OPERATING AND MAINTENANCE PROCEDURES FOR MAJOR GAS PIPELINES

This report is in response to a request made by the Public Utilities Commission of California in its letter of November 22, 1966. Pacific Gas and Electric Company and the other operating companies in California were each asked to furnish the Commission Staff with a summary of its operating practices and procedures covering major gas pipelines.

The category of major gas pipelines includes pipelines transporting gas from out-of-state sources, collecting gas from California gas fields and pipelines, which are principally employed in transporting gas throughout our system to major load centers. The majority of these pipelines operate at 40% of SMYS or above, but some of the smaller diameter pipelines and sections of the larger lines in built-up areas operate at stress levels less than 40% of SMYS. Excluded from these procedures are mains that function principally to distribute gas to customers or to support locally, mains that distribute gas to customers. Excluding these latter mains does not infer that they are not observed and properly maintained. The procedures for these mains fall into a category similar in intent, but different in scope, to that employed for major gas pipelines. In the P. G. and E. system, the mains not included all operate at less than 40% of SMYS.

The analysis of our procedures is summarized on Page II and briefly covered by items following the summary.

OPERATING PRACTICES FOR PIPELINE SURVEYS AND PERIODIC STUDIES

SUMMARY

	Function	Kind of Review	Frequency	Page
1.	Operating pressure and stress level	(a) Review of pressure ratings (b) Observation and preventive maintenance of pressure control equipment (c) Observation of pressure conditions	(a) Annual (b) Varies - Weekly to annually (c) Continuous	1
2.	Change in Location Class	Field check	As required	2
3.	Surrounding developments	Patrol	Varies - Weekly to semi-annually	4
4.	Surface changes			5
5.	Earth movements			6
6.	Cover depth	Patrol and field check	As required	7
7.	Water table	Special patrol and field check	As required	8
8.	Work by others	(a) Periodic and special patrol (b) Interagency cooperation or direct contact	(a) Varies - Daily to monthly (b) As required	
9.	External corrosion	Visual examination	As required	10
10.	Pipe coating	(a) Visual observation (b) Review of cathodic protection systems	(a) As required (b) Monthly to annually	11
11.	Cathodic protection	(a) Rectifier outputs (b) Pipe-to-soil potentials	(a) Monthly (b) Monthly to annually	12
12.	Internal corrosion	Visual observations corrosion coupons or other means to detect while in operation	As required	13
13.	Leakage survey	(a) Urban area survey (b) Rural area survey	(a) Annual (b) Every five years	14

1. Operating Pressure and Stress Level

(a) Maximum operating pressures are established by the Company for each pipeline based on specifications, condition of the main, and public exposure. A review is made annually of the established pressures and changes are made if required. In addition, an analysis of the operating pressures and stress levels is made in conjunction with population density surveys and any changes are reflected in the annual review.

(b) Pressure limiting stations, line regulators, relief devices, etc., are checked periodically for proper functioning and design. Preventive maintenance schedules are followed. The nature of the equipment and its importance establishes the period of functional observation, but the maximum interval is annually. Preventive maintenance is scheduled based on experience, but normally follows a one-year or two-year interval.

(c) The Company monitors the pressures on all its major high-pressure pipelines continuously. Remote data are telemetered to load centers or terminal stations. Alarm devices are used to assist the operators.

2. Change in Location Class (Population Density Surveys)

A population density survey is now being conducted on all mains operating at 50% of SMYS or over. The purpose of this survey is to determine the present population index on all of the higher stressed pipelines. In general, the conduct of a survey of this nature follows the procedure outlined below.

(a) A physical survey is made to determine the house count, as well as the character and extent of the development.

(b) Future development is estimated taking into consideration barriers to further density increase and closer encroachment to the pipeline right of way.

(c) A review is made of the design, construction, and testing procedures followed in original construction.

(d) The physical condition of the pipeline with respect to internal and external corrosion and leakage is ascertained from the records.

(e) The operating and maintenance history of the pipeline is reviewed.

(f) The hoop stress level of the pipeline is determined for its maximum operating pressure, for the area affected, taking into account pressure gradient.

The Company reviews the results of the above study to determine the proper action to take. This action depends on the pipe design and pipe condition, as well as the population density. Consideration may include, but is not limited to, the following courses of action:

(a) Take no action because pipe condition is good and stress level is not excessive for the present exposure.

(b) Relocate, recondition, or replace pipe to remove substandard pipe condition and reduce exposure.

(c) Lower operating pressure.

(d) Requalify by test. It is our opinion, based on industry research and experience, that a pipeline which can withstand proof-testing is safe for continued operation at its design pressure even though there has been some increase in population density. In addition, actual exposure rather than political boundaries alone is considered for determination of location class for operating facilities.

3. Surrounding Developments

Initial knowledge of surrounding developments comes from periodic patrolling together with local crew awareness of community planning, cooperation by developers and interagency exchange of information.

