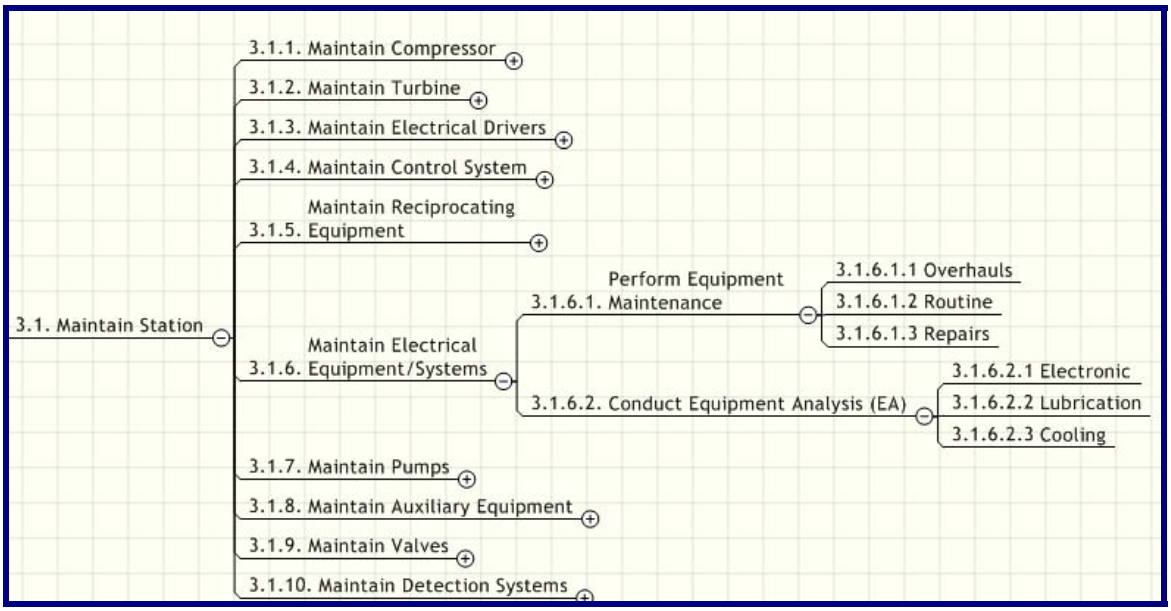
3.1.5.4.1 Maintenance Type: Engine Overhauls

3.1.5.4.2 Maintenance Type: Routine Maintenance

3.1.5.4.3 Maintenance Type: Valve Change Outs and Repairs

3.1.6 MAINTAIN ELECTRICAL EQUIPMENT/SYSTEMS

Maintain electrical equipment/systems to ensure the ability of the station and equipment to operate effectively and efficiently. Develop routine and periodic maintenance plans and schedules appropriate to specific electrical equipment. Ensure data collection and analysis for predictive maintenance where employed.



3.1.6.1 Perform Equipment Maintenance

Maintain equipment per established schedules and procedures. Perform routine and periodic maintenance plans and schedules appropriate to specific station equipment. Utilize data collection and analysis for predictive maintenance where employed. Modify future maintenance schedules and procedures to incorporate improved practices. Update and maintain maintenance records.

3.1.6.1.1 Maintenance Type: Overhauls

3.1.6.1.2 Maintenance Type: Routine

3.1.6.1.3 Maintenance Type: Repairs

3.1.6.2 Conduct Equipment Analysis (EA)

Monitor and review equipment performance data. Perform EA. Identify and assess equipment issues through analysis of results. Determine appropriate actions to address equipment issues. Modify future maintenance schedules and procedures to incorporate improved practices.

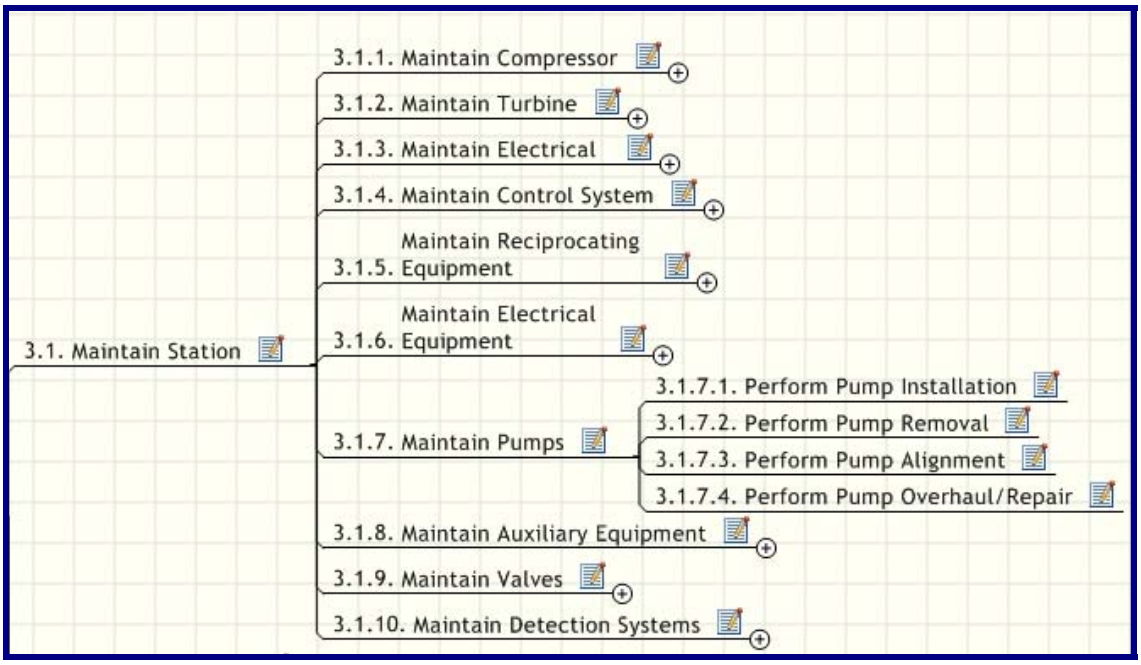
3.1.6.2.1 EA Type: Electronic

3.1.6.2.2 EA Type: Lubrication

3.1.6.2.3 EA Type: Cooling

3.1.7 MAINTAIN PUMPS

Maintain pumps to ensure the ability to operate effectively and efficiently to meet station requirements. Develop routine and periodic maintenance plans and schedules appropriate to specific pump type. Ensure data collection and analysis for predictive maintenance where employed.



3.1.7.1 Perform Pump Installation

Install the pump in accordance with specific unit and manufacturer's guidelines. Disconnect and reconnect mechanical and electrical attachments. Prepare repair log and record appropriate data.

3.1.7.2 Perform Pump Removal

Conduct the pump removal per specific unit and manufacturer's guidelines. Disconnect and reconnect mechanical and electrical attachments. Prepare repair log and record appropriate data. Utilize appropriate lock-out and safety practices.

3.1.7.3 Perform Pump Alignment

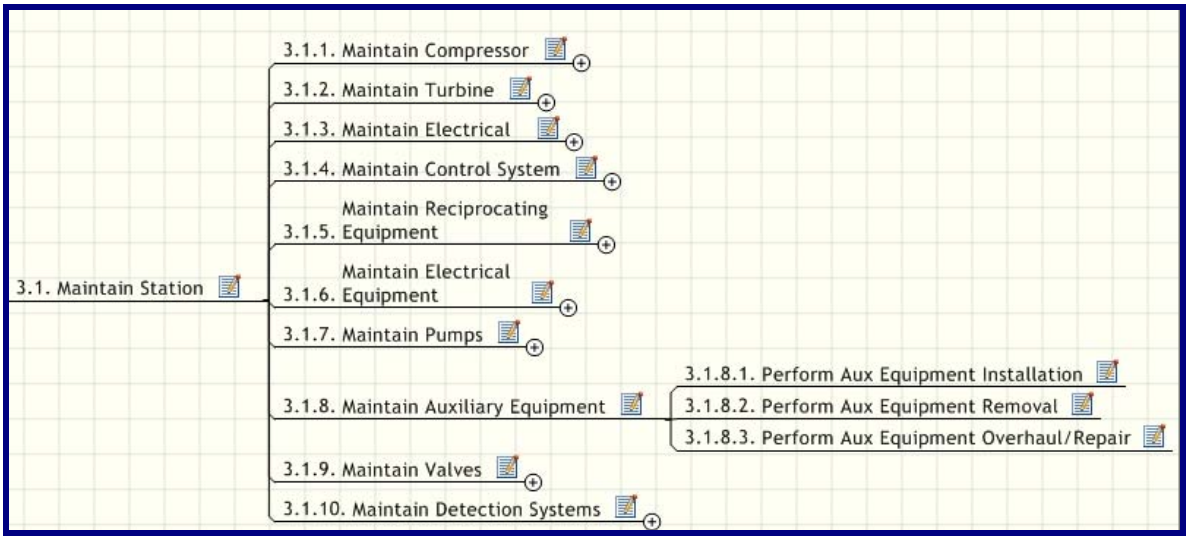
Perform and verify drive/pump alignment. Verify proper operation and return to service. Prepare repair log and record appropriate data.

3.1.7.4 Perform Pump Overhaul/Repair

Overhaul/repair the pump per the specific unit and manufacturer's guidelines. Disconnect and reconnect mechanical and electrical attachments. Complete overhaul/repair of seals, surfaces, bearings, mechanical and other parts as appropriate using approved parts and procedures. Complete repair documentation and record appropriate data.

3.1.8 MAINTAIN AUXILIARY EQUIPMENT

Maintain auxiliary equipment to ensure the ability to operate effectively and efficiently to meet station requirements. Develop routine and periodic maintenance plans and schedules appropriate to specific equipment types. Ensure data collection and analysis for predictive maintenance where employed.



3.1.8.1 Perform Auxiliary Equipment Installation

Install auxiliary equipment in accordance with specific unit and manufacturer's guidelines. Employ appropriate safety and lock-out procedures, as appropriate. Disconnect and reconnect mechanical, fluid or electrical attachments. Verify proper operation and return to service. Complete repair log and record appropriate data.

3.1.8.2 Perform Auxiliary Equipment Removal

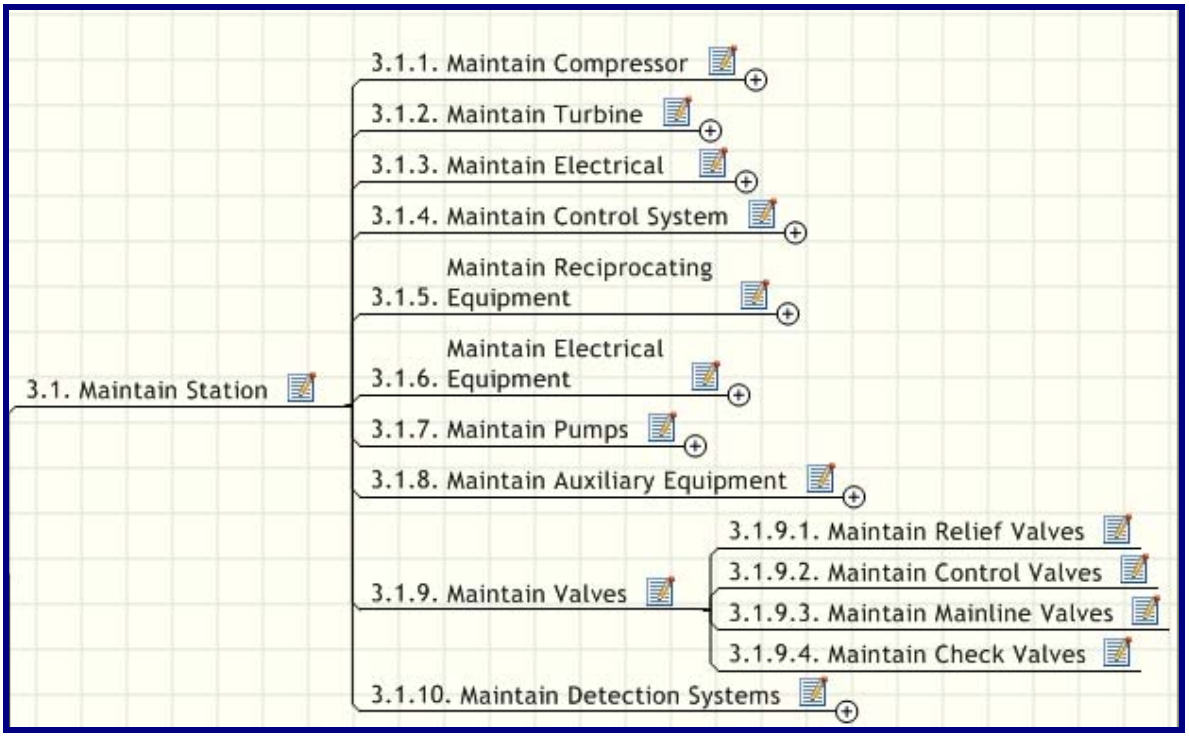
Remove auxiliary equipment in accordance with specific unit and manufacturer's guidelines. Employ appropriate safety and lock-out procedures, as appropriate. Disconnect and reconnect mechanical, fluid or electrical attachments. Verify proper operation and return to service. Complete repair log and record appropriate data.

3.1.8.3 Perform Auxiliary Equipment Overhaul/Repair

Overhaul/repair auxiliary equipment in accordance with specific unit and manufacturer's guidelines. Employ appropriate safety and lock-out procedures, as appropriate. Disconnect and reconnect mechanical, fluid or electrical attachments. Verify proper operation and return to service. Complete repair log and record appropriate data.

3.1.9 MAINTAIN VALVES

Maintain and test valves to ensure the ability to operate effectively and efficiently to meet station requirements. Develop routine and periodic maintenance plans and schedules appropriate to specific valve types. Ensure data collection and analysis for predictive maintenance where employed.



3.1.9.1 Maintain Relief Valves

Maintain and test relief valves per established procedures and standards. Conduct operations for routine and periodic maintenance per schedule. Perform analysis for predictive maintenance where employed. Update and maintain maintenance records.

3.1.9.2 Maintain Control Valves

Maintain and test control valves per established procedures and standards. Conduct operations for routine and periodic maintenance per schedule. Perform analysis for predictive maintenance, where employed. Update and maintain maintenance records.

3.1.9.3 Maintain Mainline Valves

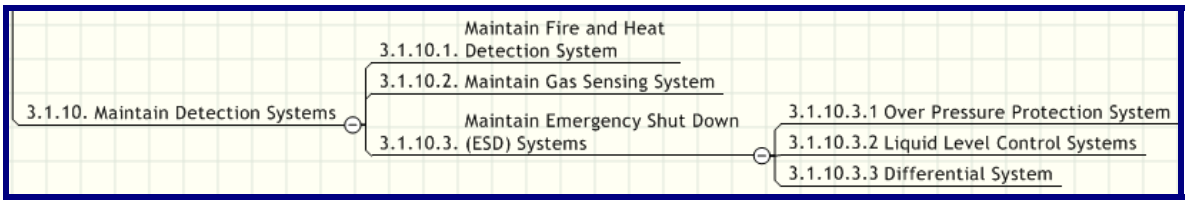
Maintain and test mainline valves per established procedures and standards. Conduct operations for routine and periodic maintenance per schedule. Perform analysis for predictive maintenance where employed. Update and maintain maintenance records.

3.1.9.4 Maintain Check Valves

Maintain and test check valves per established procedures and standards. Conduct operations for routine and periodic maintenance per schedule. Perform analysis for predictive maintenance where employed. Update and maintain maintenance records.

3.1.10 MAINTAIN DETECTION SYSTEMS

Maintain detection systems to ensure the ability to operate effectively and efficiently to meet station requirements. Develop routine and periodic maintenance plans and schedules appropriate to specific system types. Ensure data collection and analysis for predictive maintenance where employed.



3.1.10.1 Maintain Fire and Heat Detection System

Maintain fire detection system per established procedures and standards. Conduct operations for routine and periodic maintenance per schedule. Perform analysis for predictive maintenance where employed. Update and maintain maintenance records.

3.1.10.2 Maintain Gas Sensing System

Maintain gas sensing system per established procedures and standards. Conduct operations for routine and periodic maintenance per schedule. Perform analysis for predictive maintenance where employed. Update and maintain maintenance records.

3.1.10.3 Maintain Emergency Shut Down (ESD) Systems

Maintain ESD systems per established procedures and standards. Conduct operations for routine and periodic maintenance per schedule. Perform analysis for predictive maintenance where employed. Update and maintain maintenance records.

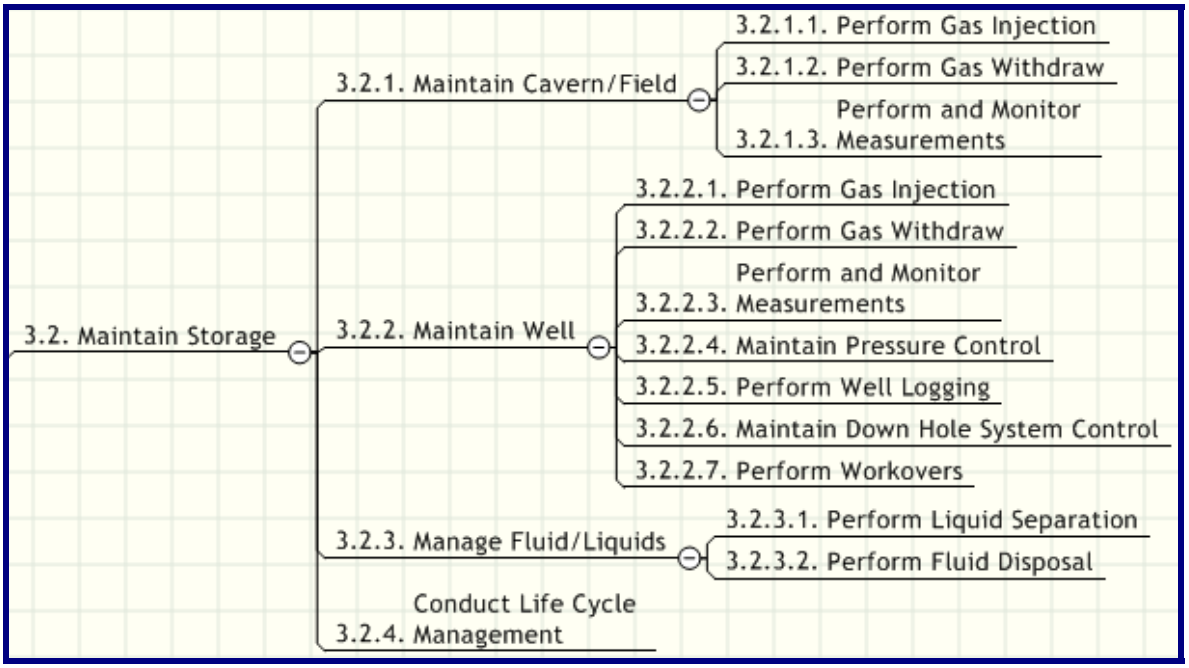
3.1.10.4 Over-pressure Protection System

3.1.10.5 Liquid level Control Systems

3.1.10.6 Differential Pressure

3.2 MAINTAIN STORAGE

Maintain storage assets to ensure the ability to operate effectively and efficiently to meet operational requirements.



