Annex 3: IFC GUIDELINE

Environmental, Health, and Safety Guidelines for Gas Distribution Systems

Introduction

The Environmental, Health, and Safety (EHS) Guidelines are technical reference documents with general and industry-specific examples of Good International Industry Practice (GIIP)[1]. When one or more members of the World Bank Group are involved in a project, these EHS Guidelines are applied as required by their respective policies and standards. These industry sector EHS guidelines are designed to be used together with the **General EHS Guidelines** document, which provides guidance to users on common EHS issues potentially applicable to all industry sectors. For complex projects, use of multiple industry-sector guidelines may be necessary. A complete list of industry-sector guidelines can be found at: www.ifc.org/ifcext/enviro.nsf/Content/EnvironmentalGuidelines

The EHS Guidelines contain the performance levels and measures that are generally considered to be achievable in new facilities by existing technology at reasonable costs. Application of the EHS Guidelines to existing facilities may involve the establishment of site-specific targets, with an appropriate timetable for achieving them.

The applicability of the EHS Guidelines should be tailored to the hazards and risks established for each project on the basis of the results of an environmental assessment in which site-specific variables, such as host country context, assimilative capacity of the environment, and other project factors, are taken into account. The applicability of specific technical recommendations should be based on the professional opinion of qualified and experienced persons. When host country regulations differ from the levels and measures presented in the EHS Guidelines, projects are expected to achieve whichever is more stringent. If less stringent levels or measures than those provided in these EHS Guidelines are appropriate, in view of specific project circumstances, a full and detailed justification for any proposed alternatives is needed as part of the site-specific environmental assessment. This justification should demonstrate that the choice for any alternate performance levels is protective of human health and the environment. .

Applicability

The EHS Guidelines for Gas Distribution Systems include information relevant to the distribution of low pressure natural gas from the city gate to residential, commercial, and industrial users. Annex A provides a summary of industry sector activities.

This document is organized according to the following sections:

Section 1.0 — Industry-Specific Impacts and Management
Section 2.0 — Performance Indicators and Monitoring
Section 3.0 — References
Annex A — General Description of Industry Activities

[1] Defined as the exercise of professional skill, diligence, prudence and foresight that would be reasonably expected from skilled and experienced professionals engaged in the same type of undertaking under the same or similar circumstances globally. The circumstances that skilled and experienced professionals may find when evaluating the range of pollution prevention and control techniques available to a project may include, but are not limited to, varying levels of environmental degradation and environmental assimilative capacity as well as varying levels of financial and technical feasibility.

1.0 Industry-Specific Impacts and Management

This section provides a summary of EHS issues associated with gas distribution systems that occur during the construction and operations phases, along with recommendations for their management. Recommendations for the management of EHS issues common to most large industrial facilities during the decommissioning phase are provided in the **General EHS Guidelines**.

1.1 Environment

Distribution pipeline construction impacts greatly depend on the location of proposed pipeline installation. In already developed urban areas, environmental impacts are considerably different than in suburban or mixed use areas. Common impacts may include noise and vibration caused by the operation of earth moving and excavation equipment, and materials transport and delivery; dust emissions generated by a combination of on-site excavation and movement of earth materials, contact of construction machinery with bare soil, and exposure of bare soil and soil piles to wind; mobile emissions from exhaust of diesel engines for earth moving equipment; and hazardous materials and waste handling, including oil spills associated with heavy equipment operation and fueling activities. In newly developed areas, impacts may also include soil erosion resulting from excavated areas prior to the reestablishment of vegetation. In urban areas, impacts may include noise, traffic interruption, disposal of contaminated soil, and presence of archeological artifacts.

Recommendations for prevention and control of construction related impacts are addressed in the **General EHS Guidelines**.

Environmental issues that may occur during gas distribution projects include the following:

- Habitat Alteration
- Air Emissions

Habitat Alteration

Habitat alteration is only considered a relevant potential impact during construction of gas distribution pipeline systems in newly developed rural or periurban areas. These impacts may be associated with excavation, trenching, pipe laying, backfilling, and the establishment of infrastructure such as regulating stations, which may create temporary or permanent terrestrial habitat alteration depending on the characteristics of existing vegetation and topographic features along the proposed right of way. The potential for impacts depends on the level of existing development, and will likely be less of an issue in urbanized areas or along existing utility rights-of-way corridors.