Pipeline Patrolling

Pipelines in this system are patrolled by air, car, or on foot periodically at intervals commensurate with exposure. In addition to observing for leakage and construction activity, the pipeline right of way and adjacent lands are surveyed for development that may affect public exposure, land surface changes and earth movement due to slides, earthquakes, floods, etc. In addition to scheduled patrolling outlined below, much of our pipeline system is frequently patrolled incidental to other field work.

Air Patrol

(a) All major pipelines affecting the system as a whole are observed weekly.

(b) Most of the other major pipelines transporting gas to a major load center are observed weekly, biweekly, or monthly--depending upon importance of supply, exposure, etc.

Car Patrol

Car patrols are made periodically, varying from weekly to semi-annually, and for special surveys as required.

(a) As a follow-up on air patrol reports.

(b) To cover known or suspected extraordinary exposure.

(c) For pipelines not patrolled by air and where an effective car patrol can be made.

Foot Patrols

Foot patrols are used for special surveys and for general patrolling. Patrolling in built-up areas is scheduled in each area commensurate with the exposure and will vary from weekly to semi-annually.

4. Surface Changes

Surface changes along right of way are observed during periodic patrolling and special patrols following heavy storms, floods, major earthquakes, etc. See patrolling section under Item 3, Surrounding Developments section. Remedial action is taken as necessary after further field investigation and evaluation. Also see items: (5) Earth Movement, (6) Cover Depth, and (7) Water Table.

5. Earth Movements

Potential areas are observed where earth movement could be expected, especially during periodic patrols and special patrols are made during periods when sliding may be more likely. Corrective action is taken to protect facilities in the event further earth movement takes place or to mitigate the slide mechanism.

Known fault areas are also observed and reference markers have been installed where past heavy earth displacement has taken place.

Earth movement for construction projects is determined before construction begins or as soon thereafter as possible by periodic or special patrolling, local awareness of area development and interagency exchange of information. See also: (3) Surrounding Developments (Patrolling), (6) Cover Depth, and (8) Work by Others.

6. Cover Depth

Land Leveling and Cultivation

In areas under cultivation or where cultivation is likely to take place, new facilities are installed to a minimum depth of 42". Many of the older facilities, however, are at a 24" depth. When a patrol report or landowner contact indicates land leveling will take place or new fields are being brought under cultivation, the depth of cover is determined for the area affected. Through negotiations with the land user, one or more of the following solutions are placed into effect:

(a) Lower pipeline

(b) Exclude pipeline right of way from leveling operation

(c) Revise leveling plan to continue adequate cover over pipeline

(d) Take other action that will assure protection of pipeline during leveling operations and subsequent cultivation work performed by the land user.

See also: (5) Earth Movement and (8) Work by Others.

7. Water Table

When changes in land use adjacent to pipelines are observed due to dam construction, rice farming, or other activity that will result in continuous or periodic flooding, a survey is made to determine the nature and effect of the exposure. Consideration is given to electrically insulating the pipe in the flooded area and adding local cathodic protection, installing weights to counteract buoyancy, sectionalizing by installing additional valves, recondition or replace with heavier wall pipe, etc., depending upon the nature and extent of the exposure, the original design and condition of the pipeline, and protective coating system.

Special surveillance is given to pipelines traversing marshy areas, waterways, and drain ditches that carry run-off to determine problem areas before serious stress conditions develop. Such corrective action, as necessary, is taken.

8. Work by Others

Protection from Mechanical Damage by Others

(a) Pipelines in rural areas are marked by readily identifiable markers in the field at road crossings, canals, rivers, angle points, and at such other locations deemed necessary so that the route of the pipeline is delineated in the field.

(b) Patrolling keeps the pipeline crews abreast of construction activities including road building, land leveling, pipeline or tower line installations and any other activity that could result in damage to pipeline facilities.

(c) Inquiry from outside agencies planning to construct in the area of our facilities is coordinated so that such information can be made available to all departments of our Company having underground facilities regardless of the point of inquiry. Similarly, construction work by other departments within the Company is also coordinated so that proper internal action can be prescribed and followed up.

(d) A Company inspector is assigned to outside construction projects where there may be damage to our pipelines. The inspector accurately locates the pipeline in the field and the facility is "day-lighted" if necessary.

(e) The Company takes other appropriate action deemed necessary to protect its facilities from damage by others working in the vicinity of its pipelines.

See also: (4) Surface Changes, (5) Earth Movements, (6) Cover Depth, and (7) Water Table.

9. External Corrosion

Whenever pipelines are uncovered for any purpose, a survey is made of the exposed wrapping and pipe condition. The majority of the pipeline system is under cathodic protection and the levels of protection are periodically observed for adequacy. Pipelines or sections of pipelines not under protection are or have been surveyed for cathodic protection. Additional areas will be placed under protection within the near future. Protection on pipelines where the coating is providing excellent insulation will be installed as necessary at a later date. Where the coating is very poor and active corrosion is evidenced, consideration is given to reconditioning.