3.2.1 MAINTAIN CAVERN/FIELD

Maintain storage cavern/field to ensure the ability to operate effectively and efficiently to meet operational requirements. Develop routine and periodic maintenance plans for cavern /field maintenance. Establish schedules appropriate to cavern maintenance elements. Ensure data collection and analysis for predictive maintenance where employed.

3.2.1.1 Perform Gas Injection

3.2.1.2 Perform Gas Withdrawal

3.2.1.3 Perform and Monitor Measurements

3.2.2 MAINTAIN WELL

Maintain storage well to ensure the ability to operate effectively and efficiently to meet operational requirements. Develop routine and periodic maintenance plans for well maintenance. Establish schedules appropriate to cavern maintenance elements. Ensure data collection and analysis for predictive maintenance where employed.

3.2.2.1 Perform Gas Injection

3.2.2.2 Perform Gas Withdrawal

3.2.2.3 Perform and Monitor Measurements

3.2.2.4 Maintain Pressure Control

3.2.2.5 Perform Well Logging

3.2.2.6 Maintain Down Hole System Control

3.2.2.7 Perform Workovers

3.2.3 MANAGE FLUID/LIQUIDS

Maintain fluid and liquid levels to ensure the ability to operate effectively and efficiently to meet operational requirements. Develop periodic maintenance schedules for pumping and / or separation functions. Ensure data collection and analysis for predictive maintenance where employed.

3.2.3.1 Perform Liquid Separation

Separate liquid per equipment and storage site requirements. Operate separation equipment. Monitor and track fluid concentrations.

3.2.3.2 Perform Fluid Disposal

Dispose of fluid in accordance with applicable regulations and permits as well as storage site requirements. Monitor and track fluid disposal. File appropriate permits and documentation, as required.

3.2.4 CONDUCT LIFE CYCLE MANAGEMENT

Maintain storage cavern/field to ensure the ability to operate effectively and efficiently to meet operational requirements. Develop routine and periodic maintenance plans for cavern

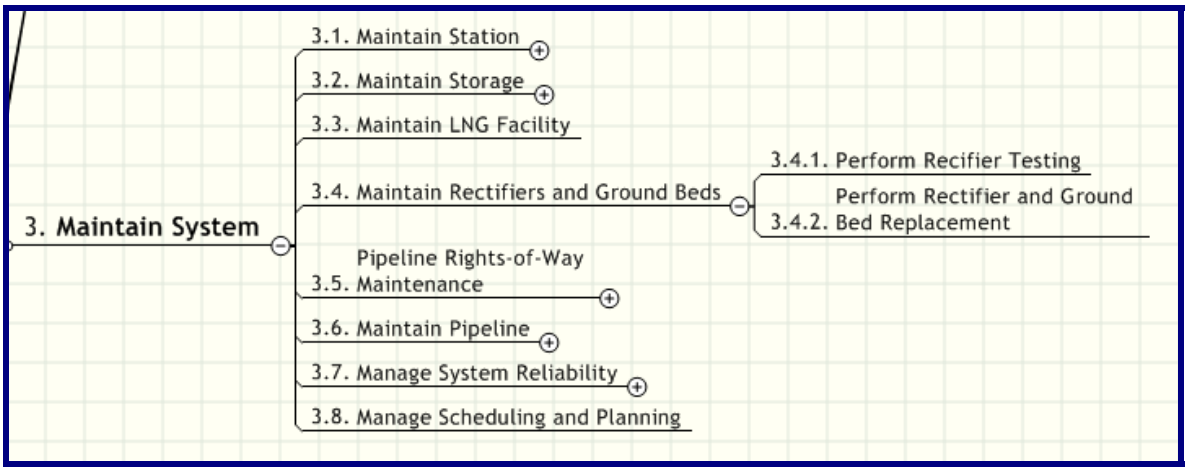
maintenance. Establish schedules appropriate to cavern maintenance elements. Ensure data collection and analysis for predictive maintenance where employed.

3.3 MAINTAIN LNG FACILITY

Maintain LNG facility assets to ensure the ability to operate effectively and efficiently to meet station requirements.

3.4 MAINTAIN RECTIFIERS & GROUND BEDS

Maintain rectifiers and ground beds to ensure the ability to operate effectively and efficiently to meet protection requirements. Develop and deploy a maintenance schedule for rectifier testing and evaluation.



3.4.1 PERFORM RECTIFIER TESTING

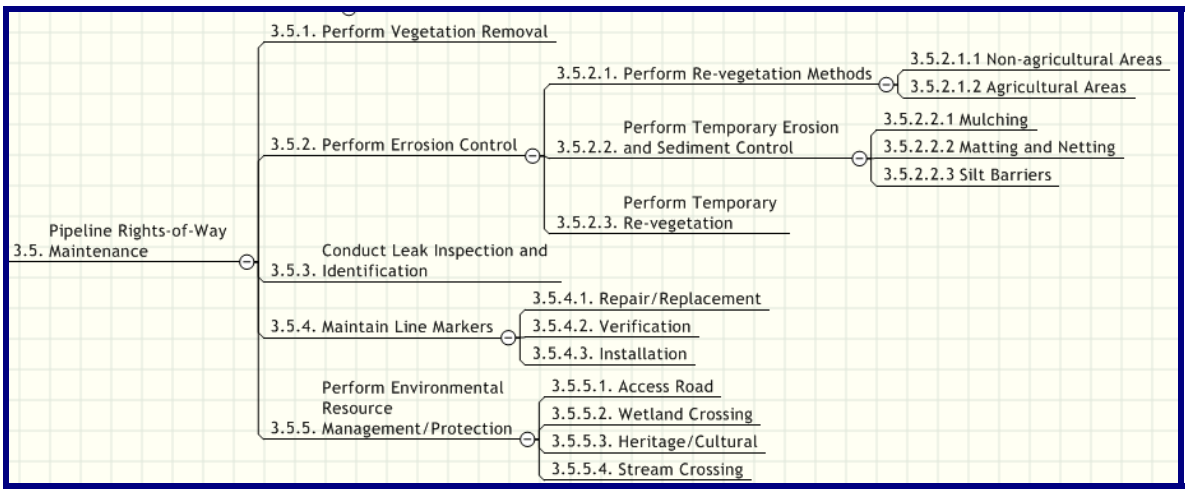
Perform rectifier testing using established procedures. Determine rectifier and ground bed performance and condition. Schedule replacements as necessary. Document testing and repairs.

3.4.2 PERFORM RECTIFIER AND GROUND BED REPLACEMENT

Replace rectifier and ground bed and verify performance using established procedures.

3.5 MAINTAIN PIPELINE RIGHTS-OF-WAY

Maintain pipeline rights-of-way to ensure the ability to protect, provide operational access and mitigate threats to the pipeline.



3.5.1 PERFORM VEGETATION REMOVAL

Remove/control vegetation from pipeline rights-of-way per established procedures and standards. Maintain clearance and distance standards per requirements. Identify threats or abnormal conditions that require follow-up actions, such as noxious weed control, wetlands and uplands.

3.5.2 PERFORM EROSION CONTROL

Control erosion in pipeline rights-of-way per established procedures and standards. Maintain cover standards per requirements. Identify threats or abnormal conditions that require follow-up actions.

3.5.2.1 Perform Re-Vegetation Methods

Re-vegetate pipeline rights-of-way per established procedures and standards. Identify agricultural and non-agricultural areas. Maintain cover standards per requirements. Identify threats or abnormal conditions that require follow-up actions.

3.5.2.1.1 Re-Vegetation: Non-Agricultural Areas

3.5.2.1.2 Re-Vegetation: Agricultural Areas

3.5.2.2 Perform Temporary Erosion & Sediment Control

Perform temporary erosion and sediment control in pipeline rights-of-way per established procedures and standards. Determine optimum choice of approach to address the erosion or sediment control situation. Identify threats or abnormal conditions that require follow-up actions. Schedule work based on urgency and priority.

3.5.2.2.1 Control: Mulching

3.5.2.2.2 Control: Matting / Netting

3.5.2.2.3 Control: Silt Barriers

3.5.2.3 Perform Temporary Re-Vegetation

3.5.3 Conduct Leak Inspection and Identification

Conduct leak inspection and identification along pipeline rights-of-way. Utilize typical procedures for inspection of leaks, including visible identification, effects on vegetation, leak testing equipment, etc. Evaluate risk and priority for repair. Initiate alerts and or mitigation steps. Coordinate repair activities.

3.5.4 Maintain Line Markers

Maintain clear identification of pipeline via line markers per applicable regulations and laws. Monitor and inspect line markers as needed. Establish and perform maintenance schedule for inspection and maintenance, as appropriate. Incorporate information from pipeline surveys / inspections to help identify maintenance needs.

3.5.4.1 Line Marker: Repair / Replacement

3.5.4.2 Line Marker: Verification

3.5.4.3 Line Marker: Installation

3.5.5 Perform Environmental Resource Management/Protection

Perform environmental resource management and protection. Be aware of applicable regulation and laws governing pipeline rights-of-way. Assess and identify environmental or other significant issues on rights-of-way.

3.5.5.1 Resource Management: Access Road

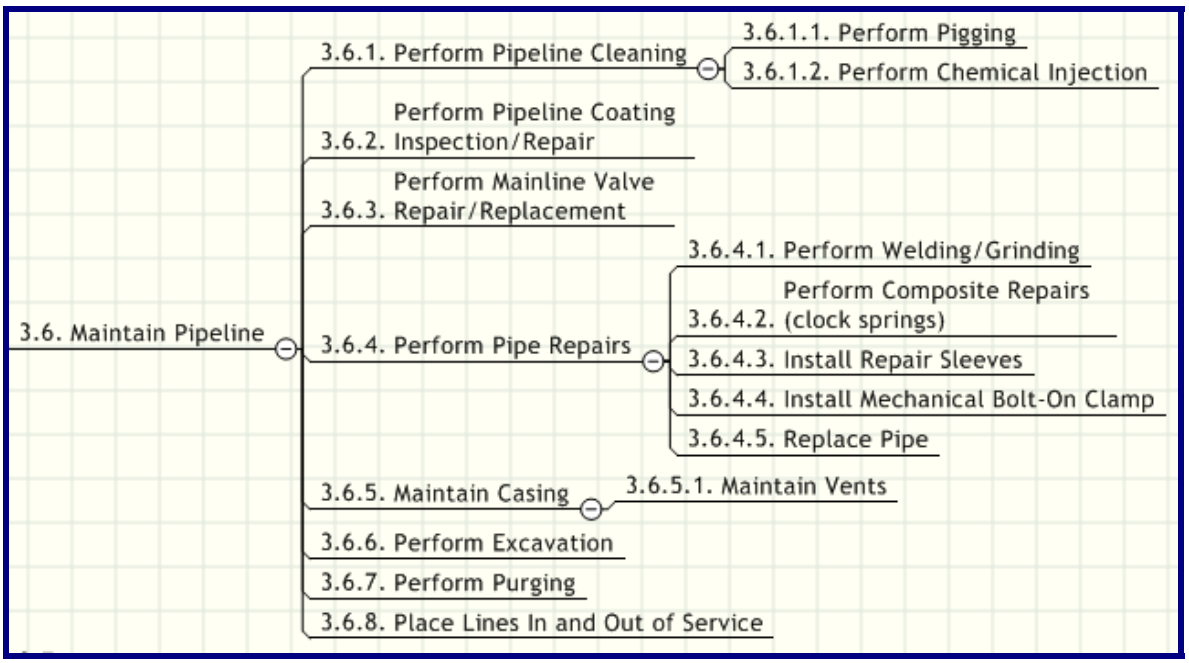
3.5.5.2 Resource Management: Wetland Crossing

3.5.5.3 Resource Management: Heritage / Cultural

3.5.5.4 Resource Management: Stream Crossing

3.6 Maintain Pipeline

Maintain pipeline assets to ensure the ability to operate effectively and efficiently to meet system requirements.



3.6.1 Perform Pipeline Cleaning

Clean the pipeline as indicated by inspection results, periodic maintenance schedule or a shift in the commodity being transported. Assess type of cleaning needed and identify the appropriate method to be utilized based on specific section and type of cleaning needed. Define and specify the cleaning work and process to be completed. Interface with contractors, as appropriate, to conduct the cleaning operation. Document and return the line to service when completed.

3.6.1.1 Perform Pigging

Perform pigging as indicated by the type of cleaning needed and accessibility on specific section and type of cleaning needed. Interface with contractors, as appropriate, to conduct the cleaning operation. Document and return the line to service when completed.

3.6.1.2 Perform Chemical Injection

Perform chemical injection as indicated by the type of cleaning needed and accessibility on specific section and type of cleaning needed. Perform operation in conjunction with all safety and chemical safeguards as well as applicable laws and legislation. Interface with contractors, as appropriate, to conduct the cleaning operation. Document and return the line to service when completed.

3.6.2 Perform Pipeline Coating Inspection/Repair

Inspect pipeline coating as indicated periodically. Assess pipeline coating. Define and specify the repair work and process to be completed. Interface with contractors, as appropriate, to conduct the repairs. Document inspection / associated repairs and return the line to service when completed.

3.6.3 PERFORM MAINLINE VALVE REPAIR/REPLACEMENT

Repair/replace mainline valves per manufacturer's and company guidelines. Employ appropriate safety, lock-out and purging procedures as appropriate. Disconnect and reconnect mechanical, fluid or electrical attachments. Verify proper operation and return to service. Complete repair log and record appropriate data.

3.6.4 PERFORM PIPE REPAIRS

Repair pipe per specific type of pipe material and repair needed. Uncover and expose the piping adequately to be able to complete the repair. Complete the repairs using techniques and materials as appropriate using approved parts and procedures. Complete repair documentation and record appropriate data.

3.6.4.1 Repairs: Perform Welding/Grinding

3.6.4.2 Repairs: Perform Composite Repairs (i.e., clock springs)

3.6.4.3 Repairs: Install Repair Sleeves

3.6.4.4 Repairs: Install Mechanical Bold-On Clamp

3.6.4.5 Repairs: Replace Pipe

3.6.5 MAINTAIN CASING

Maintain the casing head well. Perform inspections of casing and valves. Perform routine maintenance as required.

3.6.5.1 Maintain Vents

Maintain the casing vents. Perform inspections of vents. Perform routine cleaning and maintenance as required.

3.6.6 PERFORM EXCAVATION

Excavate the pipeline for inspection, maintenance or repair. Remove the pipeline from service. Excavate the pipeline using techniques appropriate to its type, such as pressurized, non-pressurized, etc.

3.6.6.1 Excavation: Pressurized

3.6.6.2 Excavation: Non-Pressurized

3.6.6.3 Excavation: Damage Prevention

3.6.6.4 Excavation: Shoring Inspection / Verification

3.6.7 PERFORM PURGING

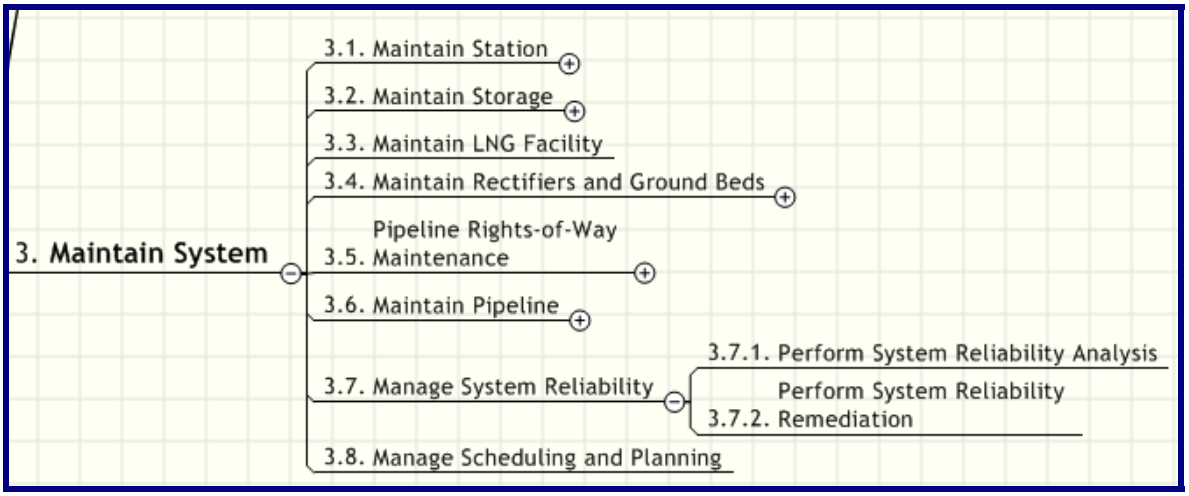
Purge the pipeline before or after inspections and / or repairs. Ensure that purging is performed using approved methods and following all safety procedures. Complete documentation and record appropriate data.

3.6.8 Place Lines In/ Out of Service

Place lines into and out of service efficiently and safely. Coordinate with operations and planning to ensure that pipeline downtime is minimized. Shut down the pipeline and return to service when gas handling instructed. Ensure that all safety and operational limitations of the line are addressed.

3.7 Manage System Reliability

Ensure that facilities, stations, pipelines and other gas transportation system components operate to promote a reliable system.



3.7.1 Perform System Reliability Analysis

Assess reliability data from overall system and component elements. Analyze data to determine and model reliability performance. Identify potential reliability concerns and opportunities for enhancing future reliability.