Depending on the level of existing urbanization in the proposed project area, examples of habitat alteration from these activities may include landscape fragmentation; loss of wildlife habitat, including for nesting; and establishment of non-native invasive plant species. In addition, construction of distribution pipelines crossing aquatic habitats that may disrupt watercourses and wetlands, and require the removal of riparian vegetation. Sediment and erosion from construction activities and storm water runoff may increase turbidity of surface watercourses.

To prevent and control impacts to terrestrial habitats, distribution pipeline rights-of-way and regulating stations should be sited to avoid critical habitat through use of existing utility and transport corridors, whenever possible. To prevent and control impacts to aquatic habitats, distribution pipeline rights-of-way should be sited to avoid critical aquatic habitat such as watercourses, wetlands, and riparian areas, as well as fish spawning habitat, and critical fish over-wintering habitat, whenever possible. Use of guided / directional drilling for distribution pipeline installation should be considered where feasible to reduce impacts to both terrestrial and aquatic habitats.

Air Emissions

Gas distribution systems may generate gas leaks as a result of normal operations, equipment venting for maintenance, and aging.[2] Gas leakage, principally consisting of methane (CH_4), a greenhouse gas, may result from corrosion[3] and degradation of pipelines and related components over time and from fugitive emissions from pipelines and regulating stations.

Recommended measures to prevent and control air emissions due to leaks include:

- Gas pipelines and pipeline components, in addition to general installation and pipe joining techniques such as welding, should meet international standards for structural integrity and operational performance;[4]
- Corrosion prevention of buried ferrous metal pipelines should be undertaken using coating or cathodic protection techniques.[5] For underground applications, the use of polyethylene pipe[6], which is not subject to corrosion, should be considered as an alternative to ferrous metal pipeline materials;
- Testing of pipelines and pipeline components for pressure specifications and presence of leaks should be undertaken prior to commissioning. The system should be gas tight when tested at a higher pressure than the normal maximum operation gas pressure;
- Leak and corrosion detection programs should be undertaken, including use of appropriate leak detection assessment techniques and equipment.[7] Maintenance programs to repair and replace infrastructure should be undertaken as indicated by detection results. Typical urban testing sites include atmospheres in confined spaces of utility infrastructure (e.g. sewer and water system manholes), as well as at openings in pavement and on streets and walkways. Areas of gas infrastructure subject to forces from heavy load traffic or physical land shifts should also be periodically monitored for leaks and ruptures;
- Comparisons of purchased and delivered gas amounts should be periodically examined for discrepancies and unaccounted for gas which may be an indicator of excessive system leakage;
- Regulating stations and vaults, both above and below ground, may contain equipment (e.g. safety valves, filters) that may emit fugitive emissions of gas. Pipelines, valves, and other component infrastructure should be regularly maintained, and ventilation and gas detection / alarm equipment installed in station buildings or vaults.

[2] The methane emission from the gas distribution sector is 26 percent of the total methane emissions in the US natural gas industry sector. United States Environment Protection Agency (US EPA) (1999).

[3] Steel and other ferrous metals used for gas pipelines may be subject to corrosion, a reaction between external and internal surfaces of the pipe and its surroundings in both below and above ground settings. Corrosion weakens the structural integrity of the pipe and may lead to leakage. The characteristics of the physical environment of the pipeline including soil resistivity, moisture, and presence of contaminants may encourage corrosive activity. US Department of Transportation, Office of Pipeline Safety (2002).

[4] For example, US 49 CFR Part 192—Transportation of Natural Gas and Other Gas by Pipeline: Minimum Federal Safety Standards subparts A to H, and European (EN) Standards: EN 12007-1:2000: Gas Supply Systems. Pipelines for maximum operating pressure up to and including 16 bar. General functional recommendations.

[5] Cathodic protection is a procedure by which an underground metallic pipe is protected against corrosion. There are two basic methods of cathodic protection: use of galvanic anode and impressed current systems. Galvanic systems rely on a sacrificial metal, such as zinc, to protect the pipe. For impressed current systems, a direct current is impressed onto the pipe by means of a rectifier, and corrosion is reduced where sufficient current flows onto the pipe. Testing of the electrical current for cathodic protection should be undertaken regularly. US Department of Transportation, Office of Pipeline Safety (2002).

[6] An example of the performance specifications for polyethylene gas pipe is the ASTM D 2513 Standard Specification for Thermoplastic Gas Pressure Pipe, Tubing, and Fittings or Standard EN 1555 Plastics Piping Systems.