See also: (11) Cathodic Protection.

10. Pipe Coating

Other than visual examination of coating condition from time to time, when portions of a pipeline are uncovered, the Company does not have a periodic program of checking coatings. Some special surveys have been made to determine protective coating condition in areas where past history has indicated a need. This has been accomplished by Pearson Type instrument survey and by visual inspection. Cathodic protection with periodic reviews of protective levels is relied on in addition to coatings to inhibit external corrosion. These reviews, as well as surveys for cathodic protection installation although indirect, prove a good method of determining the effectiveness of protective coatings. Information from above surveys together with corrosion and leakage history of the pipelines or sections of the pipelines are used in determining the additional protection or other action required in a given situation. See also: (9) External Corrosion and (11) Cathodic Protection.

11. Cathodic Protection

External Corrosion

It is the intent of this Company to survey pipelines for cathodic protection within one year after construction or when the pipeline environment has become stabilized. Normally, these pipelines are placed under cathodic protection within three to five years after installation. Most of the major older lines have also been wholly or partially placed under protection. Some bare or essentially bare mains have also been placed under cathodic protection. Reconditioning of old pipelines has been performed where protective coating has deteriorated to the extent that cathodic protection cannot be kept at a satisfactory level within economic means or where leakage has been extensive.

The effectiveness of the protection systems is observed approximately monthly by noting the rectifier voltage and current outputs and by a pipe-to-soil survey at intervals of approximately one year. A direct measurement of effectiveness is obtained in some areas where pipe-to-soil potentials are taken at intervals more often than once a year (i.e. monthly, bi-monthly or quarterly).

As required, these field surveys are reviewed by the Company engineers and corrective action is taken to assure proper protection levels.

Joint inter-company committees have been set up in several areas in California to exchange information on proposed rectifier installation plans and provide mutual assistance to avoid or mitigate interference.

12. Internal Corrosion

Whenever pipelines are cut for any reason, a visual inspection is made of the exposed internal surface for evidence of internal corrosion. Steps are taken to eliminate the entry of water, corrosive agents, and other detrimental effluent into our pipeline system. Periodic checks are made on the effectiveness of our control program.

Dehydration plants are installed at one or more locations at the periphery of major California gas field collection systems. Dew points are maintained at a level which assures that the water content in the gas is well below saturation at temperatures and pressures that will be encountered in the downstream pipeline systems. Removal of free liquid from smaller isolated collection systems is accomplished by use of separators and drips. It is the intention of the Company to continue to develop its program of liquid removal so that all gas entering the transporting pipelines has an acceptable water content. In addition, a program of inhibiting within the collection systems upstream of the dehydration plants has begun. Well systems which are known to produce water in liquid form, or other detrimental effluent, are shut in until corrective action is taken by the producer. Surveys, including corrosion coupon placement and some sampling of wall thickness deterioration by electronic measurements, are now under way to place this inhibitor program in effect in the fields where trouble has been experienced or is anticipated.

Gas received as a by-product from oil well operation is observed by periodic sampling to determine the sulfur content. Sources producing at levels above acceptable limits are shut in, pending correction of the condition by the producer.

The sulfur content of out-of-state gas is continuously sampled.

13. Leakage Surveys

It is the practice of this Company to periodically survey its facilities for leakage.

Annually

In areas where any of the following conditions exist:

(a) The surface over the pipelines is paved to the building wall and building frontages (one or more structures) exceed 150 feet.

(b) The pipeline is in proximity of a building at a school, hospital, or place of public assembly.

(c) The pipeline has a poor leakage history.

(d) Unusually corrosive conditions exist.

(e) The pipeline is operated in an urban area.

(f) A pipeline carries unodorized gas.

Every Five Years

Other pipelines not included in the annual survey are surveyed for leakage as often as experience indicates, but at least once every five years.

Definitions

(a) Urban Area - An urban area is defined as one where the number of buildings on either side of the main exceeds 10 per 1000 feet.

(b) Rural Area - A rural area is one where the number of buildings is 10 or less per 1000 feet along the main.

Method of Survey

(a) Rural areas by vegetation observation or by use of a combustible gas indicator or other methane indicator.

(b) Urban areas by manhole leak survey, bar leak survey, or other survey methods employing a methane indicator.

(c) Private rights of way, in general, are surveyed by the "vegetation method". Patrolling of pipelines includes observation for leakage indication. In addition, in desert areas where conditions permit the use of a tractor, a plow-type survey is made (4-5 year intervals).

(d) Near schools, hospitals, and places of public assembly, a gas-indicator type survey is made over pipelines and along services from the pipeline to the building.

Records

All records of leakage surveys and leak repairs are filed permanently for the life of the pipeline. Much of this record is on air patrol reports, shutdown reports, and crew patrol reports for the major pipelines operating in rural areas.