3.7.2 Perform System Reliability Remediation

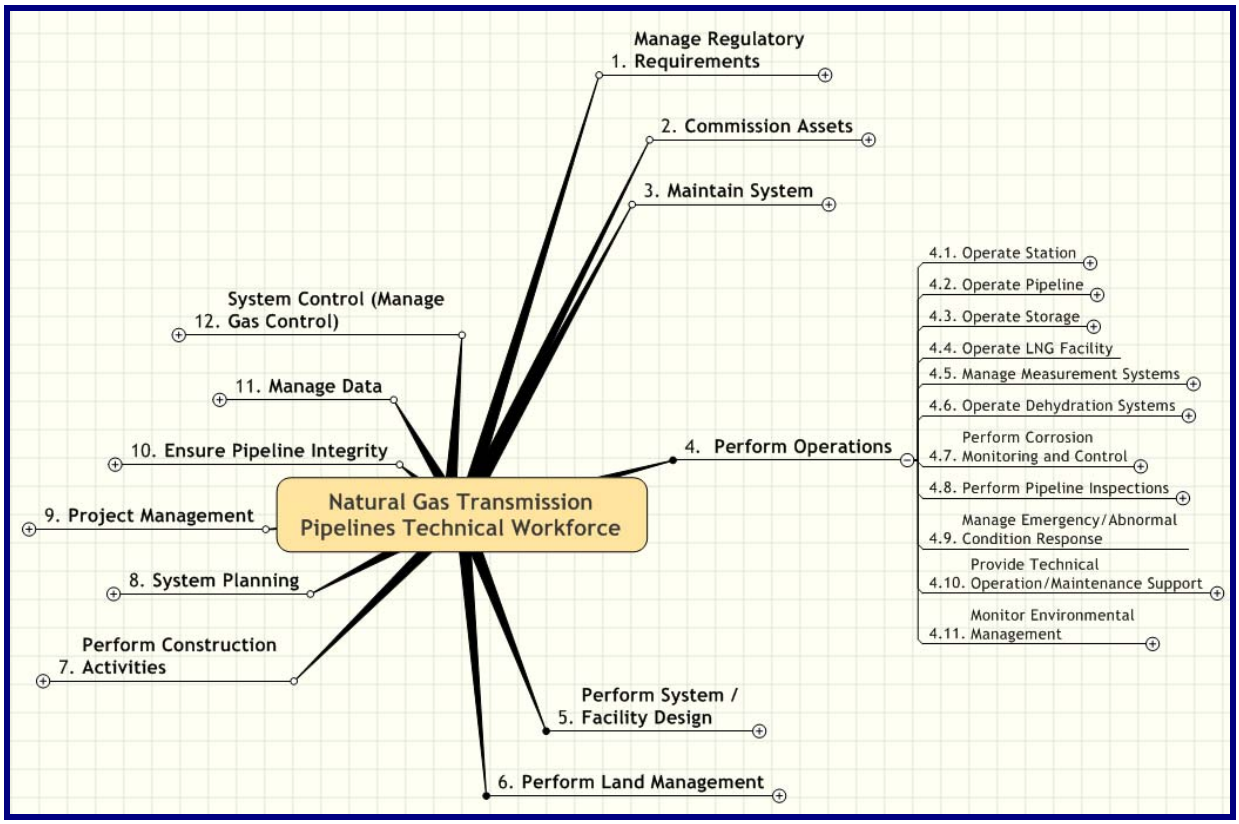
Develop and execute plans to mitigate identified reliability concerns for both system and individual system elements. Develop schedule for reliability enhancements so that overall system performance is not adversely impacted.

3.8 Manage Scheduling and Planning

Manage facility scheduling and planning for individual pipelines, storage and LNG facilities. Develop schedules and plans to minimize impact on operational availability, capacity and performance.

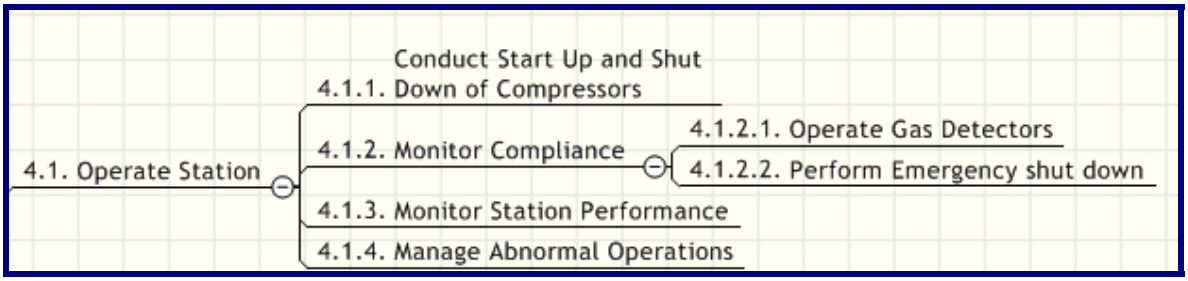
4 PERFORM OPERATIONS

Operate gas transmission facilities (including pipeline, storage, LNG and others) effectively, efficiently and safely under normal and abnormal conditions.



4.1 OPERATE STATION

Operate a natural gas processing or transmission station including ongoing operation, startup and shutdown, and monitoring station performance.



4.1.1 CONDUCT STARTUP AND SHUTDOWN OF COMPRESSORS

4.1.2 MONITOR COMPLIANCE

4.1.2.1 Operate Gas Detectors

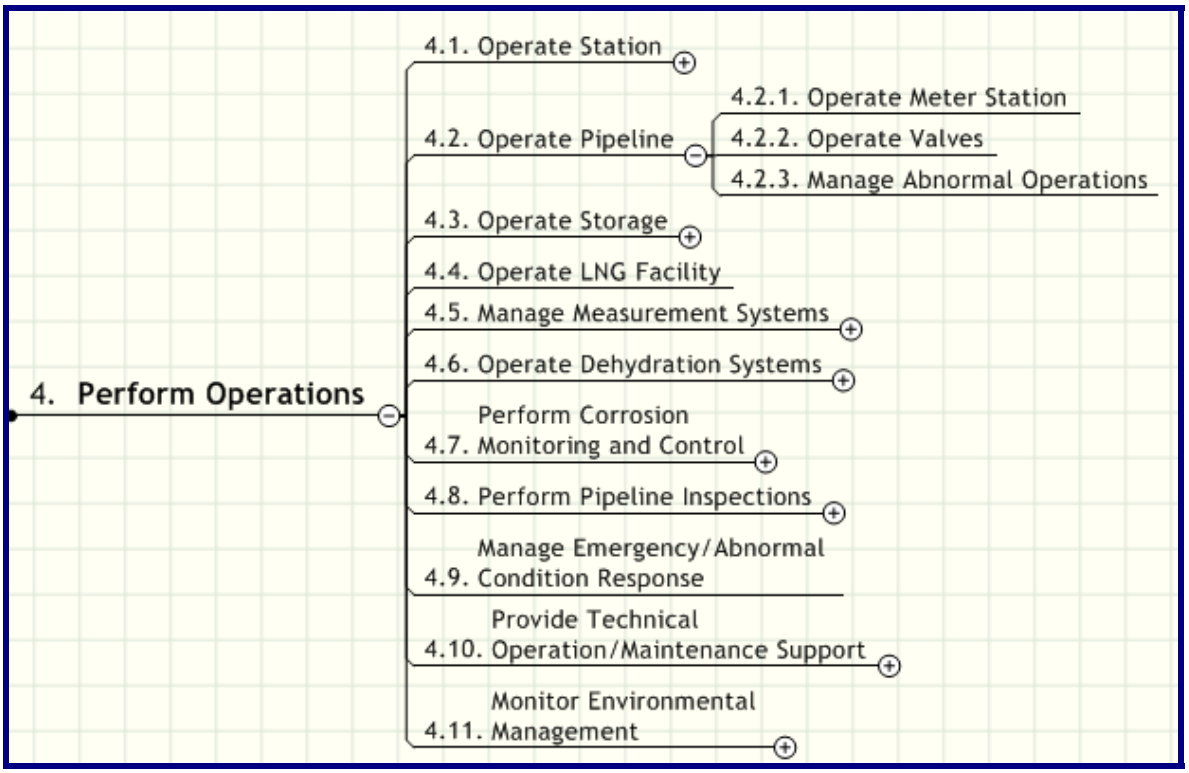
4.1.2.2 Perform Emergency Shutdown

4.1.3 MONITOR STATION PERFORMANCE

4.1.4 MANAGE ABNORMAL OPERATIONS

4.2 OPERATE PIPELINE

Operate a natural gas transmission pipeline, including meter stations and valves in ongoing operations.



4.2.1 OPERATE METER STATION

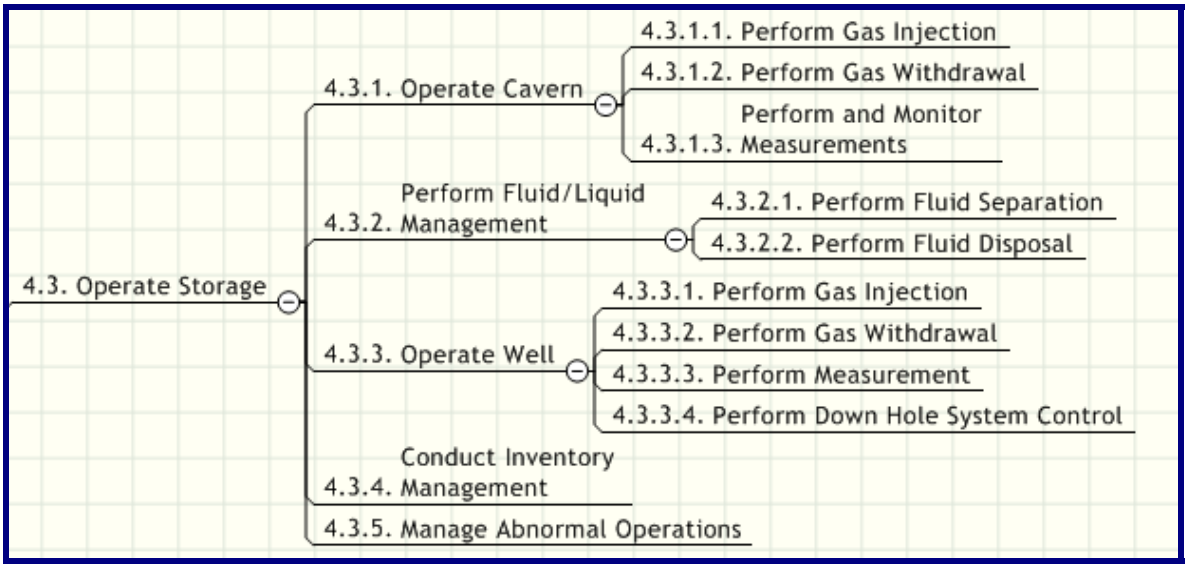
4.2.2 OPERATE VALVES

4.2.3 MANAGE ABNORMAL OPERATIONS

4.3 OPERATE STORAGE

Operate a natural gas storage system, including cavern and well storage types. Manage inventory through measurement, injection and withdrawal of supplies. Perform activities as

needed to ensure storage system performance and effective operation such as liquid management.



4.3.1 OPERATE CAVERN

Operate a natural gas storage cavern, including startup and shutdown, inventory control and monitoring storage performance.

4.3.1.1 Perform Gas Injection

Perform the injection of gas into cavern accurately and efficiently. Utilize approved procedures and observe all safety methods.

4.3.1.2 Perform Gas Withdrawal

Perform the withdrawal of gas into cavern accurately and efficiently. Utilize approved procedures and observe all safety methods.

4.3.1.3 Perform and Monitor Measurements

Perform and monitor measurements to ensure effective and safe control of operations.

4.3.2 PERFORM FLUID/LIQUID MANAGEMENT

Perform fluid management in the cavern storage facility. Adjust liquid levels as necessary to achieve effective gas control.

4.3.2.1 Perform Fluid Separation

Perform fluid separation from gas as required. Operate separation equipment safely and prudently.

4.3.2.2 Perform Fluid Disposal

Perform disposal of fluids from dehydration or cavern storage operation using approved procedures and techniques. Monitor the disposal of fluids to ensure conformance with environmental controls and regulations.

4.3.3 OPERATE WELL

Operate a natural gas storage well system. Manage inventory through measurement, injection and withdrawal of supplies. Perform activities as needed to ensure storage system performance and effective operation such as liquid management.

4.3.3.1 Perform Gas Injection

Perform the injection of gas into well accurately and efficiently. Utilize approved procedures and observe all safety methods.

4.3.3.2 Perform Gas Withdrawal

Perform the withdrawal of gas into well accurately and efficiently. Utilize approved procedures and observe all safety methods.

4.3.3.3 Perform Measurement

Perform and monitor measurements to ensure effective and safe control of operations.

4.3.3.4 Perform Down Hole System Control

Perform down hole system control. Control and maintain desired system pressure and volume. Monitor trends and changes. Maintain system control under abnormal conditions.

4.3.4 CONDUCT INVENTORY MANAGEMENT

Monitor and track natural gas inventory in the well storage system through tracking of gas injections and gas withdrawals. Manage and maintain operationally defined inventory levels. Document and record inventory levels as required.

4.3.5 MANAGE ABNORMAL OPERATIONS

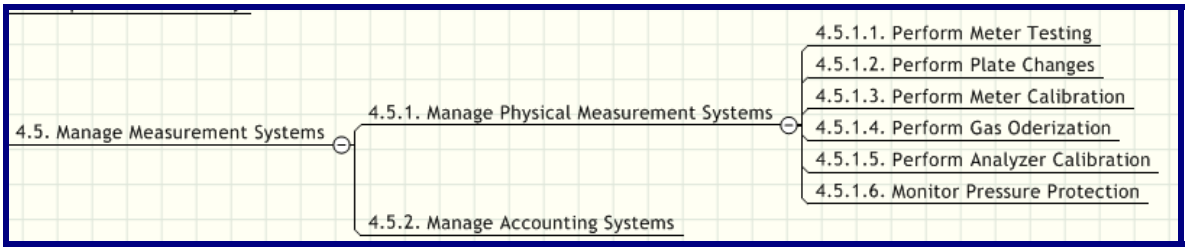
Manage abnormal operations using approved and safe operational procedures. Maintain operational control and safety.

4.4 OPERATE LNG FACILITY

Operate an LNG facility effectively and efficiently as part of the overall transportation system. Provide ongoing operational guidance. Communicate and coordinate with other system elements. Maintain schedules and commitments. Perform LNG facility maintenance and repairs so that overall transportation system effectiveness is maintained.

4.5 MANAGE MEASUREMENT SYSTEMS

Manage the measurement system so that flow quantities can be accurately determined for effective control and safe operation.



4.5.1 MANAGE PHYSICAL MEASUREMENT SYSTEMS

Manage the physical measurement systems so that flow quantities and other parameters can be accurately determined for effective control, maintaining gas quality and safe operation.

4.5.1.1 Perform Meter testing.

Perform meter testing to ensure accurate and reliable metering performance. Assess condition of equipment and identify necessary repairs needed to maintain performance.

4.5.1.2 Perform Plate Changes

Perform plate changes to maintain acceptable performance due to wear, corrosion or other factors. Ensure proper equipment performance after plate change.

4.5.1.3 Perform Meter Calibration

Perform meter calibration as indicated in defined schedule or required by meter functionality. Ensure the accuracy and precision of the meter.

4.5.1.4 Perform Gas Odorization

Perform gas odorization through the addition of an odiferous compound to provide a distinctive odor for the identification of fugitive gas vapors.

4.5.1.5 Perform Analyzer Calibration

Perform analyzer calibration as indicated in defined schedule or required by analyzer functionality. Ensure the accuracy and precision of the instrument.

4.5.1.6 Monitor Pressure Protection

Monitor pressure detection monitors and systems. Ensure that gas system is protected from out-of-specification pressure profiles and pulses.

4.5.2 MANAGE ACCOUNTING SYSTEMS

Manage and reconcile operational activities and actions with accounting systems. Ensure all costs and transactions are properly and accurately reported. Reconcile exceptions and accounting discrepancies.

4.6 Operate Dehydration Systems

Operate dehydration equipment to effectively remove water from gas or liquid sources. Monitor system for safety and efficiently performance.

4.6.1 Perform System Control

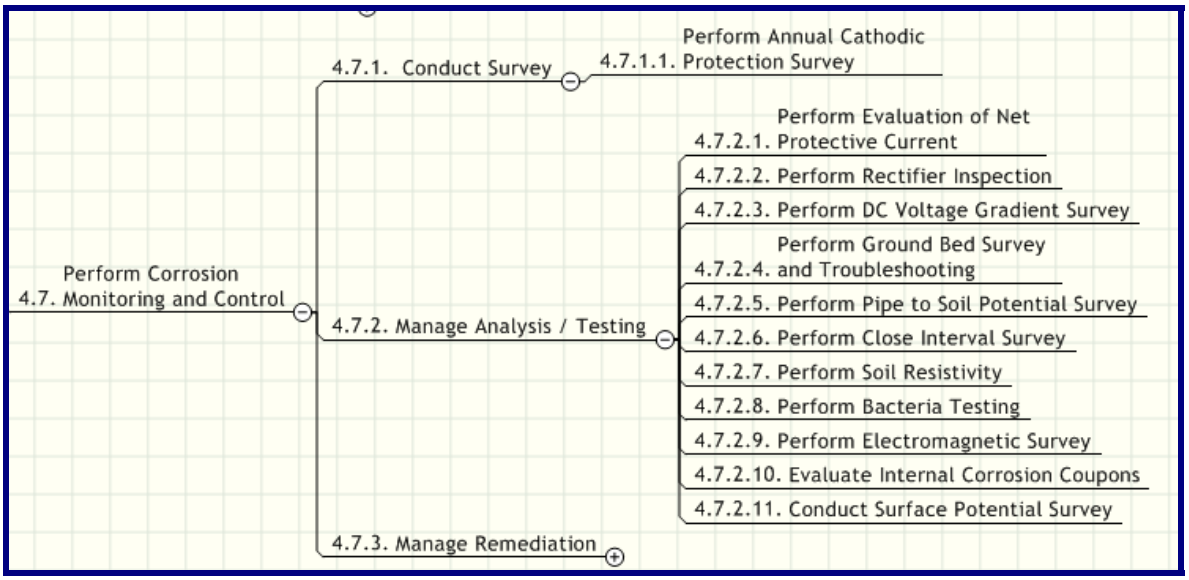
Perform system control of the dehydration system. Monitor performance and gas quality.

4.6.2 Operate Pressure Protection

Monitor pressure detection monitors and systems. Ensure that dehydration system is protected from out-of-specification pressure profiles and pulses.

4.7 Perform Corrosion Monitoring and Control

Monitor and control corrosion throughout the natural gas transmission assets, including stations, pipelines and other elements. Conduct surveys, manage corrosion data analysis and testing, and manage effective mitigation to address any unacceptable actual or potential susceptibility corrosion.



4.7.1 Conduct Survey

Conduct corrosion related surveys and inspections per designated frequency and as required by regulatory requirements.

