Prepared by [redacted]

PROCEDURES FOR PURGING GAS FACILITIES

A-38

Department	Gas System Maintenance and Technical Support	**Section** System Integrity	**Date** 04 10 03
Approved by	[redacted]	**Approved by**	[redacted]

Rev #00 This document replaces PG&E Drawing 086628 For a description of the changes see Page 4

This document also appears in the following manuals

- *Gas Applicant Design Manual*
- *Gas Distribution Operations Manual*

Purpose and Scope

This gas standard contains procedures for purging air or natural gas from the transmission and distribution facilities The procedures describe how to purge the facilities how to determine when the purge is completed and what to consider before and during purging Procedures with examples of various purging techniques are included in Attachment A on Page 5 and Attachment B on Page 8

Acronyms

AGA	American Gas Association
cf	cubic feet
cfm	cubic feet per minute
CGI	combustible gas indicator
ID	inside diameter
psig	pounds per square inch gauge

General Information

1 Purging is required when

- A New or existing facilities are brought into service
- B Existing facilities are temporarily taken out of service and the removal of natural gas is necessary
- C Lines are abandoned Section 192 727 of General Order 112 states that abandoned facilities do not have to be purged when the volume of gas is so small that there is no potential for hazard Company policy requires that all sections of abandoned main be purged (For abandonment procedures refer to Standard Practice 463 2)

2 Except for simple single line piping systems a written plan for purging should be prepared and reviewed with the Company employees involved before beginning work The following items should be discussed

- A The extent of the facility to be purged and points of isolation
- B The purging medium to be used
- C The sequence of operation and assignment of employees
- D Safe working practices (especially around plastic pipe)
- E Means of communication during the purge
- F Means of determining the end of the purge at vent points
- G Procedures for handling emergencies such as gas ignition
- H Notification of governmental authorities if required (police fire air pollution noise abatement)
- I Back up provisions in case of unanticipated occurrences (i e compressor failure insufficient supply of purging gas etc)

3. When purging, the air or gas to be removed must be removed from all sections of the piping system. Branches and services must be individually purged. The straight through section should be purged first, then each lateral.
4. Injection Rate
   A. The purging medium should be injected into a main or pipeline at a high enough velocity to create a minimum lineal flow of 100 feet/minute. This flow rate will maintain a turbulent interface, thereby minimizing the mixing of gases and the possibility of the gases stratifying.
   B. When purging air from pipelines, maintain the minimum inlet control pressure specified in Table 1 in Attachment C on Page 10 whenever possible. This pressure will create a flow velocity which greatly exceeds the 100 feet/minute requirement, maximizes turbulence, and shortens purge durations.
   C. For purging air in other than low pressure systems, a cracked main line valve will create a minimum lineal velocity that exceeds 100 feet/minute within the pipeline.
   D. When purging low pressure systems, the available injection pressure and the physical characteristics must be examined to determine if the 100 feet/minute velocity can be achieved.
5. It is essential that vented natural gas and air/gas mixtures be diffused into the air without hazard to Company employees, the general public, or property. Valved vertical vent stacks should be used to keep the natural gas out of the work area and to blow it in a safe direction. Buildings, overhead lines, aircraft landing patterns, and other obstructions or sources of ignition should be considered when determining the location for venting the gas. (See Section 13 of the *Code of Safe Practices*).
6. Consider public relations with regard to noise and odor, as well as to any applicable state and local noise and air pollution regulations. Such considerations may include the notification of residents in close proximity to the blow-down operations, the use of noise suppressors, reduction of line pressure, reduced rate of venting, etc.
7. Once the purging has started, it must be continued until the purge is complete.

Purging Air Out of Facilities To Be Placed in Service

8. Refer to Attachment A on Page 5 for procedures and examples of purging air from services, mains, and pipelines.
9. Purging Services

   Service installations may be purged by opening the riser valve after the service tee has been tapped. Care must be taken to blow gas away from structures by connecting a meter bend or street ell to the riser valve and pointing the stream of gas in a safe direction. The valve should be opened slowly to the full open position; no person or object should be in the exhaust stream area. The operator shall hold the wrench and keep it in contact with the valve at all times. Care must also be taken that no source of ignition is present in the area. A sufficient amount of gas should be blown to atmosphere to ensure that all air is removed from the line. Service lines should be purged immediately after the service tee has been tapped and gas is in the service line (refer to Procedure 1 in Attachment A on Page 5 for an example).
10. Purging of Pipelines (10" Diameter and Smaller)

    Small diameter mains should be purged of air by injecting gas at high enough velocities to create a minimum lineal flow of 100 feet/minute within the pipeline (refer to Procedure 2 in Attachment A on Page 6, for an example of the calculations). If this velocity cannot be met, a slug of nitrogen between the air and gas is required (refer to the "Purging With Nitrogen" section on Page 3).
11. Purging Pipelines (Larger Than 10" Diameter)
    A. For mains greater than 10" in diameter, it is desirable to separate the air from the natural gas with a slug of nitrogen. This technique minimizes mixing that would otherwise be accelerated due to the greater cross-sectional area of the large diameter pipe. This technique also reduces required purge time (refer to Procedure 3 in Attachment A on Page 7 for an example of the calculations). The "Purging With Nitrogen"section on Page 3 describes purging with a slug of nitrogen.
    B. When the use of nitrogen is impractical, pipelines with a diameter greater than 10" are purged of air by injecting natural gas into the line at high velocities (refer to Procedure 2 in Attachment A on Page 6 for an example of the calculations).