[7] Leaks are indicated by the presence of gas odor and hissing sounds. Additional indicators may include changes in vegetation, insect activity, and the presence of fungal growths surrounding pipelines and components. Examples of leak detection equipment include specialized soap solutions, in addition to combustible gas indicators (CGI), flame ionization detectors (FI), and sonic detectors that use sound levels to locate leaks. US Department of Transportation, Office of Pipeline Safety (2002).

1.2 Occupational Health and Safety

Occupational health and safety (OHS) issues in the construction phase include potential exposures to dust, noise, physical strain, and trenching excavation hazards. Recommendations for the management of construction phase hazards are addressed in more detail in the **General EHS Guidelines.** Occupational health and safety hazards associated with the construction and operation of gas distribution systems may also include:

- Occupational exposure to gas leaks and explosions
- Confined spaces
- Electrocution

Additional recommendations for operational phase OHS issues also applicable to gas distribution activities are also addressed in the **General EHS Guidelines**.

Occupational exposure to gas leaks and explosions

Excavation, construction, and repair of gas distribution systems may result in accidental pipeline rupture or leakage and consequent exposure of workers to harmful gases and an explosive gas atmosphere. In addition, excavation by non-gas utility personnel may result in accidental ruptures and exposure of untrained workers to explosion hazards. Recommended techniques to prevent and control exposure to gases and explosive atmospheres caused by accidental gas line ruptures and / or leaks include:

- Training of employees and contractor personnel in safety procedures, together with provision of appropriate tools and equipment;
- Identification and location of existing gas and other buried utility infrastructure prior to excavation for installation or repair of gas pipelines. Installation of visual marking of gas lines as part of installation, and updating as necessary on an ongoing basis;
- Removal of sources of ignition prior to gas venting for maintenance and repair activities. Purging of gas from pipeline or pipe components prior to welding or cutting activities;
- Installation of gas lines and components using sufficient separation distance and appropriate pipe protection layering to minimize potential interference with other underground infrastructure. Separation of plastic pipes from sources of heat;
- Odorization of gas to facilitate detection of gas leakage;[8]
- Training of gas utility workers in procedures for emergency preparedness and response involving appropriate public authorities, in addition to emergency shutdown and pressure reduction in the pipeline system. Further recommendations for emergency preparedness and response are addressed in the **General EHS Guidelines**.

Confined spaces

Accumulation of natural gas in a confined space is a potentially fatal condition. Entry by workers into confined spaces and the associated potential for accidents may vary among gas distribution project phases and facilities. Specific and unique areas for confined space entry may include excavation trenches during construction and regulating stations and vaults, both above and below ground, which may also contain equipment (e.g. safety valves, filters) that may emit fugitive emissions of gas and create a potential for oxygen deficient and explosive atmospheres. Gas distribution companies should develop and implement confined space entry procedures as described the **General EHS Guidelines**, and including the following:

[8] A combustible gas in a distribution line must contain a natural odorant or be odorized so that at a concentration in air of one-fifth of the lower explosive limit, the gas is readily detectable by a person with a normal sense of smell. See US 49 CFR Part 192.

- Requiring work permits for all confined space entries;
- Installation of appropriate access controls for unauthorized personnel including signage to alert workers to the hazards of confined spaces;
- Use of ventilation and oxygen / explosive level detection and alarm equipment prior to access.

Electrocution

Excavation, construction, and repair of gas distribution systems may result in workers' exposure to existing aboveground or underground utilities, including aerial or buried electric transmission lines. Identification and location of all relevant existing underground utilities should be undertaken prior to any construction and excavation activities.

1.3 Community Health and Safety

Community health and safety hazards associated with the construction and operation of gas distribution systems include public exposure to gas leaks and explosions. Additional recommendations for community health and safety issues common to most industry sectors are addressed in the **General EHS Guidelines**.

Public exposure to gas leaks and explosions

The presence of gas distribution systems within populated areas may expose the public to hazards from gas leaks and explosions. Gas leakage may result from accidental rupture of pipelines during installation and repair or from contact during excavation unrelated to the gas system. Gas utility operators should inform and advise affected communities, schools, businesses / commercial facilities, and residents about the potential hazards presented by gas infrastructure. Gas distribution system operators should establish an emergency preparedness and response plan and communicate this plan to the public as necessary.