4.7.1.1 Perform Annual Cathodic Protection Survey

Perform an annual survey of the cathodic protection system for each pipeline segment.

4.7.2 MANAGE ANALYSIS / TESTING

Manage analysis and testing of corrosion control surveys and testing. Develop data driven solutions for monitoring and testing frequency. Determine recommendations for ongoing monitoring and analysis strategies.

4.7.2.1 Perform Evaluation of Net Protective Current

Evaluate net protective current protection devices. Assess condition of the system and recommend maintenance or repair.

4.7.2.2 Perform Rectifier Inspection

Inspect rectifiers according to established schedules or when indicated. Assess operation and determine condition. Determine recommendations for repair or maintenance.

Troubleshoot suspect rectifiers to determine appropriate repair or replacement options. Effectively repair rectifiers and safely return system back to operation.

4.7.2.3 Perform DC Voltage Gradient Survey

Conduct DC voltage gradient survey according to established schedules and procedures. Collect and analyze results. Determine recommendations for mitigation activities as appropriate.

4.7.2.4 Perform Ground Bed Survey and Troubleshooting

Conduct ground bed survey according to established schedules and procedures. Collect and analyze results. Troubleshoot ground bed issues and establish root cause. Determine recommendations for mitigation activities as appropriate.

4.7.2.5 Perform Pipe to Soil Potential Survey

Conduct pipe to soil potential survey according to established schedules and procedures. Collect and analyze results. Determine recommendations for mitigation activities as appropriate.

4.7.2.6 Perform Close Interval Survey

Conduct close interval survey according to established schedules and procedures. Collect and analyze results. Determine recommendations for mitigation activities as appropriate.

4.7.2.7 Perform Soil Resistivity

Assess soil resistivity according to established schedules and procedures. Collect and analyze results. Determine recommendations for mitigation activities as appropriate.

4.7.2.8 Perform Bacteria Testing

Test bacteria according to established schedules and procedures. Collect and analyze results. Determine recommendations for mitigation activities as appropriate.

4.7.2.9 Perform Electromagnetic Survey

Conduct electromagnetic survey according to established schedules and procedures. Collect and analyze results. Determine recommendations for mitigation activities as appropriate.

4.7.2.10 Evaluate Internal Corrosion Coupons

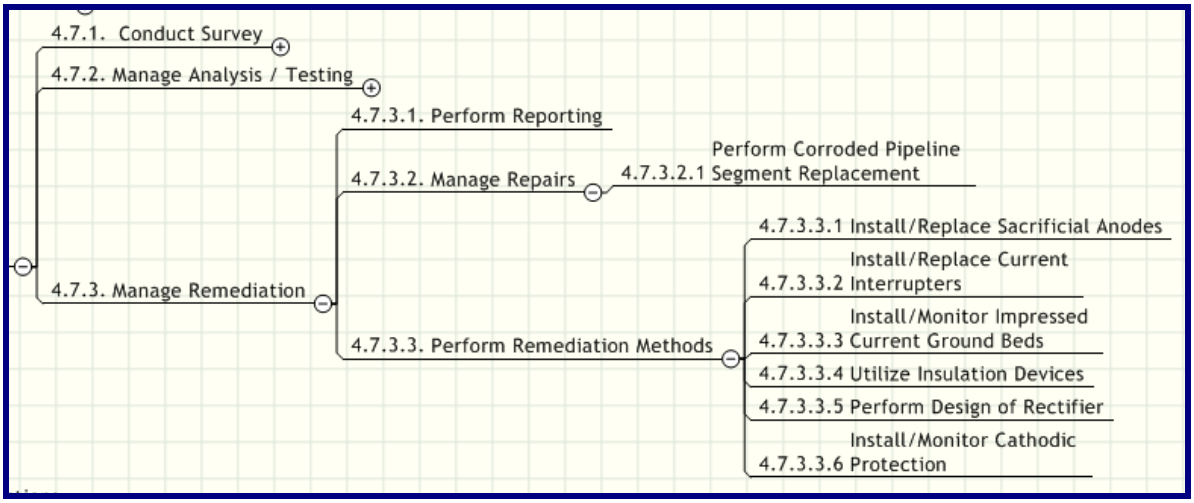
Perform internal assessment of corrosion coupons according to established schedules and procedures. Remove system from service as required. Remove and install monitoring coupons safely. Collect and analyze results. Determine recommendations for mitigation activities as appropriate.

4.7.2.11 Conduct Surface Potential Survey

Conduct surface potential survey according to established schedules and procedures. Collect and analyze results. Determine recommendations for mitigation activities as appropriate.

4.7.3 MANAGE REMEDIATION

Coordinate and manage remediation of pipeline and corrosion control systems. Identify and coordinate repair or replacement of pipeline elements damaged by corrosion, including ongoing replacement of sacrificial remediation system components.



4.7.3.1 Perform Reporting

Perform the accurate and timely reporting of pipeline segment condition and status.

4.7.3.2 Manage Repairs

Manage the repair of pipeline segments identified as being significantly affected by corrosion. Schedule and track repair progress and completion. Coordinate the repair activity to minimize interruption and impact to overall system.

4.7.3.2.1 Perform Pipeline Corrosion Replacement

Replace the pipeline segment using approved methods and procedures.

4.7.3.3 Perform Remediation Methods

Use remediation methods to counteract electrically inducted corrosion on pipeline segments. Identify optimum method of remediation. Understand and assess impact of method used on other segments of the pipeline.

4.7.3.3.1 Install / Replace Sacrificial Anodes

Install / Replace sacrificial anodes according to established schedules and procedures. Ensure system is restored to effective operating condition and return to service.

4.7.3.3.2 Install / Replace Current Interrupters

Install / Replace current interrupters according to established schedules and procedures. Ensure system is restored to effective operating condition and return to service.

4.7.3.3.3 Install / Monitor Impressed Current Ground Beds

Install / Monitor impressed current ground beds according to established schedules and procedures. Ensure system is restored to effective operating condition and return to service.

4.7.3.3.4 Utilize Insulation Devices (Perform Testing & Perform Installation)

Utilize insulation devices to mitigate susceptibility to corrosion. Perform installation of the insulation devices. Test insulation to ensure proper installation and condition. Assess effectiveness and recommend modifications as needed.

4.7.3.3.5 Perform Rectifier Design

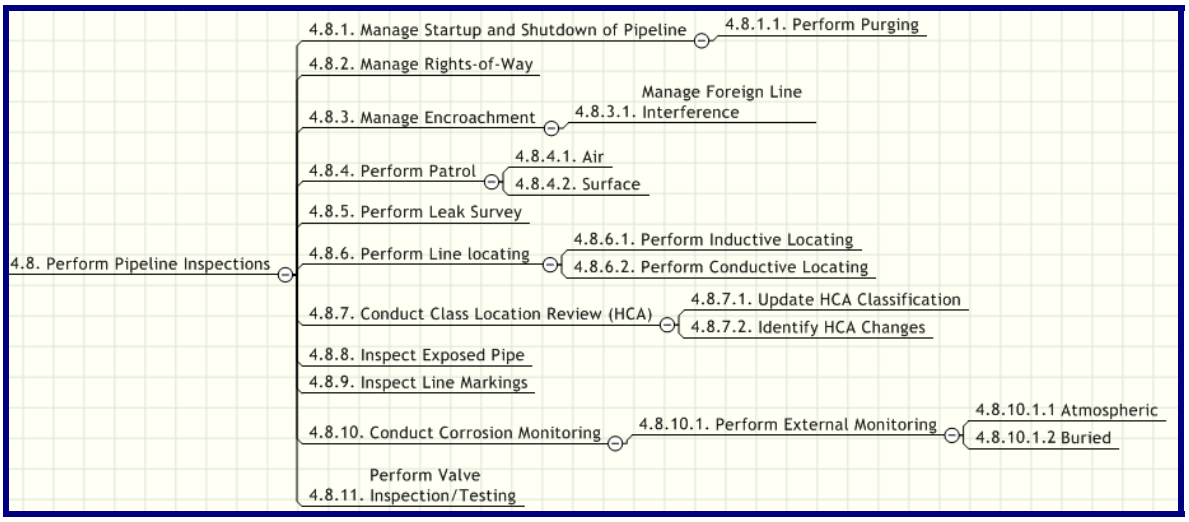
Design rectifier to mitigate against corrosion of pipeline segments. Evaluate the needs of the pipeline segment and design rectifier system appropriate to the requirements of the system using established design criteria.

4.7.3.3.6 Install / Monitor Cathodic Protection

Install / Monitor cathodic protection devices according to established schedules and procedures. Ensure system is restored to effective operating condition and return to service.

4.8 PERFORM PIPELINE INSPECTIONS

Inspect pipeline to insure the safe and reliable operation of the pipeline system. This includes inspection of all elements of the pipeline including the rights-of-way, piping, and corrosion monitoring. Monitor, update and manage HCA status and impact.



4.8.1 MANAGE STARTUP & SHUTDOWN OF PIPELINE

Manage the startup and shutdown of pipeline safely and with minimal impact on other transmission system elements. Coordinate the startup and shutdown operations.

4.8.1.1 Perform Purging

Purge pipeline segment according to established methods and procedures. Ensure system is restored to effective operating condition and return to service.

4.8.2 MANAGE RIGHTS-OF-WAY

Manage the rights-of-way used by the pipeline and other related transmission elements. Ensure that the rights-of-way is maintained in a condition that protects transmission assets.

4.8.3 MANAGE ENCROACHMENT

Manage encroachment on the rights-of-way. Review survey and other information to assess future and actual encroachment. Determine appropriate actions for mitigation. Coordinate response to effectively manage encroachment activity.

4.8.3.1 Manage Foreign Line Interference

Manage foreign line interference and ensure documentation/mapping of foreign lines. Assess impact and threat. Coordinate appropriate response and corrective action, as needed.

4.8.4 PERFORM PATROL

Assess condition of the pipeline segment via patrol activity. Identify potential issues. Document patrol results and coordinate mitigation activities. Issue permits, recommend mitigation or remediation, attend developer meetings.

4.8.4.1 Air

Perform and document Air Patrol, assess condition using standardized inspection guidelines.

4.8.4.2 Surface

Perform and document Surface Patrol, assess condition using standardized inspection guidelines.

4.8.5 Perform Leak Survey

Perform leak survey per schedule. Evaluate results and recommend repairs or further assessment as appropriate. Schedule follow-ups.

4.8.6 Perform Line Locating

Perform leak survey per request. Document the location of the pipeline and communicate information to requestor.

4.8.6.1 Perform Inductive Locating

4.8.6.2 Perform Conductive Locating

4.8.7 Conduct Class Location Review (HCA)

Per established schedule, conduct a class location review for High Consequence Areas (HCA). Review information sources such as patrols, surveys, and others to identify current and potential HCAs. Utilize HCA criteria to determine proper HCA status. Establish and maintain HCA documentation.

4.8.7.1 Update HCA Classification

4.8.7.2 Identify HCA Changes

4.8.8 Inspect Exposed Pipe

Inspect exposed pipeline elements using established criteria and procedures. Identify and assess any deficiencies. Develop recommendations for effective mitigation and control.

4.8.9 Inspect Line Markings

Inspect Line Markings using established criteria and procedures. Identify and assess any deficiencies. Develop recommendations for effective mitigation and control.

4.8.10 Conduct Corrosion Monitoring

Conduct Corrosion monitors using established criteria and procedures. Identify and assess any deficiencies. Develop recommendations for effective mitigation and control.

4.8.10.1 Perform External Monitoring

4.8.10.1.1 Atmospheric

4.8.10.1.2 Buried

4.8.10.2 Perform Internal Monitoring

4.8.11 Perform Valve Inspection/Testing

Inspect exposed pipeline elements using established criteria and procedures. Identify and assess any deficiencies. Develop recommendations for effective mitigation and control.

4.9 Manage Emergency/Abnormal Condition Response

Manage the system in abnormal or emergency conditions. Ensure the safety and protection of all persons and the pipeline assets. Provide communication and coordination with gas system elements as needed.

4.9.1 Manage Emergency Shutdown (ESD) Systems

Manage ESD systems for pipeline control, including periodic/annual tests of shutdown equipment related to pipeline segments, pipeline automatic shutdown devices and station shutdown. Monitor and analyze test results. Identify any potential shutdown concerns and recommend corrective actions as needed.

4.10 Provide Technical Operation/Maintenance Support

Provide higher level technical support to gas transportation activities from a specialist standpoint to ensure correct operational strategies are utilized. Develop technical guidance and support in response to the specific technical requirements based on expertise.

4.10.1 Pipeline

Provide technical support for pipeline.

4.10.2 Facility

Provide technical support for facility.

4.10.3 STORAGE

Provide technical support for storage facility.

4.10.4 MEASUREMENT / SUPERVISORY CONTROL AND DATA ACQUISITION (SCADA)

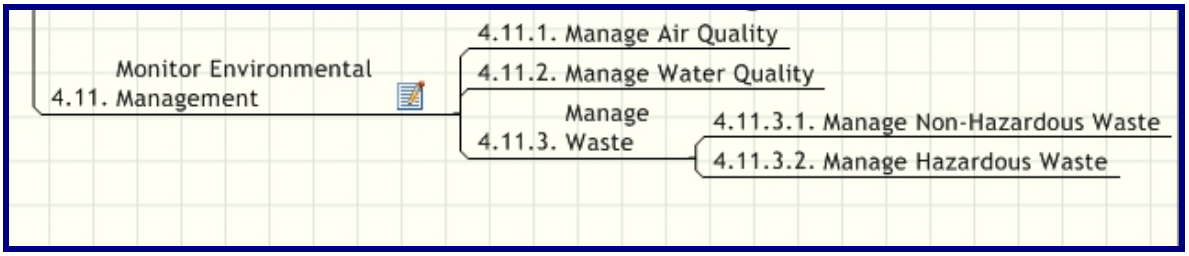
Provide technical support for SCADA system.

4.10.5 LNG

Provide technical support for LNG facility.

4.11 MONITOR ENVIRONMENTAL MANAGEMENT

Monitor the full spectrum of environmental compliance concerns. Identify and initiate the proper preventative or corrective actions to be taken when inappropriate trends or conditions are detected. Follow up to ensure actions taken are sufficient and effective.



4.11.1 MANAGE AIR QUALITY

Manage Air Quality in compliance with all regulatory and organizational requirements. Monitor and track compliance-related information.

4.11.2 MANAGE WATER QUALITY

Manage Water Quality in compliance with all regulatory and organizational requirements. Monitor and track compliance-related information.

4.11.3 MANAGE WASTE

Manage waste in compliance with all regulatory and organizational requirements. Monitor and track compliance-related information.

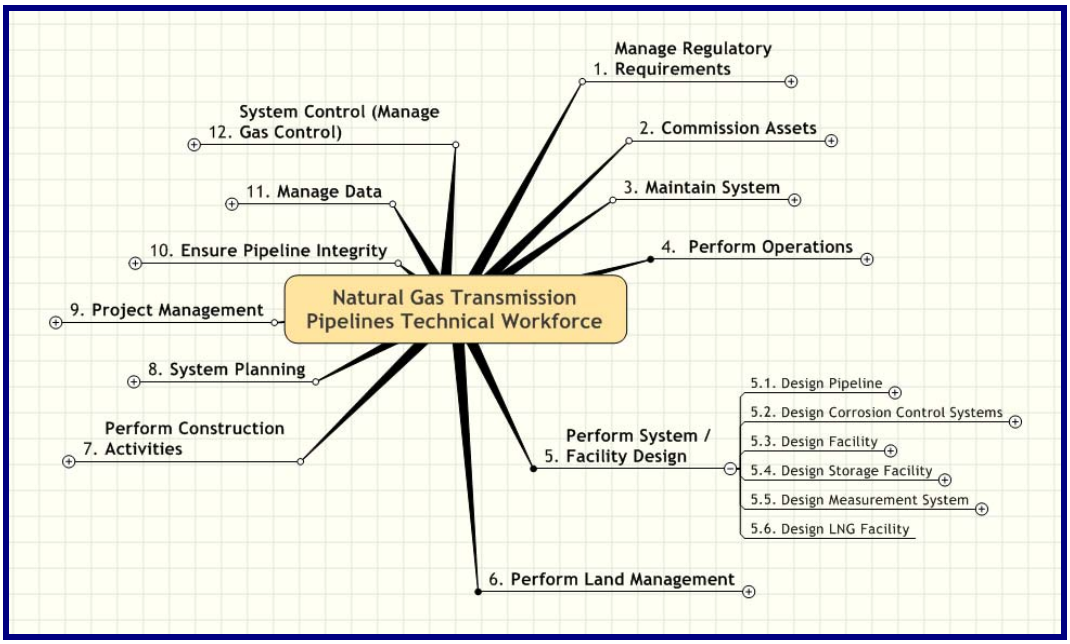
4.11.3.1 Manage Non-Hazardous Waste

Manage non-hazardous waste in compliance with all regulatory and organizational requirements. Monitor and track compliance-related information.

4.11.3.2 Manage Hazardous Waste

Manage hazardous waste in compliance with all regulatory, safety and organizational requirements. Monitor and track compliance-related information. Ensure the proper disposal / discarding of hazardous waste. Document and retain material custody records, as appropriate.

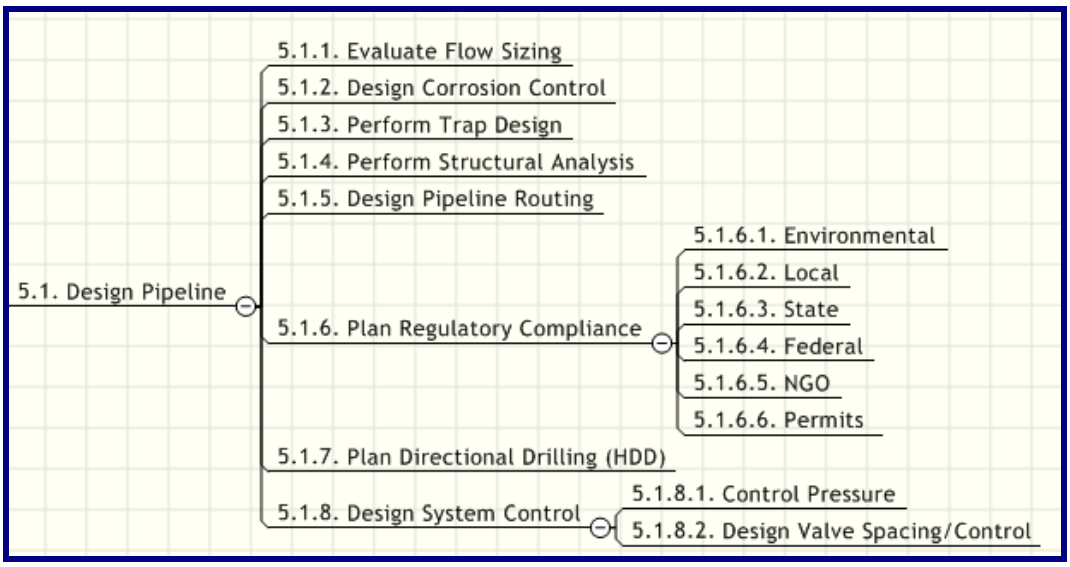
5 PERFORM SYSTEM / FACILITY DESIGN



Design systems and facilities, including pipelines, corrosion control, plant/facility, storage, and measurement systems, so that projects meet business and operational objectives.