12. The following methods can be used to determine the absence of air:

    A. A portable CGI (see Gas Standard M-53, "Portable Combustible Gas Indicator Specification") set on the percent gas scale. The reading must indicate 100% gas.

    B. A small amount of the vented gas can be blown through a hose into a bucket of soapy water. Move the bucket to a safe location, stand upwind, and ignite the gas contained in the bubbles. If the gas burns with an orange or yellow flame, the purge is complete. If the gas burns with a blue flame then there is air present and further purging is necessary.

Purging Natural Gas Out of Existing Facilities

13. Lines may be purged of natural gas using a Lamb air mover or by injecting a supply of air. [1]

    A. Lamb air movers are recommended to be used when purging natural gas from lines larger than 8" in diameter. They are less effective for use in purging smaller lines. See Gas Standard A-38.1, "Installation and Operation of Air Movers" for information on the use of air movers.

    B. When natural gas is purged by injecting air into lines less than 10" in diameter, it is unnecessary to separate the air and natural gas with a nitrogen slug. See Procedure 1 in Attachment B on Page 8 for additional information.

    C. When natural gas is purged by injecting air into lines greater than 10" in diameter, it is recommended to separate the natural gas from the air with a slug of nitrogen whenever practical. The nitrogen slug minimizes the mixing of flammable gas with air that would otherwise increase significantly in large diameter pipes due to their greater cross-sectional area (see the "Purging With Nitrogen" section below and Procedure 2 in Attachment B on Page 9 for information on purging with nitrogen.).

[1] A standard Company air compressor is rated at 150 cfm. It will provide the minimum required flow rate for lines up to 16" in diameter. Air compressors with 250 cfm and 650 cfm capabilities can also be obtained. Attachment C on Page 10 gives flow-pressure relationships for air through flexible hoses.

14. The disposal of large volumes of natural gas into the atmosphere should be minimized as far as practical by transferring as much of the gas as possible to adjacent systems.

15. The following methods can be used to determine the absence of natural gas:

    A. Use a CGI.

    B. Blow a small portion of the vented gas through soapy water, and, in a safe location, attempt to ignite the gas contained in the bubbles. It the gas ignites, continue the purge.

16. Working on Existing Pipelines Which Have Been Purged

    When it is necessary to perform work on an existing pipeline which has been purged in accordance with Item 13, take precautions to verify that a combustible mixture has not developed inside the pipeline due to leakage from a segment of pipeline remaining in service, or from the release of gas from residual liquids in the pipeline. Special care must be taken when performing cutting or welding on such a line. Each segment of purged or cut off line is to be rechecked (using an appropriate CGI) and cleared of any combustible gas by following the procedure in Items 13A and 13B above. The air mover installation or the injection of air must be at the extreme end(s) of the pipeline segment. The degree of isolation should be determined by observing any pressure increases within the purged space with all vents closed and by monitoring for the presence of combustible gas using the method outlined in Item 15.

Purging With Nitrogen

17. Purging With a Slug of Nitrogen

    A. In order to prevent explosive mixtures when purging long, large diameter lines, a slug of nitrogen can be injected into line before injecting the purging medium. The nitrogen will mix with the air and the gas, but as long as a sufficient amount of nitrogen is injected, an explosive mixture will not occur. Refer to Procedure 3 in Attachment A on Page 7 and Procedure 2 in Attachment B on Page 9 for purging procedures using a slug of nitrogen.

    B. Consider the following additional facts when purging with a slug of nitrogen:

        (1) Purge velocity is extremely important. Avoid a slow purge. Velocities less than 100 feet/minute in large diameter pipe allow stratification between heavier and lighter gases.

(2) The amount of nitrogen necessary to purge short lengths (500' or less) of large diameter pipe satisfactorily at practical purge velocities exceeds the volume of the line.

(3) Changes in horizontal or vertical direction because of elbows or return bends do not destroy the nitrogen slug.

(4) A temperature variation in the order of 20°F has no effect on mixing of the nitrogen slug with combustible gas or air.

(5) The same amount of nitrogen, may be used if either combustible gas or air is being purged from a line.

(6) Turbulence, even if it causes mixing, is much less the cause of deterioration of the slug than is stratification.

(7) A delay of approximately 3 minutes between adding the nitrogen and injecting the air or combustible gas will destroy the slug.

18. Purging With 100% Nitrogen

A. When it is suspected that hydrate formations are in the pipeline, natural gas must be purged with 100% nitrogen. After the natural gas has been purged, the nitrogen should be left in the line until all of the hydrates have sublimated. Hydrate sublimation can be accelerated by injecting methanol.