As part of the plan, gas system operators should implement a telephone notification system to respond to reports of leaks or questions of general safety from the affected community and other interested parties. Operators should also provide a pipe location service to assist outside contractors and the general public to determine the location of gas infrastructure prior to construction works proximate to gas pipelines.

Improper operation of natural gas fuelled appliances and equipment may expose the user and the public to gas leakage and explosion hazards. Gas distribution system operators should make information available to customers (e.g. through flyers and internet-based information) regarding the safe operation of gas fueled appliances and equipment. This information should address issues of proper and safe use of gas-fired appliances, which in the case of residential use, may include the following issues:

- Proper location, installation, and maintenance of appliances and equipment such as natural gas fired heating units. For example, installation in areas with adequate ventilation to ensure dispersion of residual carbon monoxide. Poor combustion in a natural gas fired appliance or piece of equipment may expose the user and the public to carbon monoxide exposure, especially in confined spaces;
- Recognition of potential hazards or operating problems. For example, recognition of the hazards of poor ventilation or identification of gas surges requiring action by the gas utility (identifiable when flame color in natural gas burning appliances is orange or yellow rather than blue), and how to respond to possible accumulation of gas vapors when odor is detected with instructions on proper response procedures. These procedures may include avoiding

sources of ignition (e.g. electrical switches, lighters), ventilating area of gas accumulation, and calling the emergency contact number of the local gas utility from a safe location.

2.0 Performance Indicators and Monitoring

2.1 Environment

Emissions and Effluent Guidelines

Although there are no significant point source emissions or effluents for the gas distribution sector, fugitive emissions (from city gate and regulating stations, underground piping, and third party damage) from gas distribution systems constitute a significant portion of the overall atmospheric losses from the natural gas transmission and distribution industry. Gas distribution system operators should conduct volume reconciliation programs as an indicator of leakages by comparing delivered gas amounts against sales to customers.[9] Operators should also implement inspection and maintenance programs to maintain and upgrade infrastructure and minimize fugitive gas emissions.

Environmental Monitoring

Environmental monitoring programs for this sector should be implemented to address all activities that have been identified to have potentially significant impacts on the environment, during normal operations and upset conditions. Environmental monitoring activities should be based on direct or indirect indicators of emissions, effluents, and resource use applicable to the particular project.

Monitoring frequency should be sufficient to provide representative data for the parameter being monitored. Monitoring should be conducted by trained individuals following monitoring and record-keeping procedures and using properly calibrated and maintained equipment. Monitoring data should be analyzed and reviewed at regular intervals and compared with the operating standards so that any necessary corrective actions can be taken. Additional guidance on applicable sampling and analytical methods for emissions and effluents is provided in the **General EHS Guidelines**.

2.2 Occupational Health and Safety

Occupational Health and Safety Guidelines

Occupational health and safety performance should be evaluated against internationally published exposure guidelines, of which examples include the Threshold Limit Value (TLV®) occupational exposure guidelines and Biological Exposure Indices (BEIs®) published by American Conference of Governmental Industrial Hygienists (ACGIH),[10] the Pocket Guide to Chemical Hazards published by the United States National Institute for Occupational Health and Safety (NIOSH),[11] Permissible Exposure Limits (PELs) published by the Occupational Safety and Health Administration of the United States (OSHA),[12] Indicative Occupational Exposure Limit Values published by European Union member states,[13] or other similar sources.

Accident and Fatality Rates

Projects should try to reduce the number of accidents among project workers (whether directly employed or subcontracted) to

[9] Supervisory Control and Data Acquisition (SCADA) systems may be another useful means of monitoring system volume flows, especially in new system installations.

[10] Available at: http://www.acgih.org/TLV/ and http://www.acgih.org/store/
[11] Available at: http://www.cdc.gov/niosh/npg/
[12] Available at: http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9992
[13] Available at: http://europe.osha.eu.int/good_practice/risks/ds/oel/

a rate of zero, especially accidents that could result in lost work time, different levels of disability, or even fatalities. Facility rates may be benchmarked against the performance of facilities in this sector in developed countries through consultation with published sources (e.g. US Bureau of Labor Statistics and UK Health and Safety Executive)[14].

Occupational Health and Safety Monitoring

The working environment should be monitored for occupational hazards relevant to the specific project. Monitoring should be designed and implemented by accredited professionals[15] as part of an occupational health and safety monitoring program. Facilities should also maintain a record of occupational accidents and diseases and dangerous occurrences and accidents. Additional guidance on occupational health and safety monitoring programs is provided in the **General EHS Guidelines**.