5.1 DESIGN PIPELINE

Design gas transportation pipeline for operational effectiveness and regulatory compliance. Ensure design is well suited for specific application and use.



5.1.1 Evaluate Flow Sizing

Evaluate pipeline flow and size to ensure adequate capacity and reserve. Calculate critical dimensions for all components in the pipeline segment. Document and record design outputs.

5.1.2 Design Corrosion Control

Evaluate pipeline potential for corrosion, including materials, terrain and other factors. Determine necessary corrosion control systems, active or passive, to be employed. Specify all corrosion control components used in the pipeline segment. Document and record corrosion control design outputs.

5.1.3 Perform Trap Design

Design effective traps for the pipeline segment. Appropriately size the trap for the capacity of the pipeline as well as the types of tools planned for inspection/clearing..

5.1.4 Perform Structural Analysis

Perform the structural analysis for the pipeline segment, including anticipated in-ground or atmospheric structures. Design system to operate to a specified MAOP level.

5.1.5 Design Pipeline Routing

Analyze and design the pipeline routing to achieve the proper tradeoffs between operational, environmental construction, and maintenance costs; HCA, rights-of-way, and other routing factors. Document and record the routing design and strategy.

5.1.6 Plan Regulatory Compliance

Develop a plan for the full regulatory compliance of the new pipeline. Ensure that all aspects of regulatory compliance are addressed from the initial design proposal through pipeline commissioning and ongoing operation. Develop data collection and verification strategy. Document and record the regulatory compliance plans and strategy.

5.1.6.1 Environmental

5.1.6.2 Local

5.1.6.3 State

5.1.6.4 Federal

5.1.6.5 NGO

5.1.6.6 Permits

5.1.7 Plan Directional Drilling (HDD)

Plan directional drilling as required to route pipe and other transmission components. Maintain compliance with applicable regulation and requirements, including local permits and authorization.

5.1.8 Design System Control

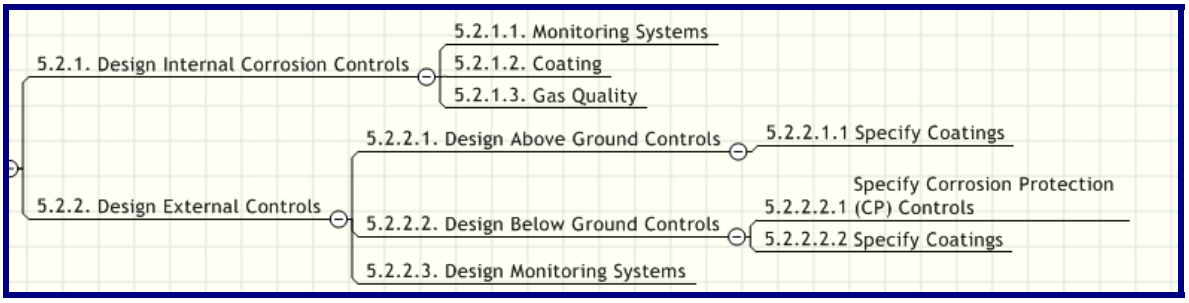
Design control system for the safe and efficient operation of the pipeline within the MAOP.

5.1.8.1 Control Pressure

5.1.8.2 Design Valve Spacing/Control

5.2 Design Corrosion Control Systems

Design corrosion control systems, both internal and external, to ensure long term resistance to corrosion. Corrosion systems may include both active and passive control systems, as appropriate.



5.2.1 Design Internal Corrosion Controls

Design corrosion internal control systems to ensure long term resistance to corrosion. Corrosion systems may include both active and passive control systems, as appropriate.

5.2.1.1 Monitoring Systems

5.2.1.2 Coating

5.2.1.3 Gas Quality

5.2.2 Design External Controls

Design corrosion external control systems to ensure long term resistance to corrosion. Corrosion systems may include both active and passive control systems, as appropriate.

5.2.2.1 Design Above Ground Controls

5.2.2.1.1 Specify Coatings

5.2.2.2 Design Below Ground Controls

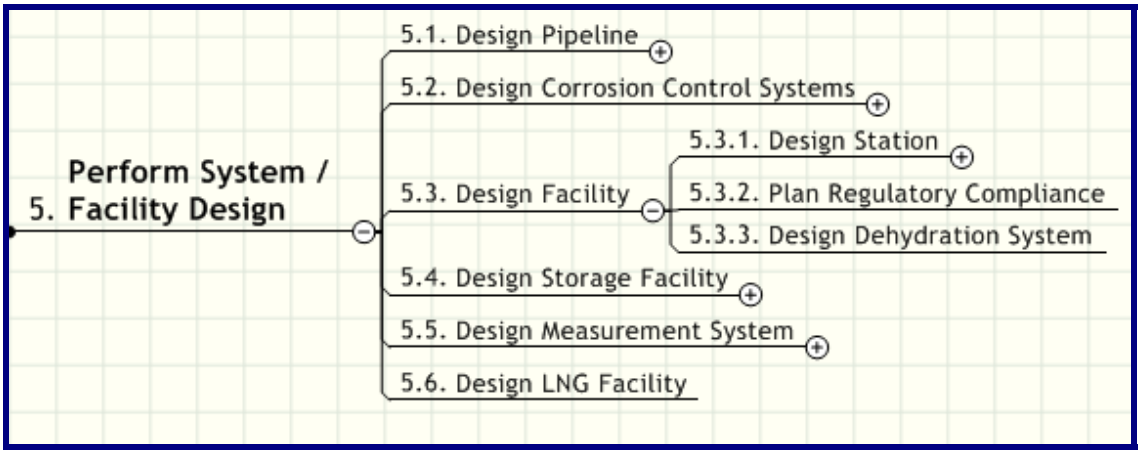
5.2.2.2.1 Specify Corrosion Protection (CP) Controls

5.2.2.2.2 Specify Coatings

5.2.2.3 Design Monitoring Systems

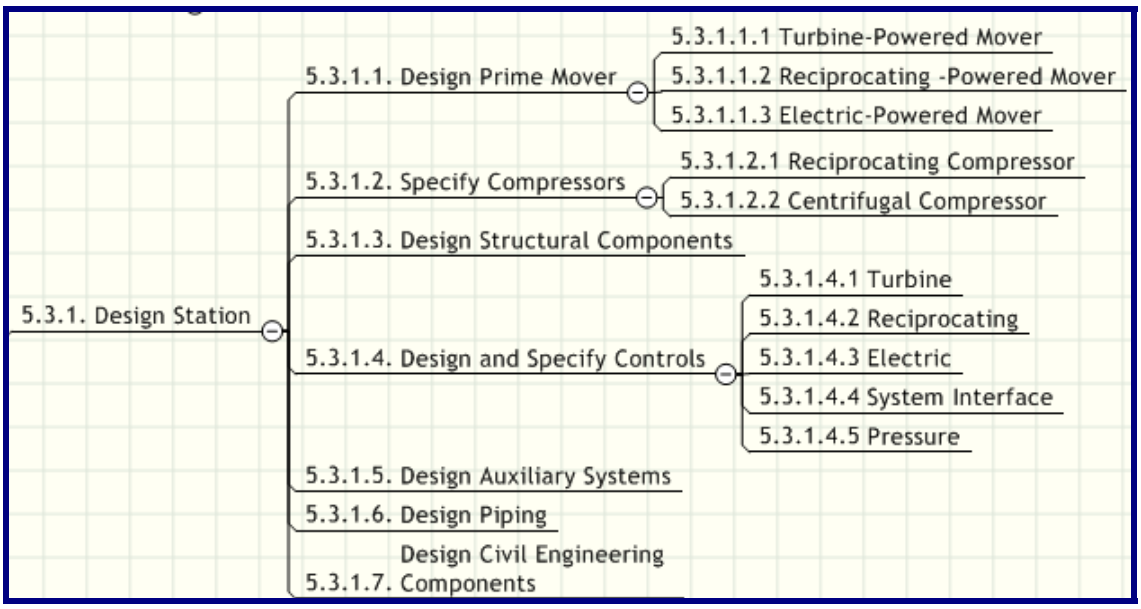
5.3 Design Facility

Design the natural gas transmission facility to achieve operational, regulatory and business requirements. A facility may include one or more stations as part of the system as well as dehydration systems.



5.3.1 Design Station

Design natural gas transmission station to achieve operational, regulatory and business requirements. A facility may include one or more stations as part of the system as well as dehydration systems.



5.3.1.1 Design Prime Mover

Design the prime mover to be used for the primary energy source for compression purposes. Identify, analyze and specify the type of prime mover to be used based on compression power and sizing requirements as well as other operational performance needs. Assess available fuel and power sources along with operational needs to determine optimum selection of the prime mover type.

5.3.1.1.1 Turbine-Powered Mover

5.3.1.1.2 Reciprocating-Powered Mover

5.3.1.1.3 Electric-Powered Mover

5.3.1.2 Specify Compressors

Design the compressor system to be used for gas movement purposes. Identify, analyze and specify the type of compressor to be used based on compression power and sizing requirements as well as other operational performance needs.

5.3.1.2.1 Reciprocating Compressor

5.3.1.2.2 Centrifugal Compressor

5.3.1.3 Design Structural Components

5.3.1.4 Design & Specify Controls

5.3.1.4.1 Turbine

5.3.1.4.2 Reciprocating

5.3.1.4.3 Electric

5.3.1.4.4 System Interface

5.3.1.4.5 Pressure

5.3.1.5 Design Auxiliary Systems

5.3.1.6 Design Piping

5.3.1.7 Design Civil Engineering Components

5.3.2 PLAN REGULATORY COMPLIANCE

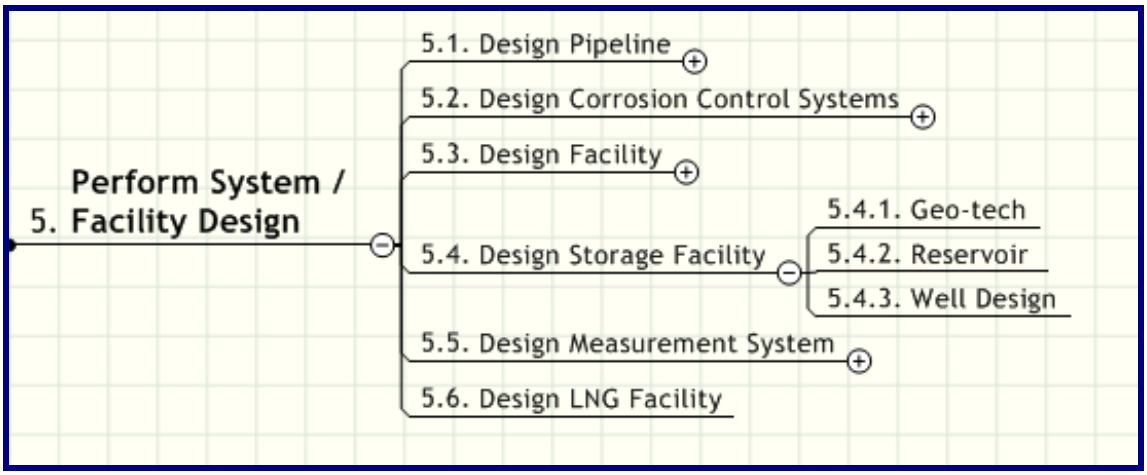
Develop a plan for the full regulatory compliance of the new station. Ensure that all aspects of regulatory compliance are addressed from the initial design proposal through station commissioning and ongoing operation. Develop data collection and verification strategy. Document and record the regulatory compliance plans and strategy.

5.3.3 DESIGN DEHYDRATION SYSTEMS

Design dehydration systems to effectively remove water from gas flow to prevent formation of hydrates, condensation of free water and to prevent corrosion. Determine capacity and analyze performance requirements. Prepare drawings and gain necessary reviews / approvals.

5.4 DESIGN STORAGE FACILITY

Design the natural gas storage facility to achieve operational, regulatory and business requirements.



5.4.1 GEO-TECH

Design the natural gas geo-tech storage facility to achieve operational, regulatory and business requirements.

5.4.2 RESERVOIR

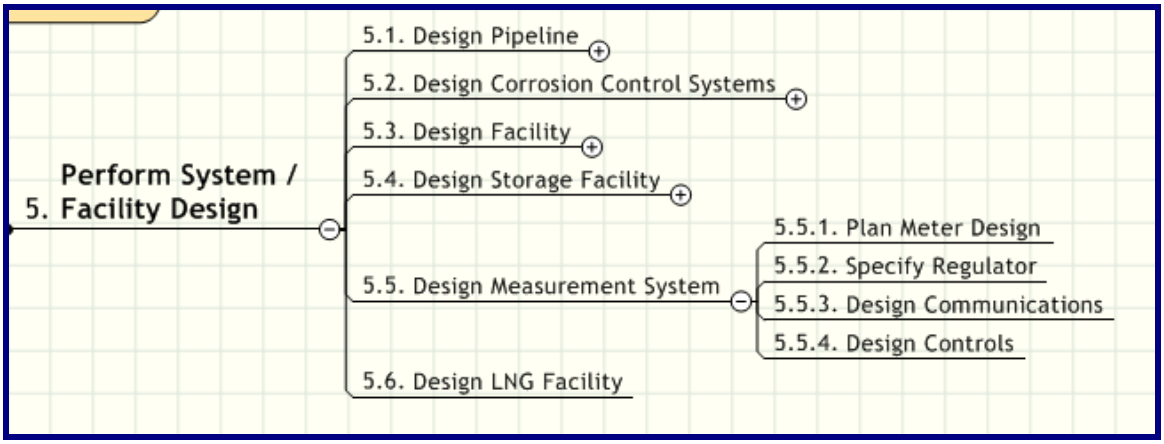
Design the natural gas storage reservoir facility to achieve operational, regulatory and business requirements.

5.4.3 WELL DESIGN

Design the natural gas well storage facility to achieve operational, regulatory and business requirements.

5.5 DESIGN MEASUREMENT SYSTEM

Design measurement system to adequately and efficiently control aspects of the system, facility, station, or pipeline. Include specifics of measurement tools design as well as associated communication systems design.



5.5.1 PLAN METER DESIGN

Design meter to meet storage station requirements.

5.5.2 SPECIFY REGULATOR

Analyze and properly size regulator equipment to meet storage station requirements.

5.5.3 DESIGN COMMUNICATIONS

Design equipment and control system communications for the storage facility.

5.5.4 DESIGN CONTROLS

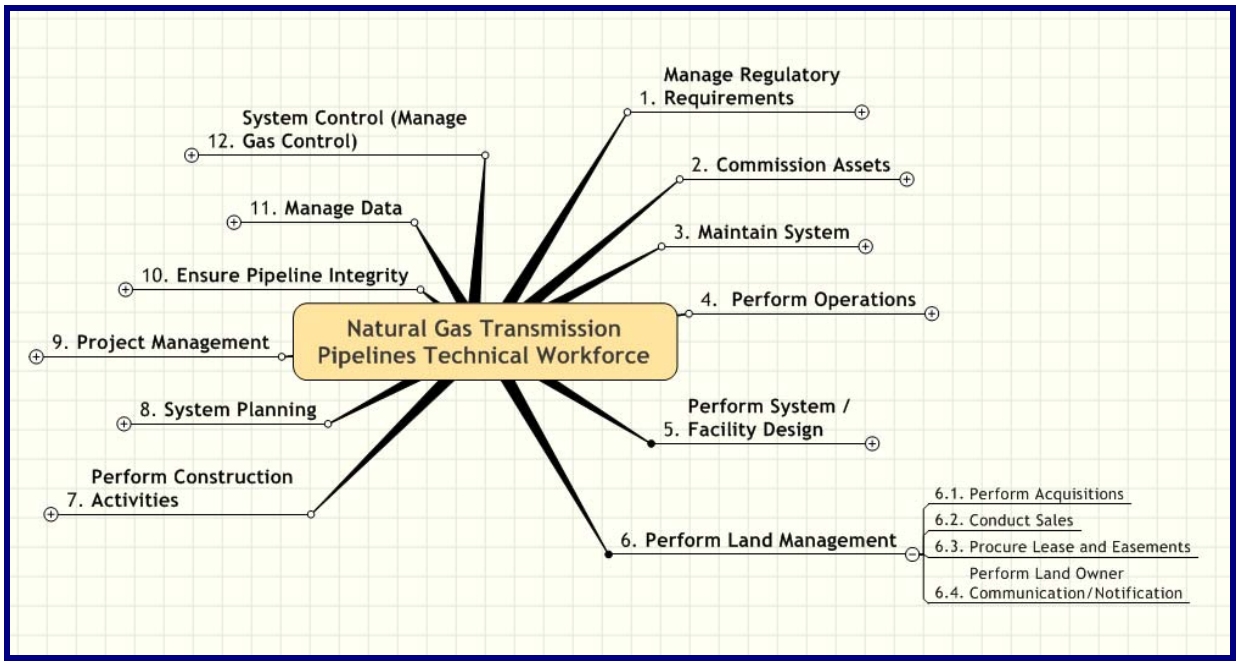
Design storage facility controls to maintain safe and effective operation of the facility, monitor conditions and alert operators to abnormal situations.

5.6 DESIGN LNG FACILITY

Design the LNG facility to achieve operational, regulatory and business requirements.

6 PERFORM LAND MANAGEMENT

Manage land for natural gas transmission needs, including acquisition of land for projects, negotiation of leases and easements, sales of surplus land as well as landowner communication and notification. Secure the permits, rights-of-way, etc. required to execute project. Ensure timing is linked and coordinated with start, duration and complexity of project activity.



6.1 PERFORM ACQUISITIONS

Acquire land needed for current and future business needs.

6.2 CONDUCT SALES

Sell surplus or other land in accordance with business needs.