B. When it is suspected that natural gas may be entrained in liquids in the pipeline, 100% nitrogen should also be considered. The exclusion of air in the purging medium prevents the formation of an explosive mixture subsequent to the passage of the purge gas through the pipeline.

C. Consideration should also be given to pigging a line to remove entrained liquids if they are known to be present.

Note: One cylinder of nitrogen at 2,200 psig contains 220 cf of gas at atmospheric pressure. Use the following formula to calculate how much nitrogen remains in a partially used cylinder:

$$V = \frac{P + 14.7}{2214.7} \times 220$$

where,

V = volume of remaining gas (cf)
P = pressure in cylinder (psig)

Revision Notes

Revision 00 has the following changes:

1. Converted PG&E Drawing 086628 to Gas Standard A-38.
2. This document is part of Change 52.

Attachment A

Gas System Maintenance and Technical Support
Rev 02/03

Purging Air From Services and Pipelines

Procedure 1 Purging Air From Services Using Natural Gas [1]

Example 1 Replace air with natural gas in newly installed services

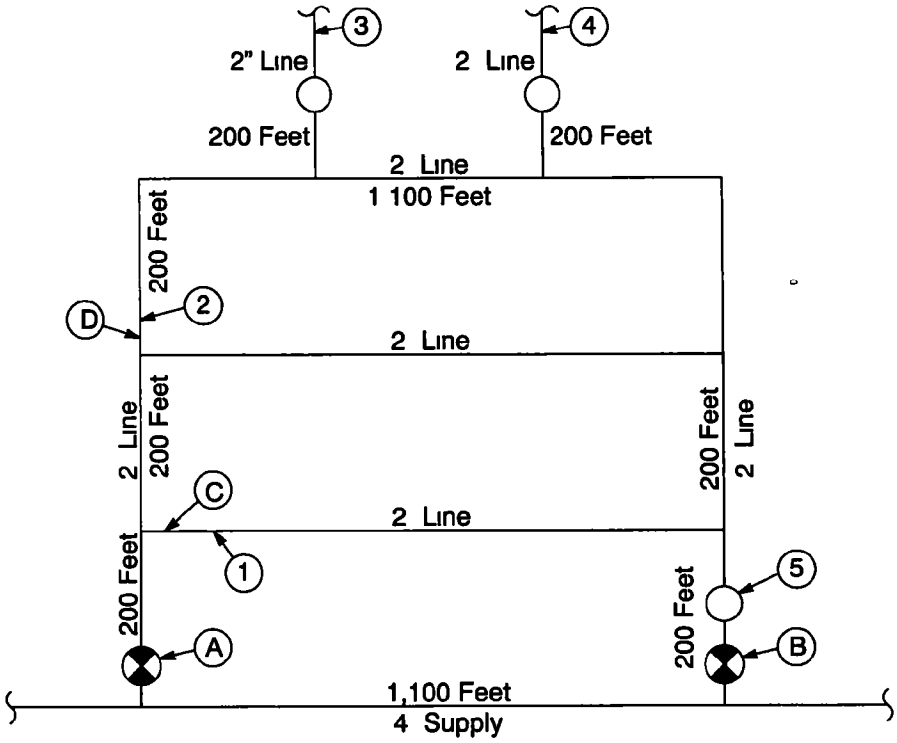

Figure 1
Distribution Main System for New Subdivision

Procedure

1 Close off 2 lines at C and D isolating by pinch fitting valve or other means
2 Open vent at 1
3 Open valve A Leave valve B closed
4 Close vent at 1 when 100% natural gas is detected
5 Open vent at 2 Close when 100% natural gas is detected
6 Open vent at 3 Close when 100% natural gas is detected
7 Open vent at 4 Close when 100% natural gas is detected
8 Open vent at 5 Close when 100% natural gas is detected
9 Open isolation points C and D
10 Open valve B
11 Purge all service lines installed Stub services do not have to be purged

[1] Purging Principles and Practices AGA Catalog Number XK0775 1975

Attachment A, continued

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Procedure 2: Purging Air From Pipelines Using Natural Gas Without a Nitrogen Slug

This procedure is typically used for purging air out of pipelines 10" in diameter and less. It should only be used when purging pipelines greater than 10" in diameter when purging with a nitrogen slug is impractical. As the pipe diameter increases, the length of the flammable mixture increases and becomes an important consideration during purging operations.

Example 2: Replace air with natural gas in a 6,000 foot segment of 6" pipe. Nitrogen purge is not required. Blowoff size is 2".