[14] Available at: http://www.bls.gov/iif/ and http://www.hse.gov.uk/statistics/index.htm
[15] Accredited professionals may include Certified Industrial Hygienists, Registered Occupational Hygienists, or Certified Safety Professionals or their equivalent.

3.0 References and Additional Sources

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Annex A: General Description of Industry Activities

Gas distribution systems deliver natural gas to residential, commercial, and industrial clients for use in appliances, heating applications, and industrial process equipment. The distribution system typically begins at the 'city gate' where natural gas from high pressure transmission pipelines (typically at 50 to 70 bar[16]) is depressurized, metered and odorized (to facilitate leak detection). City gates are secure, above ground facilities, typically less than 1 ha in area and containing equipment belonging to both the transmission and distribution companies. Once metered and odorized, gas is fed into distribution mains and service lines for delivery of low pressure gas to end users through underground, small diameter steel or plastic pipe systems. Pressure is further lowered, often in stages, for delivery to the customer.

Gas supplied to distribution systems is normally referred to as "pipeline quality natural gas", which has been processed to remove water vapor and other contaminants and has predictable burning characteristics and heat content. Processed natural gas typically contains 75 to 90+ percent methane, 3 to 4 percent nitrogen, and 2 percent carbon dioxide, but these fractions may vary in different countries. In exceptional cases, gas distribution systems may need to include additional processing if supplied gas is not of pipeline quality, such as gas produced locally from landfills, biomass, or manure.

Gas distribution systems are often a mix of new construction and old infrastructure that may contain legacy issues such as old gas meters that contain mercury, obsolete gas processing facilities, and plants that were used for manufacture of synthetic gas. Special attention should be paid to leak management when old and new infrastructure is combined or when the source of gas is changed.

The construction and installation of natural gas distribution pipeline systems involves planning and design for the right-of-way, including use of existing utility corridors (e.g. co-location with sewer, water, telecommunication, and power systems) where possible. Establishment of the right-of-way may involve clearing of vegetation and grading of surfaces. Pipe is laid following trenching activities using a backhoe, and, where appropriate, the use of directional drilling to minimize land disturbance. Guided drilling may be particularly useful when crossing under roadways, waterways or wetland habitats. Trenches are then backfilled and the right-of-way is restored using existing vegetation. Distribution pipes are typically of steel or plastic materials. Various coating and cathodic protection techniques are employed to protect steel piping from corrosive reactions, both above and below ground.

Gas distribution systems typically involve the use of regulating stations to adjust the pressure of gas throughout the distribution network. These installations are typically located above ground and occupy approximately 20 m^2 of land area. Regulating stations are located after the 'city gate' and may operate in a sequential fashion to reduce gas pressure during distribution to end users. Final pressure adjustment is undertaken at the individual residential customer (to about 0.1 bar), and at commercial, and industrial meters (to from 1 to 15 bar).

Activities by the gas distribution system during operation and maintenance include overall systems operation and monitoring of infrastructure components, such as valves, regulating stations, and pipes through flow meter data analysis and onsite inspection. Operators regularly undertake inspections for gas leaks, corrosion, and overall system integrity. Ongoing connection of new subscribers within the distribution market is a regular operational activity, and is typically undertaken while the distribution pipes are pressurized, so as not to interrupt service

[16] 1 bar is approximately 1 atmosphere, or 14.5 lb/in^2.

to other customers. Repair activities involve all parts of the distribution system and typical tasks include repair and replacement of pipes and valves, in particular after accidental damage due to excavation near pipeline infrastructure.

Gas distribution operators are also typically responsible for training their employees, and ensuring that contractors are trained, in the procedures and actions necessary for effective emergency response to leaks, ruptures, and other incidents caused by the operators themselves, third parties, or natural hazards. Effective emergency response requires that gas distribution operators integrate with local government and municipal authorities, in addition to residential, commercial and industrial partners to ensure coordinated actions in the event of an emergency.

Decommissioning of distribution lines typically involves the closure and securing of valves to impede flow of gas to the customer and disconnection and sealing of the distribution mains and service line piping after purging of residual gas. Above ground structures such as regulating stations may be removed. Below ground pipelines, vaults and other components may be removed or left in place depending on site specific considerations.