6.3 PROCURE LEASES AND EASEMENTS

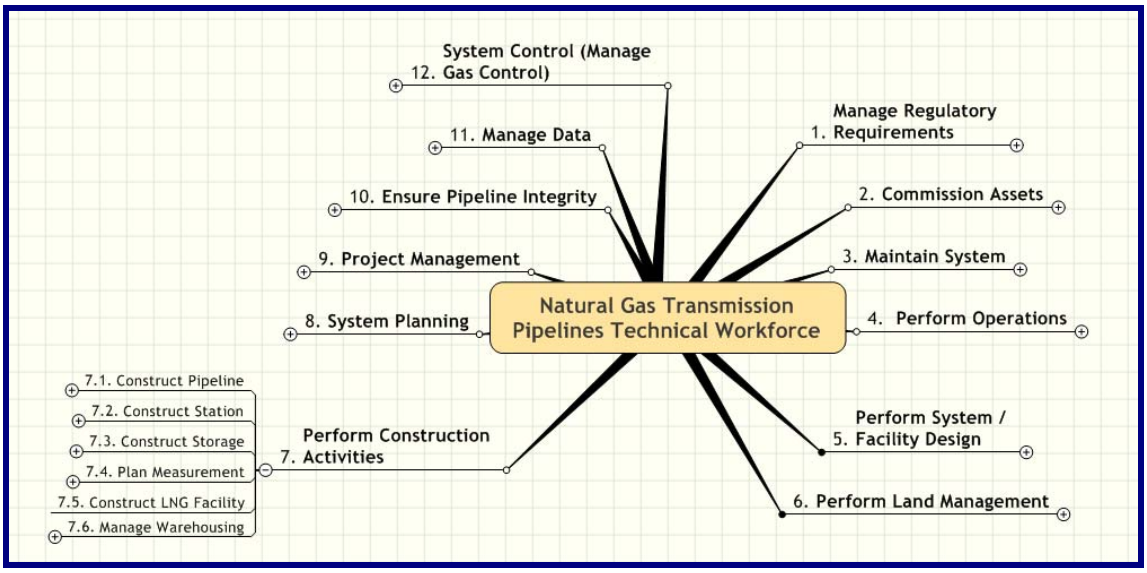
Procure leases and easements as needed for current and future business needs.

6.4 PERFORM LAND OWNER COMMUNICATION/NOTIFICATION

Communicate with landowners as required for construction activities, including notification for access, crossing, impacts on rights-of-way, etc.

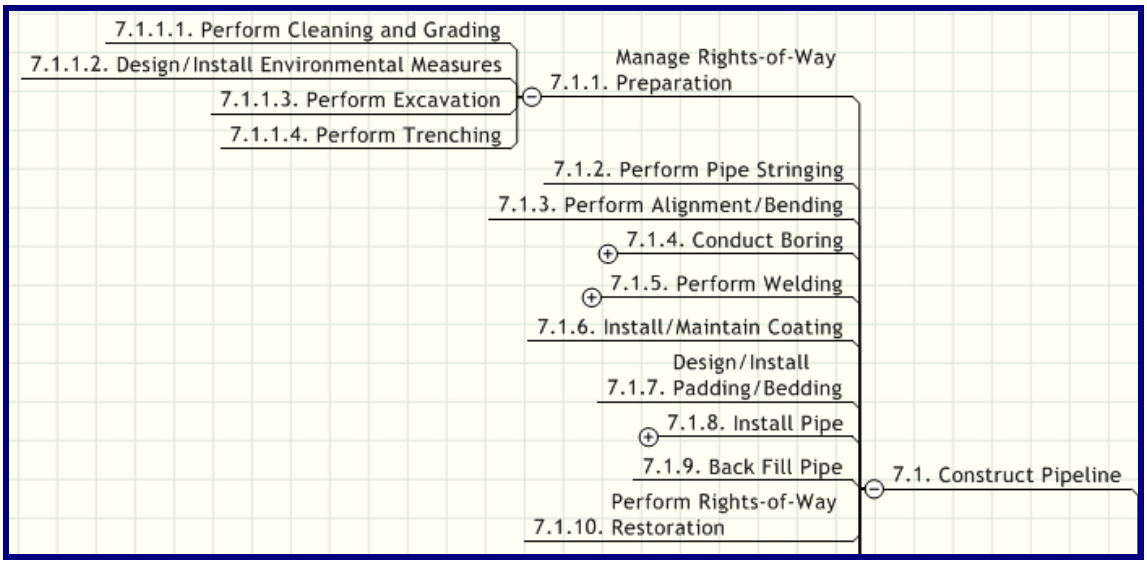
7 PERFORM CONSTRUCTION ACTIVITIES

Construct projects supporting the transmission of natural gas including pipelines, facilities, storage, LNG and warehousing functions. Integrate measurement and control systems to monitor system performance.



7.1 CONSTRUCT PIPELINE

Plan and construct the pipeline, including excavation, pipe assembly, installation of pipeline, addition of backfill and cover. Inspect all construction-related activities and materials. Documentation and management of the construction project up to the pipeline commissioning.



7.1.1 MANAGE RIGHTS-OF-WAY PREPARATION

Prepare the rights-of-way for the construction activity. Coordinate with construction personnel, land owners and others, as appropriate.

7.1.1.1 Perform Cleaning and Grading

7.1.1.2 Design/Install Environmental Measures

7.1.1.3 Perform Excavation

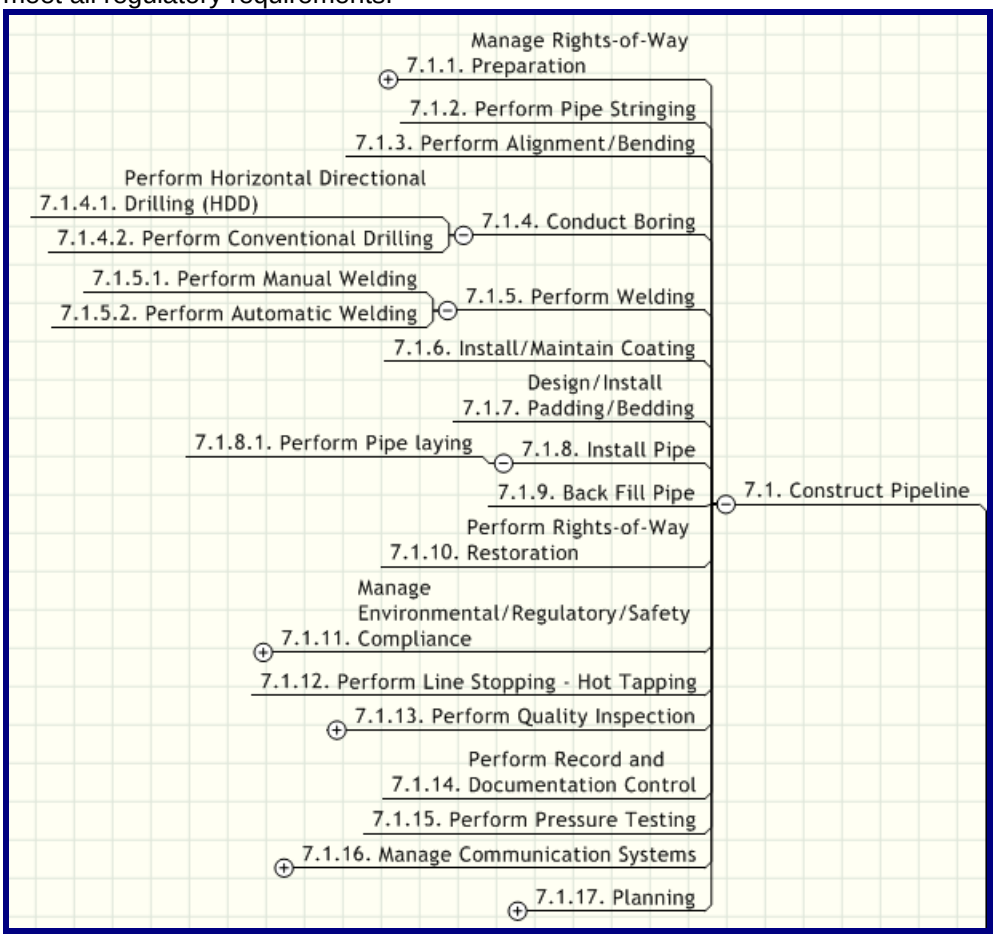
7.1.1.4 Perform Trenching

7.1.2 PERFORM PIPE STRINGING

Perform pipe stringing as a part of the construction activities. Ensure that stringing operations are conducted with approved methods. Verify that stringing operations meet all regulatory requirements.

7.1.3 PERFORM ALIGNMENT/BENDING

Align and bend pipe as a part of the construction activities. Ensure that alignment and bending operations are conducted with approved methods. Verify that alignment and bending operations meet all regulatory requirements.



7.1.4 CONDUCT BORING

Bore pipeline as a part of the construction activities. Ensure that boring operations are conducted with approved methods. Verify that boring operations meet all regulatory requirements.

7.1.4.1 Perform Horizontal Directional Drilling (HDD)

7.1.4.2 Perform Conventional Boring

7.1.5 PERFORM WELDING

Conduct welding operations as a part of the construction activities. Ensure that welding operations are conducted with approved methods. Verify that welding operations meet all regulatory requirements.

7.1.5.1 Perform Manual Welding

7.1.5.2 Perform Automatic Welding

7.1.6 INSTALL / MAINTAIN COATING

Install and maintain coating systems as a part of the construction activities. Ensure that coating operations are conducted with approved methods and materials. Verify that coating operations meet all regulatory requirements. Adhere to all applicable regulatory and organizational requirements.

7.1.7 DESIGN / INSTALL PADDING/BEDDING

Design and install pipeline padding and bedding systems to protect the pipeline from damage. Identify the proper bedding materials and location. Coordinate pipeline bedding with the other the construction activities which are underway. Ensure that operations are conducted with approved methods and materials. Verify that padding and bedding operations meet all regulatory requirements. Adhere to all applicable regulatory and organizational requirements.

7.1.8 INSTALL PIPE

Install pipe as a part of the construction activities. Ensure that piping operations are conducted with approved methods and materials. Verify that piping operations meet all regulatory requirements. Adhere to all applicable regulatory and organizational requirements.

7.1.8.1 Perform Pipe Laying

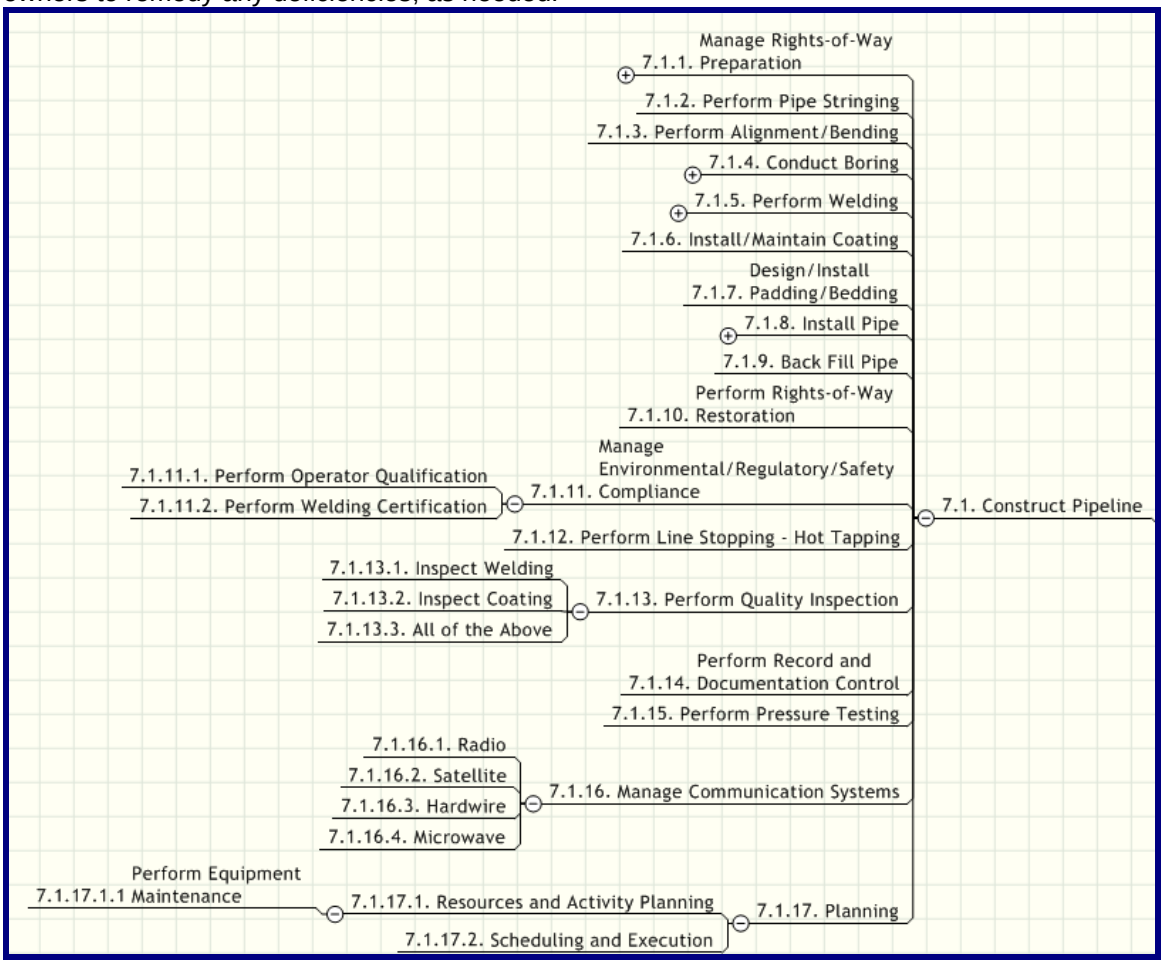
7.1.9 BACKFILL PIPE

Backfill and cover the piping as a part of the construction activities. Ensure that backfill operations are conducted with approved methods and materials. Verify that backfill operations meet all regulatory requirements. Adhere to all applicable regulatory and organizational requirements.

7.1.9.1 Provide Minimum Cover

7.1.10 PERFORM RIGHTS-OF-WAY RESTORATION

Restore rights-of-way after the completion of construction activities. Ensure that pipeline cover and rights-of-way meet specifications. Coordinate with other construction functions and land owners to remedy any deficiencies, as needed.



7.1.11 MANAGE ENVIRONMENTAL/REGULATORY/SAFETY COMPLIANCE

Manage environmental, regulatory, and safety compliance for the construction project. Monitor and analyze the environmental impact of the project. Identify necessary mitigation measures. Perform notification and reporting activities as required.

7.1.11.1 Perform Operator Qualification

7.1.11.2 Perform Welding Certification

7.1.12 PERFORM LINE STOPPING AND HOT-TAPPING

Conduct line stopping and hot-tapping operations according to approved procedures and requirements. Maintain and observe all safety precautions and procedures. Coordinate any line stopping with the system or facility personnel.

7.1.13 PERFORM QUALITY INSPECTION

Perform quality inspection to ensure that approved construction techniques have been employed and documented. Verify and document the use of approved materials. Identify and resolve construction issues or discrepancies, as needed. Issue and file an inspection report.

7.1.13.1 Inspect Welding

7.1.13.2 Inspect Coating

7.1.13.3 All of the Above

7.1.14 PERFORM RECORD AND DOCUMENTATION CONTROL

Maintain and protect all construction records. Perform document control functions for the construction activity including revision control of drawings, documents and procedures. Ensure authorized access to construction documents.

7.1.15 PERFORM PRESSURE TESTING

Pressure test newly constructed pipeline segments according established procedures. Perform inspections and analyze results. Identify and resolve any discrepancies identified through the testing. Record and document the results of the evaluation.

7.1.16 MANAGE COMMUNICATION SYSTEMS

Manage the construction of the communication systems for the pipeline. Integrate communication construction and installation into the overall construction schedule. Perform initial check out of communication systems. Ensure that the communication system and all associated elements are fully documented.

7.1.16.1 Radio

7.1.16.2 Sat

7.1.16.3 Hardwire

7.1.16.4 Microwave

7.1.17 PLANNING

Plan the overall pipeline construction effort to ensure efficient and effective execution of the project. Plan for the proper sequencing of construction resources and activities. Develop overall and detailed schedules of construction phases. Communicate with other personnel regarding schedule and logistics. Manage changes and modifications to schedule and construction tasks.

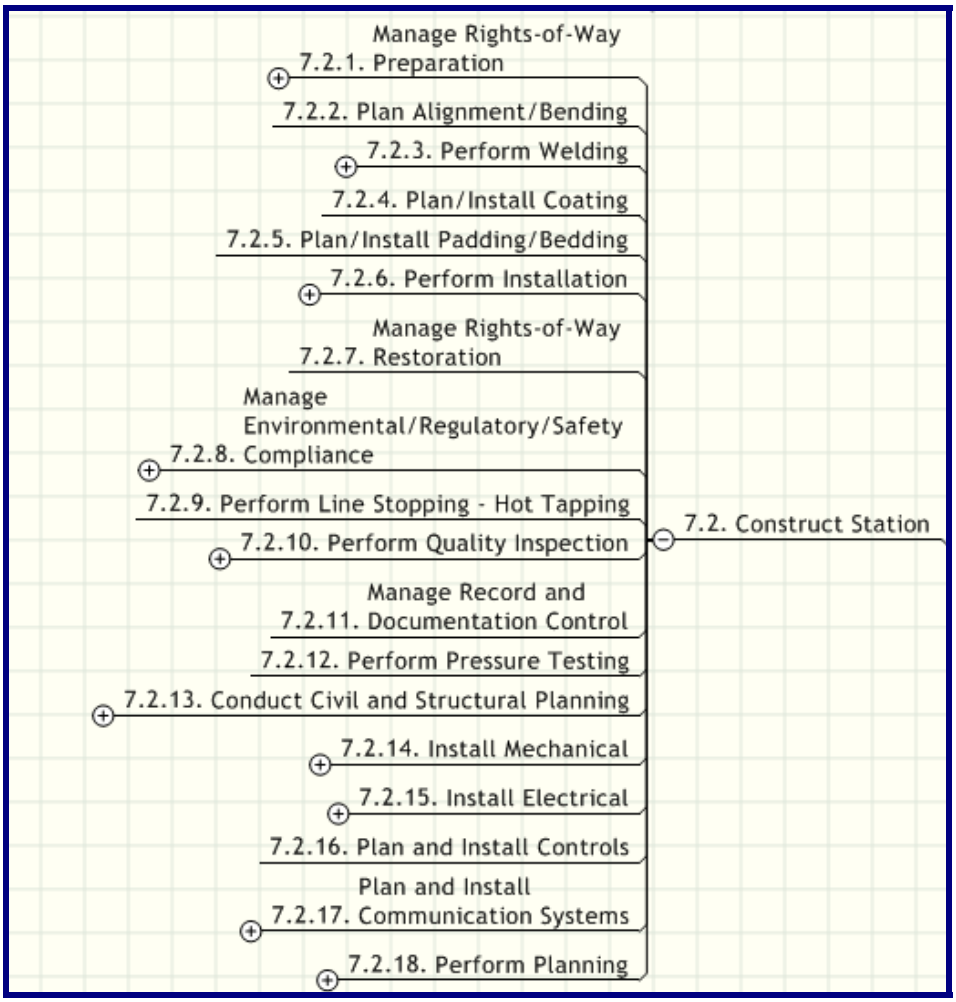
7.1.17.1 Resource and Activity Planning

7.1.17.1.1 Perform Equipment Maintenance

7.1.17.2 Scheduling & Execution

7.2 CONSTRUCT STATION

Plan and construct the gas transportation station. Inspect all construction-related activities and materials. Complete project documentation. Complete management role up to the commissioning of the station.