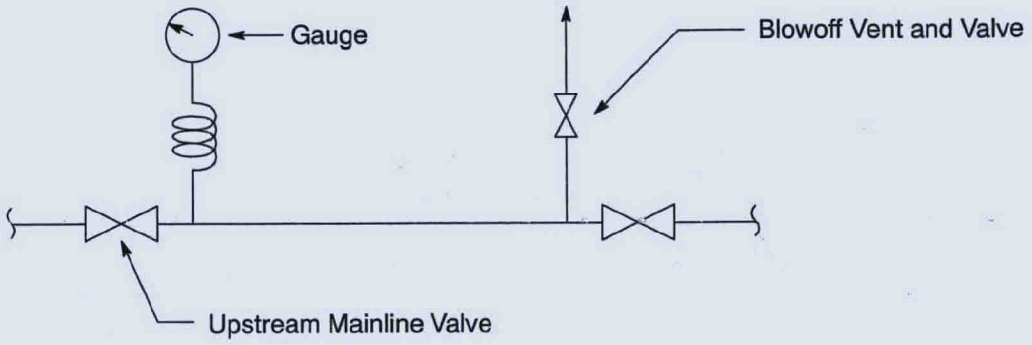

Figure 2
Purging Air Without Nitrogen

Procedure:

1. Determine the blowoff valve size from Table 1 in Attachment C on Page 10, using the line size and length of pipeline to be purged (e.g., 2" blowoff valve, 6" pipeline, 6,000' section).
2. Determine the minimum inlet control pressure from Table 1 in Attachment C on Page 10 (22.4 psig). Verify that the upstream pressure is equal to or greater than the inlet control pressure. If it is not, determine if adequate pressure exists to ensure a flow velocity of 100 feet/minute. If this velocity cannot be met, a slug of nitrogen is required between the air and gas (see Example 3 on Page 7, Steps 3 through 15).
3. On the section to be purged and near the upstream mainline valve, install a pressure gauge which is accurate and readable within 1 psi, so that the inlet pressure can be observed. (The gauge should be connected through several feet of flexible tubing to minimize vibration).
4. Open the blowoff valve at the downstream end of the section to be purged. The downstream blowoff valves should always be in the fully open position.
5. Begin purging by cracking the upstream mainline valve to quickly bring the inlet pressure to the minimum inlet control pressure (22.4 psig) or greater. When the minimum inlet control pressure cannot be obtained, purge at highest feasible inlet pressure.
6. Monitor the blowoff gas until a CGI reads essentially 100% natural gas. Close the mainline valve to stop injection. The use of a CGI provides a means of analyzing the gas/air mixture throughout the purging operation. If the pressure at the gauge is maintained at the minimum inlet control pressure, the time it takes for natural gas to reach the blowoff location should be approximately 2 minutes for every mile of pipeline being purged.
7. Close the blowoff valve and return the pipe to service.

***Attachment A,** continued*

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Procedure 3: Purging Air From Pipelines Greater Than 10" in Diameter Using a Nitrogen Slug

Example 3: Replace air with natural gas in a newly installed segment of 5,000 feet of 16" pipe using a nitrogen slug purge to prevent forming a flammable mixture.

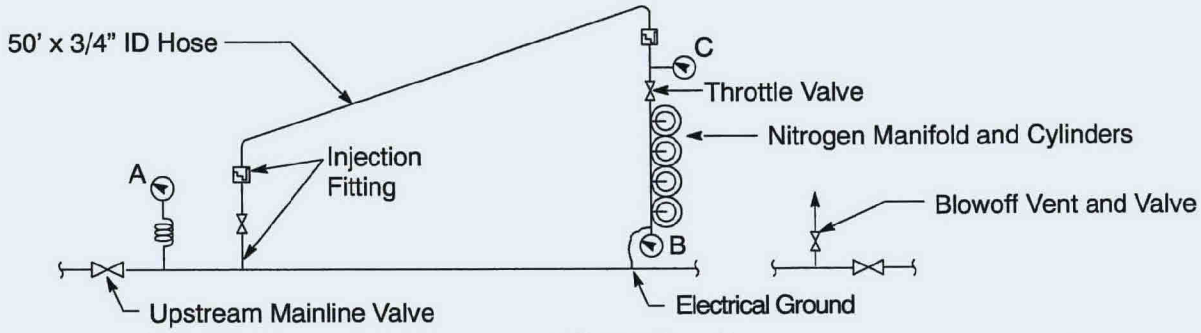

Figure 3
Purging Air With Nitrogen

Procedure:

1. Determine the blowoff size from Table 1 in Attachment C on Page 10 using the line size and length of pipeline to be purged (e.g., 6" blowoff valve and vent pipe).
2. Determine the minimum inlet control pressure from Table 1 in Attachment C on Page 10 (11 psig). Verify that the upstream pressure is equal to or greater than the inlet control pressure. If it is not, determine if adequate pressure exists to ensure a flow velocity of 100 feet/minute. If this velocity cannot be met, use a slug velocity of 100 feet/minute and double the amount of nitrogen required by Table 2 in Attachment C on Page 11.
3. From Table 2 in Attachment C on Page 11, select a slug velocity (100 feet/minute, for example) and determine the volume of nitrogen required to maintain that velocity. (790 cubic feet or four cylinders of nitrogen will be required.)
4. Determine the injection rate from Table 2 in Attachment C on Page 11 (130 cfm).
5. Determine the minimum allowable nitrogen injection pressure from Table 3 in Attachment C on Page 13 using the injection rate for the applicable size and length of hose (49 psig for 3/4" ID 50' hose).
6. On the section to be purged and near the upstream mainline valve, install a pressure gauge which is accurate and readable within 1 psi, so that inlet pressure can be observed. (The gauge should be connected through several feet of flexible tubing to minimize vibration.)
7. Install a nitrogen injection fitting near the upstream mainline valve.
8. Install a nitrogen injection manifold as shown above. Close all manifold valves.
9. Open the blowdown valve near the downstream mainline valve.
10. Blow down the line to atmospheric pressure and leave the vent open.
11. Open the cylinder valves and pressurize the manifold.
12. Open the injection fitting valve.
13. Crack the throttle valve until Gauge C reads above the minimum required nitrogen injection pressure.
14. When the required volume of nitrogen has been injected and the injection pressure cannot be maintained, close the throttle valve, then close the injection fitting valve.
15. Immediately crack open the upstream mainline valve until Gauge A reads the minimum inlet control pressure (11 psig) or greater. If the minimum inlet control pressure cannot be obtained, purge at highest feasible inlet pressure.
16. Monitor the blowoff gas until the CGI reads essentially 100% natural gas. Close the mainline valve to stop the injection. The use of a CGI provides a means of analyzing the gas/air mixture throughout the purging operations. If the pressure at Gauge A is maintained at the minimum inlet control pressure, the time it takes for natural gas to reach the blowoff location should be approximately 2 minutes for every mile of pipeline being purged.
17. Close the blowoff valve and return the pipe to service.

Attachment B

Gas System Maintenance and Technical Support
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Purging Natural Gas From Pipelines

Procedure 1 Purging Natural Gas From Pipelines Using Air Without a Nitrogen Slug

This procedure is typically used for purging pipelines 10 in diameter and less It can be used on pipelines larger than 10 in diameter but should only be used if Lamb air movers are not available and using a nitrogen slug is impractical

Example 4 Replace the natural gas with air in a section of 16 pipe 5 000 feet long

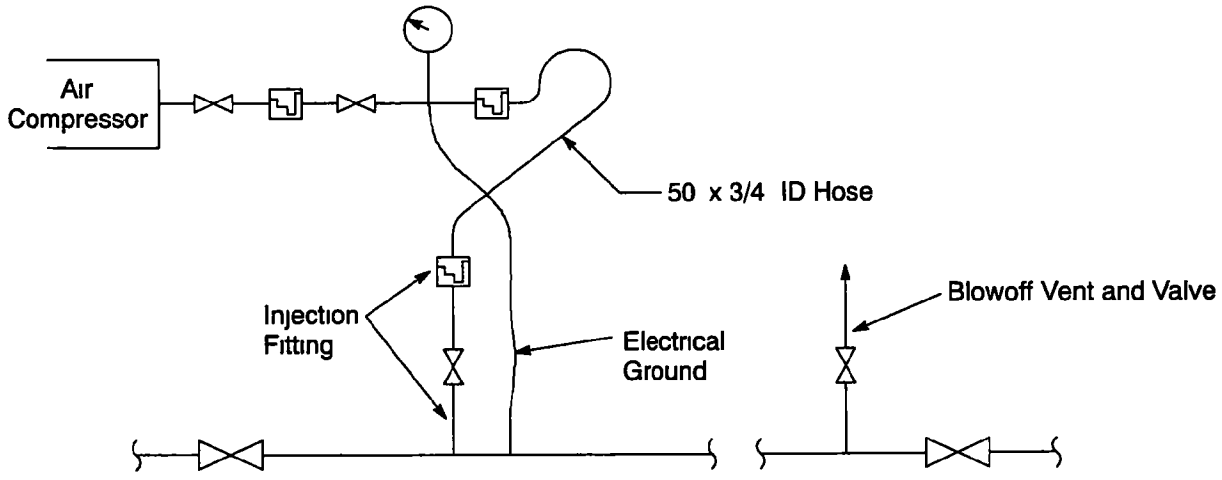

Figure 1
Purging Gas Without Nitrogen

Procedure

1 Determine the blowoff valve size and vent piping diameter from Table 1 in Attachment C on Page 10 (e g 6" blowoff valve and vent pipe)
2 Determine the injection rate required for a minimum slug velocity of 100 feet/minute for a 16 pipe Table 2 in Attachment C on Page 11 shows an injection rate of 130 cfm is required If a 150 cfm compressor is used an injection rate of about 120 feet/minute is selected to make maximum use of the 150 cfm compressor
3 Determine the air injection pressure Table 3 in Attachment C on Page 13 shows that the air injection pressure for 150 cfm through a 3/4 ID 50 hose is 59 psig (interpolated)
4 Install a connection to inject air
5 Open the blowoff valve near the downstream mainline valve
6 Blow down the line to atmospheric pressure and leave the vent open
7 Inject air Maintain at least 59 psig on the gauge at the inlet to air hose
8 Stop the injection of air when no natural gas can be detected Refer to Item 15 on Page 3 for methods to determine the absence of natural gas
9 Positive steps shall be taken before working on a section of pipeline which has been purged to isolate the purged section from any source of leakage (refer to Item 16 on Page 3) Isolation of the section may be accomplished by flooding the section inserting blanks or approved stoppers or by actual detachment Actual detachment is the preferred method