7.2.1 MANAGE RIGHTS-OF-WAY PREPARATION

7.2.1.1 Perform Excavation

7.2.1.2 Perform Trenching and Grading

7.2.2 PLAN PIPE ALIGNMENT/BENDING

7.2.3 PERFORM WELDING

7.2.3.1 Manual Welding

7.2.3.2 Automatic Welding

7.2.3.3 Material Preparation

7.2.3.4 Iron Welding

7.2.3.5 Stainless Steel Welding

7.2.3.6 Other Welding

7.2.4 PLAN / INSTALL COATING

7.2.5 PLAN / INSTALL PADDING / BEDDING

7.2.6 PERFORM INSTALLATION

7.2.6.1 Pipe Excavation/Installation

7.2.6.2 Perform Backfilling

7.2.7 MANAGE RIGHTS-OF-WAY RESTORATION

7.2.8 MANAGE ENVIRONMENTAL/REGULATORY/SAFETY COMPLIANCE

7.2.8.1 Perform Operator Qualification

7.2.8.2 Conduct Welding Certification

7.2.9 PERFORM LINE STOPPING AND HOT TAPPING

Manage equipment utilization and material inventories, develop plans and schedules, and perform the physical work related to line stopping and hot tap.

7.2.10 PERFORM QUALITY INSPECTION

7.2.10.1 Welding

7.2.10.2 Coating

7.2.10.3 All of the Above

7.2.11 MANAGE RECORDS & DOCUMENTATION CONTROL

Obtain construction data for the station. Maintain and update existing records to reflect construction changes and document the actual station elements.

7.2.12 PERFORM PRESSURE TESTING

7.2.13 CONDUCT CIVIL & STRUCTURAL PLANNING

7.2.13.1 Foundation Pads, Piers

7.2.13.2 Buildings

7.2.14 INSTALL MECHANICAL

7.2.14.1 Install Rotating Equipment

7.2.14.2 Install Piping

7.2.14.3 Install HVAC

7.2.15 INSTALL ELECTRICAL

7.2.15.1 Install Low Voltage

7.2.15.2 Install High Voltage

7.2.15.3 Install Power Supply/Backup

7.2.16 PLAN AND INSTALL CONTROLS

7.2.17 PLAN & INSTALL COMMUNICATION SYSTEMS

7.2.17.1 Radio

7.2.17.2 Satellite

7.2.17.3 Hardwire

7.2.17.4 Microwave

7.2.18 PERFORM PLANNING

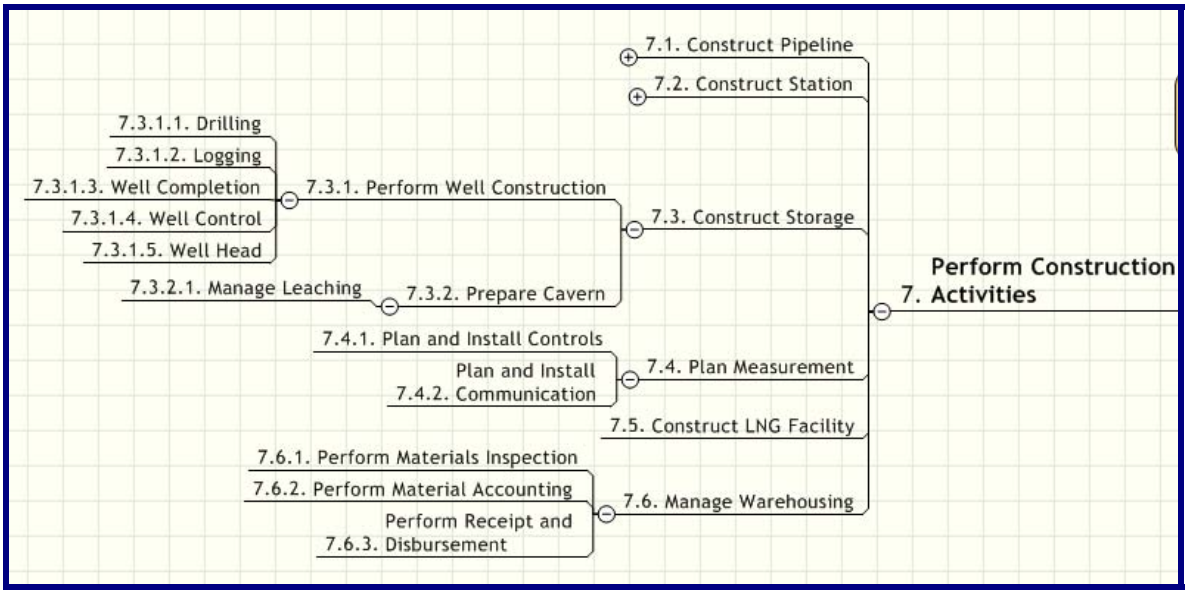
7.2.18.1 Manage Scheduling & Execution

7.2.18.2 Conduct Equipment Maintenance

7.2.18.3 Perform Resource and Activity Planning

7.3 CONSTRUCT STORAGE

Plan and construct the gas storage operation. Inspect all construction-related activities and materials. Complete storage documentation. Complete management role up to the commissioning of the gas storage facility.



7.3.1 PERFORM WELL CONSTRUCTION

Construct well using approved techniques and methods. Monitor drilling progress and record results. Verify that construction elements have been satisfactorily completed.

7.3.1.1 Drilling

7.3.1.2 Logging

7.3.1.3 Well Completion

7.3.1.4 Well Control

7.3.1.5 Well Head

7.3.2 PREPARE CAVERN

Prepare storage cavern for natural gas storage. Verify geology of the formation and suitability for storage use. Evaluate moisture and liquid levels. Identify and prioritize tasks needed to complete the cavern storage facility. Monitor cavern preparation and document actions.

7.3.2.1 Manage Leaching

7.4 PLAN MEASUREMENT

Plan the construction and installation of measurement system. Coordinate with other trades and construction tasks to sequence control system assembly. Test and verify measurement system prior to commissioning.

7.4.1 PLAN & INSTALL CONTROLS

Plan and install controls for the facility. Coordinate with other construction personnel for efficient integration of installation activities with other construction tasks. Test and verify installation of the controls and their operation. Document installation and prepare system for commissioning.

7.4.2 PLAN & INSTALL COMMUNICATION

Plan and install communication system for the facility. Coordinate with other construction personnel for efficient integration of installation activities with other construction tasks. Test and verify installation of the equipment and their proper operation. Document installation and prepare system for commissioning.

7.5 CONSTRUCT LNG FACILITY

Plan and construct the LNG facility, including one or more stations. Inspect all construction-related activities and materials. Complete LNG Facility documentation. Complete management role up to the commissioning of the LNG facility.

7.6 MANAGE WAREHOUSING

Manage the inventory, accounting, protection and storage of materials and equipment used for construction.

7.6.1 PERFORM MATERIALS INSPECTION

Inspect materials used in the construction process using approved procedures. Verify that materials are in compliance with any applicable requirements or certification. Track, record and document the use of materials in the construction process. Provide a traceable system to relate specific material use to a specific construction point.

7.6.2 PERFORM MATERIAL ACCOUNTING

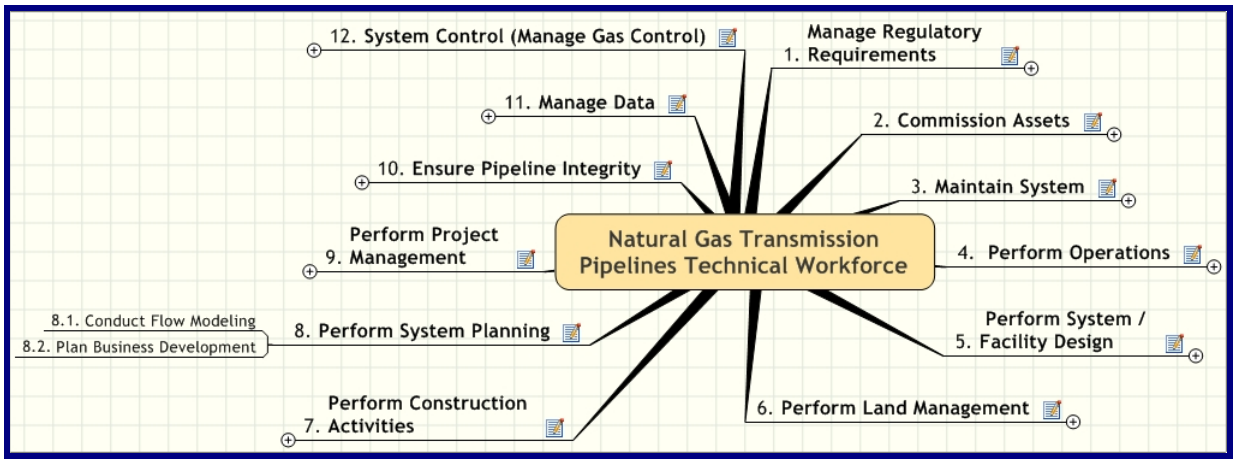
Perform material accounting to track and allocate the costs of materials used in the construction project. Ensure that accounting procedures provide traceability. Track, document and report on the construction material expenditures and consumption.

7.6.3 PERFORM RECEIPT AND DISBURSEMENT

Perform the receipt and disbursement of materials from the warehouse. Provide safeguards for the protection and accounts of warehouse materials. Administrate the receipt and disbursement of materials according to established policies and procedures.

8 SYSTEM PLANNING

Perform system planning and modeling to ensure overall system optimization and integration with business needs/ requirements.



8.1 CONDUCT FLOW MODELING

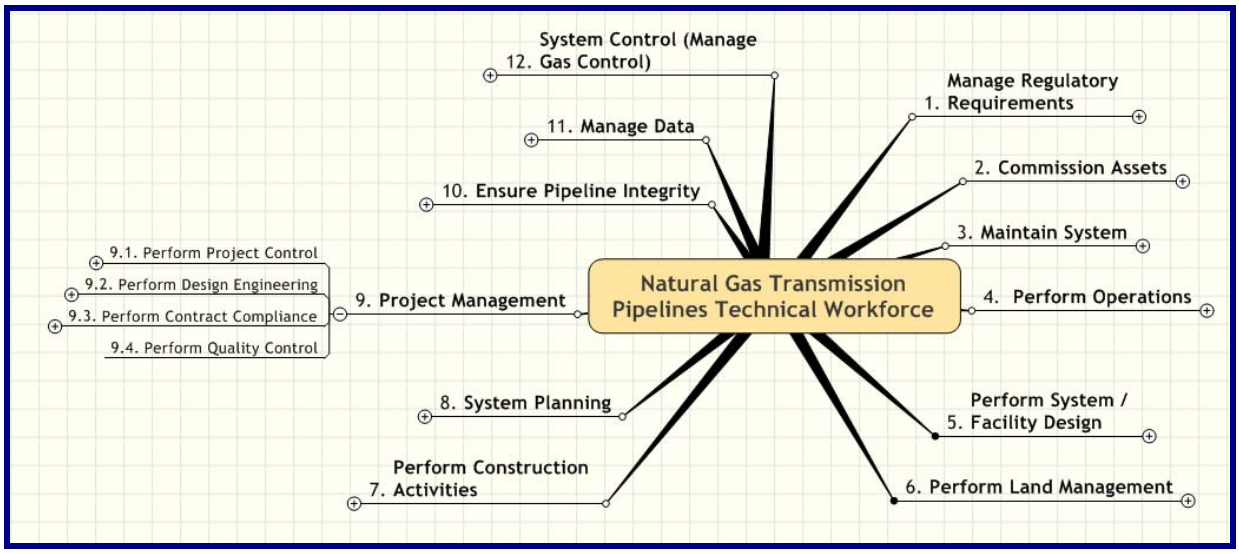
Conduct flow modeling to ensure overall system performance. Analyze and model system flow to ensure that the desired operational performance is achieved. Anticipate future requirements as well as the effect of abnormal or emergency conditions. Document and maintain flow modeling results. Keep flow model current to changing operational and business conditions, as needed.

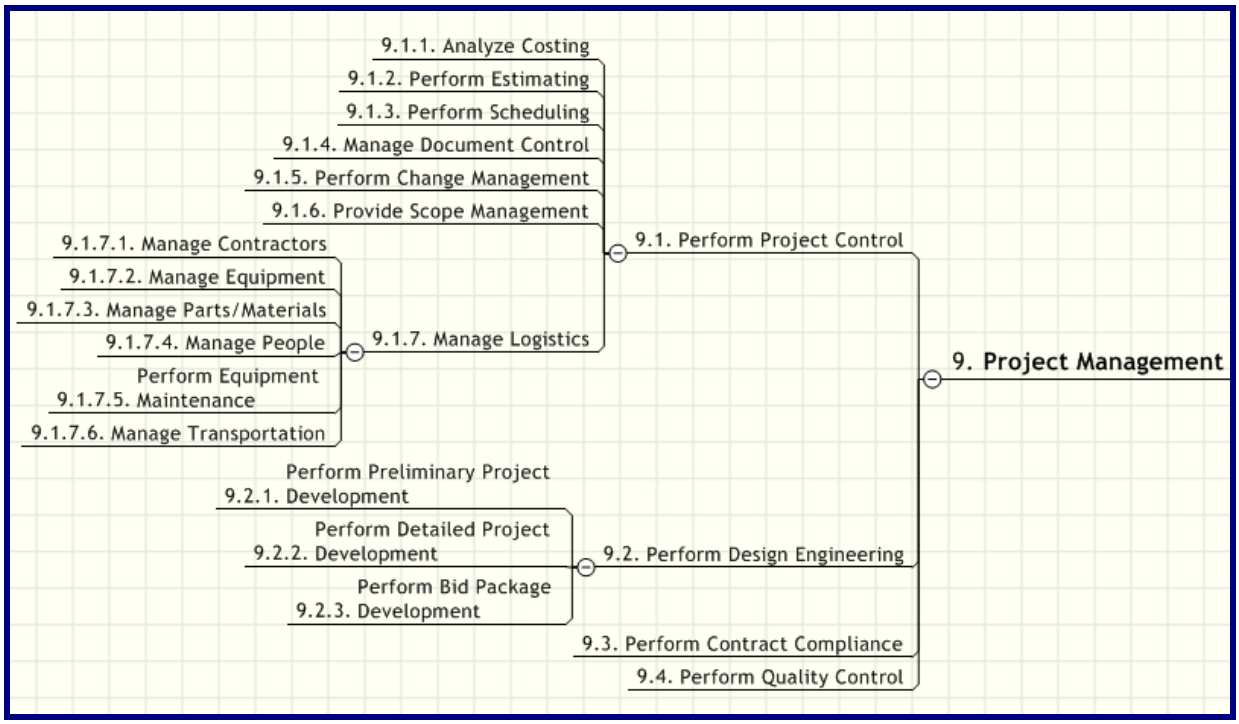
8.2 PLAN BUSINESS DEVELOPMENT

Keep business development plan current to changing business conditions, as needed.

9 PROJECT MANAGEMENT

Manage significant organizational projects including definition of scope and design engineering functions. Track and manage change control, contract compliance and quality control. Manage the physical execution of the project based on the project design and schedule. Coordinate materials and services procurement, contractors and subcontractors, field personnel, equipment and other resources to conform to cost, schedule and specifications. Oversee field activities, monitor progress and results, and institute corrective action as required. Oversee physical construction, interface with stakeholders, perform progress reviews and reporting.





9.1 PERFORM PROJECT CONTROL

Install standard project controls to manage cost, schedule and logistical performance.

9.1.1 ANALYZE COSTING

Monitor cost performance, identify causes of unfavorable variances, evaluate options and institute corrective action.

9.1.2 PERFORM ESTIMATING

Monitor estimating performance, identify causes of unfavorable variances, evaluate options and institute corrective action.

9.1.3 PERFORM SCHEDULING

Monitor schedule performance, identify causes of unfavorable variances, evaluate options and institute corrective action.

9.1.4 MANAGE DOCUMENT CONTROL

Manage project documentation to ensure proper revision control and change management for documents and drawings.

9.1.5 PERFORM CHANGE MANAGEMENT

Manage change for the project, including design revisions. Coordinate project changes and modifications with technical experts and project leaders.

9.1.6 PROVIDE SCOPE MANAGEMENT

Manage the scope of the project so that adequate focus and resources are employed. Ensure the project's definition is clearly defined and accepted. Manage the impact of scope changes with project participants and leaders. Communicate changes in project related to estimated cost and other factors to project sponsor.

9.1.7 MANAGE LOGISTICS

Manage bills of material, source materials, evaluate bids and proposals, award the work and manage transportation and delivery to site(s).

9.1.7.1 Manage Contractors

9.1.7.2 Manage Equipment

9.1.7.3 Manage Parts/Materials

9.1.7.4 Manage People

9.1.7.5 Perform Equipment Maintenance

9.1.7.6 Manage Transportation

9.2 PERFORM DESIGN ENGINEERING

Perform design engineering from preliminary project analysis through detailed project and bid package development.

9.2.1 PERFORM PRELIMINARY PROJECT DEVELOPMENT

Develop a preliminary plan for a project. Estimate initial cost and schedule. Assess and identify major obstacles or issues that must be resolved in order to complete project. Identify major project phases and milestones. Establish project tracking system. Obtain appropriate approvals to proceed to next project phase.