Attachment B, continued

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Procedure 2 Purging Natural Gas With Air From Pipelines Greater Than 10 ' In Diameter Using Air With a Nitrogen Slug

Example 5 Replace the natural gas with air in a section of 16" pipe 5 000 feet long using a nitrogen slug to prevent forming a flammable mixture

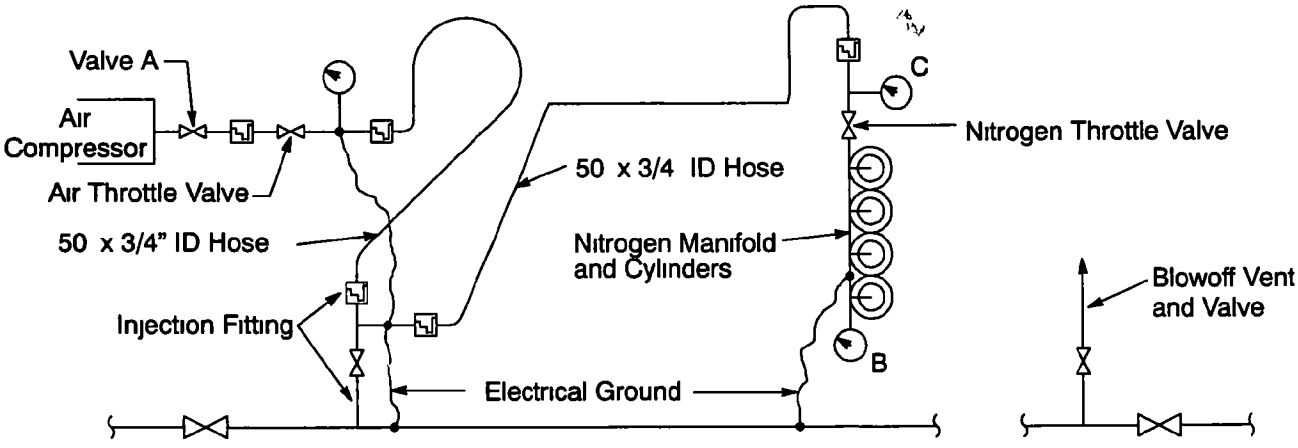

Figure 2
Purging Gas With Nitrogen

Procedure

1 Determine the blowoff size from Table 1 in Attachment C on Page 10 using the line size and length of pipeline to be purged (e g 6" blowoff valve and vent pipe)
2 From Table 2 in Attachment C on Page 11 select a slug velocity (100 feet/minute for example) and determine the volume of nitrogen required to maintain that velocity 790 cubic feet (or four standard cylinders at 2 200 psig) of nitrogen will be required if a slug velocity of 100 feet/minute is selected The corresponding injection rate of 130 cfm would require two 105 cfm air compressors A purge velocity of 150 feet/minute (200 cfm injection rate) is selected in order to make maximum use of the two 105 cfm compressors Only three cylinders of nitrogen will be needed to provide the 590 cf required for the higher purge velocity
3 Determine the nitrogen and air injection pressure from Table 3 in Attachment C on Page 13 using the injection rate for the applicable size and length of hose (87 psig for 3/4" ID 50 hose)
4 Install a nitrogen manifold and air injection fitting as shown above Pressure gauges should be accurate and readable within 1 psi so that the inlet pressure can be observed
5 Open the blowoff valve near the downstream mainline valve
6 Blow down the line to atmospheric pressure and leave the vent stack open
7 Start the air compressor and open valve A The air throttle valve should be closed
8 Open the nitrogen cylinder valves and pressurize the manifold
9 Open the injection fitting valve
10 Crack open the nitrogen throttle valve until Gauge C reads above the minimum required injection pressure (87 psig)
11 When the required volume of nitrogen has been injected and the injection pressure cannot be maintained, close the nitrogen throttle valve
12 Immediately open the air throttle valve and maintain the minimum injection pressure (87 psig)
13 Monitor the blowoff gas until the purge is complete Refer to Item 15 on Page 3 Stop injection of air when no natural gas can be detected
14 Positive steps shall be taken before working on a section of pipeline which has been purged to isolate the purged section from any source of leakage (refer to Item 16 on Page 3) Isolation of the purged section may be accomplished by flooding the section inserting blanks or approved stoppers or by actual detachment Actual detachment is the preferred method

Attachment C

Gas System Maintenance and Technical Support
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Table 1 Minimum Inlet Control Pressures (psig) [1]