9.2.2 PERFORM DETAILED PROJECT DEVELOPMENT

Develop a detailed plan for a project. Estimate specific costs and schedules. Identify and define project phases along with specific project milestones for each element of the plan. Maintain and mature the project tracking system. Obtain appropriate approvals to proceed to next project phase.

9.2.3 PERFORM BID PACKAGE DEVELOPMENT

Develop the project bid package. Generate RFQs for the project components, as needed. Review resulting quotations and make selection based on bid selection criteria.

9.3 PERFORM CONTRACT COMPLIANCE

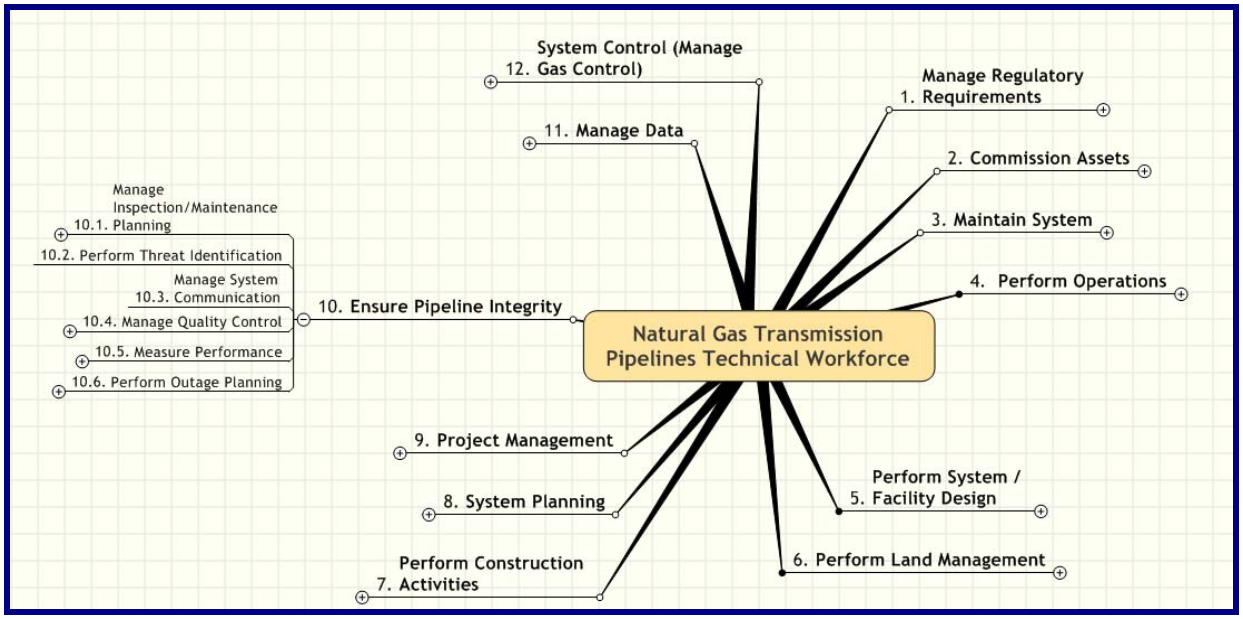
Install standard project controls to manage cost and schedule performance, control quality, and to manage compliance.

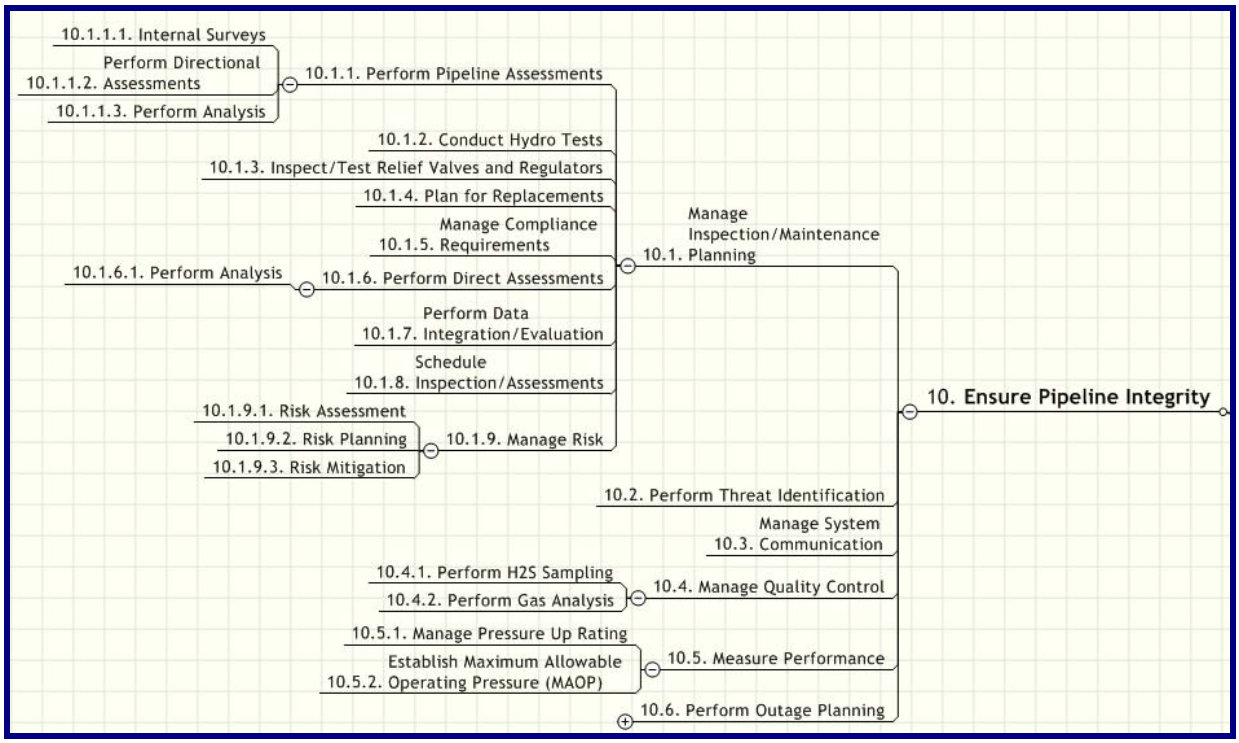
9.4 PERFORM QUALITY CONTROL

Perform quality control for the project, including any necessary validation and/ or testing of project phases, verification of Certificates of Conformance, assurance of documentation and record retention.

10 ENSURE PIPELINE INTEGRITY

Organize and maintain a system to support pipeline integrity management, assessment, remediation and repair. Ensure natural gas pipeline integrity through prudent threat assessment and inspection / maintenance planning, including performance measurement, outage control and management of the ongoing quality of the system and gas.





10.1 MANAGE INSPECTION/MAINTENANCE PLANNING

Manage inspection to ensure pipeline integrity. Conduct all required regulatory testing and pipeline surveys, including assessments and evaluations. Manage risk in conjunction with all regulatory and organizational requirements.

10.1.1 PERFORM PIPELINE ASSESSMENTS

Conduct pipeline assessments to assess pipeline for corrosion or other defects. Utilize approved procedures to perform the survey. Analyze and interpret results. Identify any discrepancies and recommend corrective actions as needed.

10.1.1.1 Internal Surveys

10.1.1.2 Perform Direct Assessments

10.1.1.3 Perform Analysis

10.1.2 CONDUCT HYDRO TESTS

Conduct hydro testing to verify pipeline integrity according to regulatory requirements or as needed. Utilize approved procedures to perform the survey. Analyze and interpret results. Identify any discrepancies and recommend corrective actions as needed.

10.1.3 MANAGE COMPLIANCE REQUIREMENTS

Manage compliance requirements for pipeline integrity. Ensure that all regulatory requirements are fully addressed and completed as required. Monitor and track compliance activities to ensure timely completion. Identify and manage to resolution any potential compliance issues.

10.1.4 PERFORM DIRECT ASSESSMENTS

Determine best assessment method to perform direct assessment in relation to risk / type level and segment characteristics. Conduct the physical assessment of the pipeline segments.

10.1.5 PERFORM DATA INTEGRATION/EVALUATION

Establish and maintain a data integration and evaluation system which collects, compiles and analyzes pipeline integrity information. Evaluate survey and assessment results. Establish survey and inspection schedules based on pipeline evaluations and defect / discrepancy trends. Document and record pipeline integrity evaluation results.

10.1.6 SCHEDULE INSPECTION/ASSESSMENTS

Deploy and assign the schedule for pipeline integrity inspections and assessments based updated information. Monitor and track progress of inspections. Ensure completion of all inspections and assessment to the established schedule.

10.1.7 MANAGE RISK

Analyze the results of the physical assessment and determine if actions are required to mitigate findings from assessment. Determine urgency and effect immediate repair/replacement or schedule repair/replacement, other mitigating action, or reassessment interval.

10.1.7.1 Risk Assessment

10.1.7.2 Risk Planning

10.1.7.3 Risk Mitigation

10.2 PERFORM THREAT IDENTIFICATION

Integrate and analyze data on pipeline segments to identify threats and conditions, length of service, inspection interval, experience on pipeline segments with similar characteristics or other factors related to the probability of future conditions. Conduct risk assessment for all pipeline segments and develop a near-term (annual) and long-term plan to assess high risk segments and HCA's.

10.3 MANAGE SYSTEM COMMUNICATION

Manage pipeline system communication.

10.4 MANAGE QUALITY CONTROL

Manage pipeline quality control, including sampling and analysis of gas for quality (e.g. measure BTU content, moisture, hydrogen sulfide, carbon dioxide and/or mercaptans) and impurities. Monitor gas quality trends and levels. Identify and initiate appropriate actions for controlling gas quality. Manage overall system gas quality to achieve operational and business objectives.

10.4.1 PERFORM H2S SAMPLING

Perform H2S gas sampling according to established procedures to ensure proper operation and functionality according to established schedules. Utilize approved procedures to perform the testing. Analyze and interpret results. Identify any discrepancies and recommend corrective actions as needed.

10.4.2 PERFORM GAS ANALYSIS

Perform gas analysis according to established procedures to ensure proper operation and functionality according to established schedules. Utilize approved procedures to perform the testing. Analyze and interpret results. Identify and recommend corrective actions as needed.

10.5 MEASURE PERFORMANCE

Obtain performance information for pipeline segments. Update the results. Organize and maintain in a system to support pipeline integrity management decisions.

10.5.1 MANAGE PRESSURE UP RATING

Manage pressure up rating analysis and recommend changes in rating as appropriate. Consider reliability, pipeline life and risk in determining appropriate rating. Record and document the analysis. Based on the results of the analysis, up rate the pipeline segment, if appropriate.

10.5.2 ESTABLISH MAXIMUM ALLOWABLE OPERATION PRESSURE (MAOP)

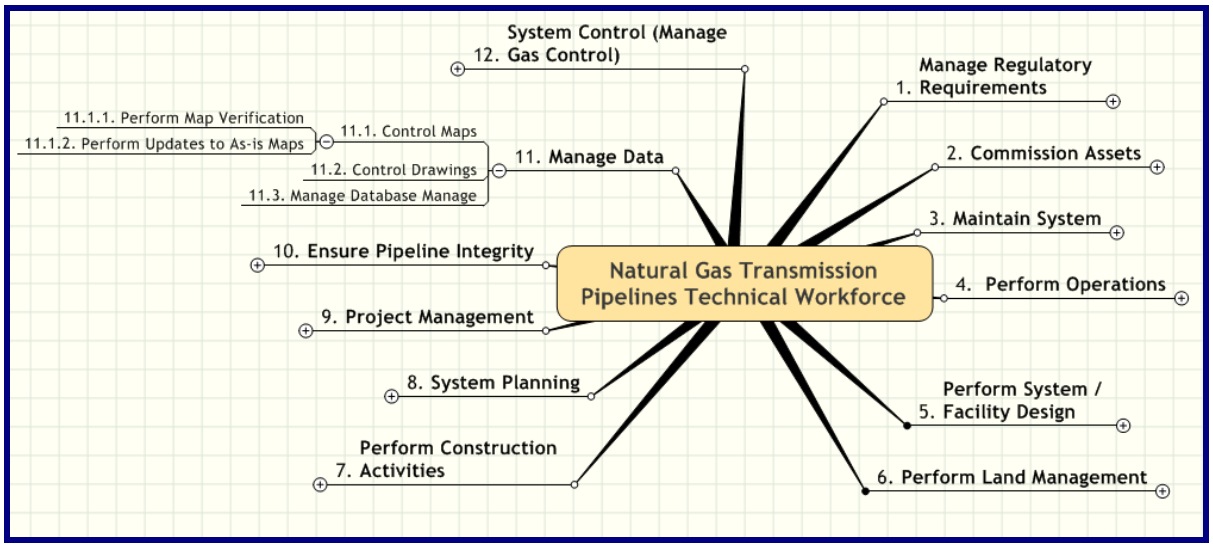
Establish MAOP rating for each pipeline segment as required by regulation. Consider the pipeline segment's class location, system time, O&M history, overpressure results and other factors as needed in determining appropriate rating. Record and document MAOP analysis and results.

10.6 PERFORM OUTAGE PLANNING

Develop outage planning for planned and unplanned interruptions. Maintain compliance with applicable regulations and requirements.

11 MANAGE CONTROL MAPS, DRAWINGS AND DATABASES

Manage the control and revision of the organization's data assets, including map and drawing resources.



11.1 CONTROL MAPS

Control and protect the mapping information contained on new and revised plots for pipelines, facilities and other physical assets.

11.1.1 PERFORM MAP VERIFICATION

Verify all site and pipeline maps are accurate and reflect current conditions, features and locations.

11.1.2 PERFORM UPDATES TO AS-IS MAPS

Perform systematic updates of current maps. Provide for appropriate revision control as well as verification of updated information.

11.2 CONTROL DRAWINGS

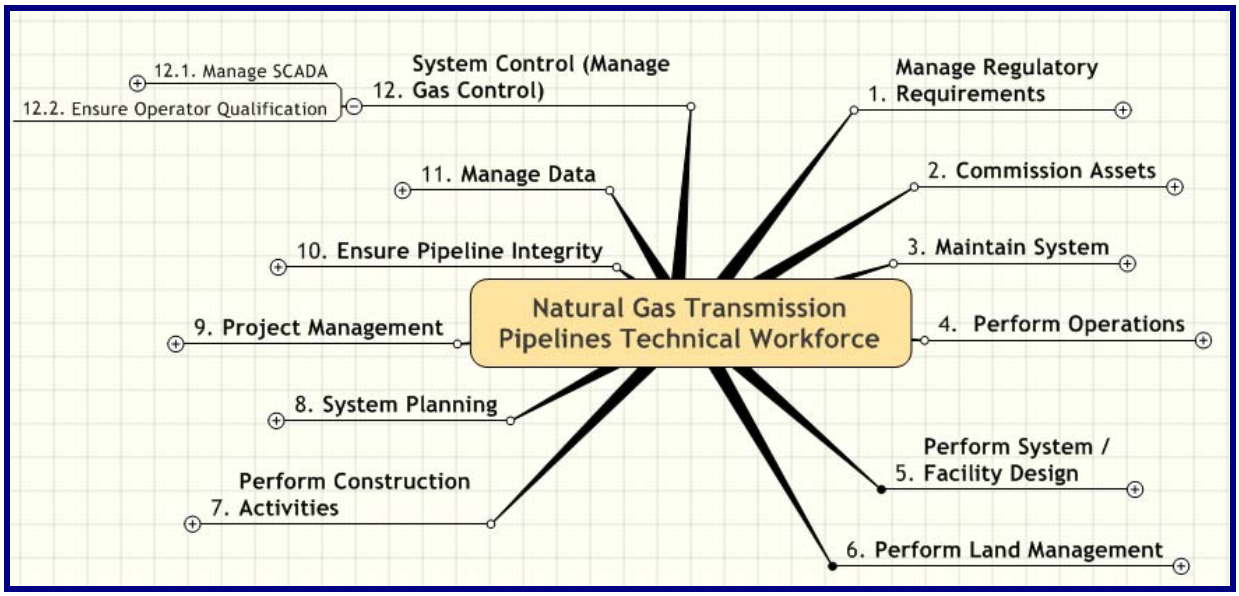
Control drawing information through an effective revision control and distribution system.

11.3 MANAGE DATABASE

Manage organization data assets, including reliability, accuracy, accessibility, and security.

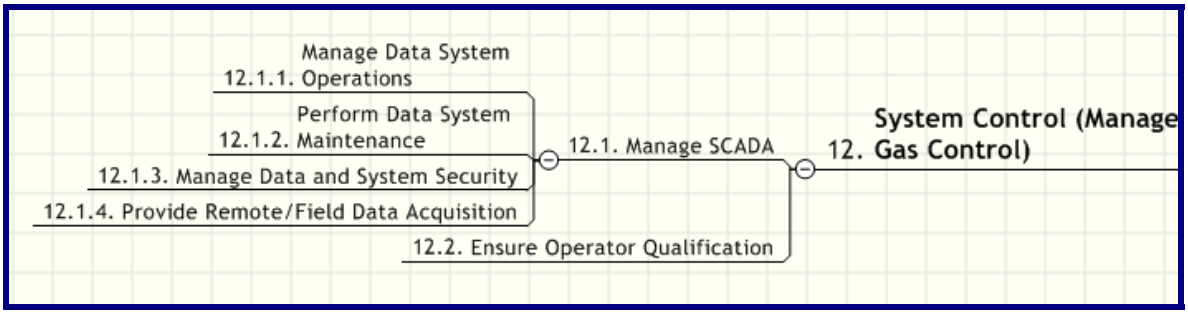
12 MANAGE SYSTEM CONTROL DATA

Manage gas control systems, including effective system control and appropriate operator qualifications.



12.1 MANAGE SCADA

Manage SCADA system to ensure appropriate control and data acquisition is maintained for effective, safe and efficient transmission and facility operation.



12.1.1 MANAGE DATA SYSTEM OPERATIONS

Manage data systems operations day to day. Ensure ongoing system control and alerting functions.

12.1.2 PERFORM DATA SYSTEM MAINTENANCE

Maintain data systems to ensure the ongoing reliability and accessibility of vital operational data.

12.1.3 MANAGE DATA AND SYSTEM SECURITY

Manage system data to ensure accurately and reliability. Provide proper backups for data and key systems. Ensure appropriate security for data and access to sources.

12.1.4 PROVIDE REMOTE / FIELD DATA ACQUISITION

Provide for the acquisition of remote data as well as appropriate control and sensing capability.

12.2 ENSURE OPERATOR QUALIFICATION

Ensure that facility and pipeline personnel have the demonstrated skills and appropriate knowledge to perform functions needed for their role.