Blowoff Valve Size (Inches)	Line Size (Inches)	Length of Pipeline (Miles)														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
2	4	14	20	25	29	33	37	40	43	46	49	52	55	57	60	62
	6	22	25	28	30	32	35	37	39	41	43	44	46	48	50	51
4	6	8	12	16	19	22	24	27	29	32	34	36	38	40	41	43
	8	8	11	13	16	18	20	22	24	26	28	29	31	32	34	35
	10	11	13	15	17	18	20	21	23	24	25	26	28	29	30	31
	12	18	20	21	22	23	24	25	26	27	28	29	30	31	32	33
6	12	6	8	10	11	13	14	16	17	18	20	21	22	23	24	25
	16	11	12	13	14	15	16	17	18	19	20	21	22	23	24	24
	18	14	15	16	17	18	19	20	20	21	22	23	23	24	25	25
	20	21	22	23	23	24	25	25	26	26	27	28	28	29	29	30
	22	28	28	29	29	30	30	31	31	31	32	32	33	33	34	34
	24	36	36	36	37	37	37	38	38	39	39	39	40	40	40	41
8	20	9	10	11	12	13	13	14	15	16	17	17	18	19	20	20
	22	12	13	13	14	15	16	16	17	18	19	19	20	21	21	22
	24	16	17	18	18	19	19	20	21	21	22	22	23	23	24	24
10	24	8	9	10	11	12	12	13	14	15	15	16	17	17	18	19
	26	9	10	11	11	12	13	13	14	15	15	16	16	17	17	18
	30	15	15	16	16	17	17	18	18	19	19	20	20	20	21	21
12	34	13	13	14	14	15	15	15	16	16	17	17	18	18	18	19

[1] Information from Table 8-1 "Purging Principles and Practice", AGA CAT# XK0775, 1975

Notes:

1. Add 5 psig to the pressure shown in Table 1 if purging is done through a crossover arrangement and pressure is measured at the crossover valve.
2. Calculations are based on using a plug valve and 10' blowdown stack. For blowdown stack lengths greater than 10', or for valves with flow restriction greater than a plug valve, increase the inlet pressure to compensate for additional pressure losses.
3. If the blowoff valve size is smaller than indicated, increase the inlet pressure to compensate for the flow restriction.
4. The minimum inlet control pressure will maintain a purge velocity of approximately 1/2 mile/minute.
5. Interpolate as required.

Procedures for Purging Gas Facilities

Attachment C, continued

Gas System Maintenance and Technical Support
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Table 2 Nitrogen Purging Data for 4" – 36" Pipe [1]

Volume of Nitrogen Required for Inert Slug for Various Pipe Sizes and Injection Rates										
Pipe Size (In.)	Pipe Content (Cu. Ft./Ft.)	Slug Velocity (Ft/Min.)	Inject Rate (Cu. Ft/Min.)	Cubic Feet Nitrogen per Length of Pipeline						
				500'	1,000'	2,000'	5,000'	10,000'	20,000'	50,000'
4	0.09	100	10	10	10	20	20	20	30	30
6	0.22	100	20	30	30	30	40	50	70	100
8	0.37	100	40	70	70	80	90	120	160	200
10	0.58	100	60	130	140	150	180	230	280	350
12	0.83	100	80	280	300	340	370	400	430	470
		125	100	250	270	300	330	350	390	420
		150	120	210	240	260	290	310	340	370
		175	140	180	200	220	250	270	290	320
16	1.30	100	130	580	630	700	790	850	910	1,000
		125	160	500	550	620	700	750	810	890
		150	200	430	470	520	590	640	700	770
		175	230	350	400	450	530	570	610	660
18	1.67	125	210	740	850	970	1,100	1,200	1,300	1,400
		150	250	600	690	750	850	940	1,000	1,100
		175	290	500	550	620	700	770	820	920
		200	340	400	450	500	550	600	650	700
20	2.08	125	270	1,100	1,200	1,400	1,600	1,700	1,800	2,000
		150	320	830	930	1,100	1,200	1,300	1,400	1,600
		175	370	690	780	890	1,000	1,100	1,200	1,300
		200	420	540	600	680	770	830	890	980
22	2.51	125	320	1,500	1,700	1,900	2,200	2,400	2,600	2,900
		150	380	1,200	1,300	1,500	1,700	1,900	2,000	2,200
		175	440	960	1,100	1,200	1,400	1,500	1,600	1,900
		200	500	730	860	960	1,100	1,200	1,300	1,400
24	2.95	125	420	2,800	3,200	3,700	4,200	4,700	5,000	5,600
		150	530	2,200	2,500	2,800	3,200	3,500	3,800	4,300
26	3.51	175	620	1,800	2,000	2,300	2,600	2,900	3,100	3,400
		200	700	1,300	1,500	1,700	2,000	2,200	2,300	2,600
30	4.67	150	720	3,800	4,500	5,400	6,100	6,800	7,200	8,500
		175	830	3,100	3,600	4,200	5,000	5,500	6,100	6,800
		200	950	2,500	2,900	3,400	4,000	4,400	4,900	5,500
		225	1,070	1,900	2,200	2,600	3,100	3,500	3,600	4,200

[1] Information from Tables 8-4 and 8-5 "Purging Principles and Practice", AGA CAT# XK0775, 1975. See notes and example below.

2700/220 ⇒ 13 bottles

Attachment C, continued

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Table 2 Nitrogen Purging Data for 4" – 36" Pipe [1] continued

Volume of Nitrogen Required for Inert Slug for Various Pipe Sizes and Injection Rates										
Pipe Size (In)	Pipe Content (Cu Ft /Ft)	Slug Velocity (Ft/Min)	Inject Rate (Cu Ft/Min)	Cubic Feet Nitrogen per Length of Pipeline						
				500	1 000	2 000	5 000	10 000	20 000	50 000
34	5 97	150	900	6 300	7 500	8 600	10 000	12 000	13 000	14 000
		175	1 050	5 100	6 100	7 000	8,300	9 200	10 000	12 000
		200	1 200	4 100	4 800	5 600	6 600	7 300	8 100	9 100
		225	1 350	3 100	3 600	4 200	4 900	5 500	6 000	6 800
36	6 72	150	1 000	8 100	9 600	11 000	13 000	15 000	16 000	18 000
		175	1 170	6 600	7 800	9 000	11 000	12 000	13 000	15 000
		200	1 350	5 300	6 300	7 200	8 400	9 500	11 000	12 000
		225	1 520	4 100	4 800	5 500	6 400	7 100	7 800	8 800

[1] Information from Tables 8 4 and 8 5 Purging Principles and Practice AGA CAT# XK0775 1975 See notes and example below

Table 2 in Attachment C on Page 11 is based on providing a slug which will reduce to about 100 feet in length at the end of the purge To provide an additional safety factor some operators use double the amount of nitrogen indicated Doubling the volume of inert gas indicated in the table is recommended if carbon dioxide is used for slug purging at purge velocities less than 300 feet per minute

Use Table 3 in Attachment C on Page 13 to determine the method and pressures needed to obtain the desired injection rates

Note

One cylinder of nitrogen at 2 200 psi = 200 cf at atmospheric pressure

One cylinder of 50 pounds of liquid carbon dioxide = 400 cf of gas at atmospheric pressure

Example 6

Natural gas is to replace air in a 5,000 segment of 16 pipe Determine the quantity of nitrogen required and the upstream pressure requirement if 50 of 3/4 hose is used to connect the nitrogen manifold and injection fitting

1 From Table 2 in Attachment C on Page 11 790 cf (or four bottles) of nitrogen are required for a slug velocity of 100 feet/minute Note that less nitrogen is required if a higher slug velocity is selected

2 From Table 2 in Attachment C on Page 11 the required injection rate of 130 cfm is determined

3 From Table 3 in Attachment C on Page 13 a pressure of 49 psig is required for a 130 cfm injection rate through 50 of 3/4 ID hose

***Attachment C,** continued*

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Table 3 Measuring Injection Pressure Through Hoses and Orifices [1]

Determination of pressure required to inject various flow rates of nitrogen or air through various size hoses and orifices, which can be used as flow meters.

Desired Inject Rate (cfm)	Minimum Required Pressure Upstream of Hose or Orifice, psig								
	Each 3/4" ID 50' Hose	Each 1-1/4" ID 50' Hose	Each 2" ID 50' Hose	Orifices					
				3/8"	1/2"	5/8"	7/8"	1-1/8"	1-3/8"
10	3	–	–	–	–	–	–	–	–
20	5	–	–	–	–	–	–	–	–
40	11	–	–	–	–	–	–	–	–
60	18	–	–	25	–	–	–	–	–
80	26	–	–	39	–	–	–	–	–
100	35	6	–	52	23	–	–	–	–
120	44	8	–	65	30	–	–	–	–
130	49	9	–	72	34	–	–	–	–
140	54	10	–	78	38	–	–	–	–
160	64	12	–	92	46	24	–	–	–
200	87	17	–	118	60	33	–	–	–
230	103	21	–	–	73	41	–	–	–
270	–	26	4	–	86	49	–	–	–
320	Note: Multiple hoses may be used to increase the volume	33	5	–	105	61	24	–	–
370		40	7	–	–	73	30	–	–
420		46	8	–	–	86	36	–	–
430		47	9	–	–	88	38	–	–
530		60	12	–	–	112	50	25	–
620		75	16	–	–	–	61	32	–
700		87	19	–	–	–	71	38	20
720		89	20	–	–	–	73	39	21
830		105	26	–	–	–	87	43	27
900		–	30	–	–	–	95	53	30
950		–	31	–	–	–	101	56	33
1,000		–	32	–	–	–	–	60	35
1,050		–	33	–	–	–	–	64	38
1,070		–	34	–	–	–	–	65	39
1,170		–	38	–	–	–	–	73	44
1,200		–	39	–	–	–	–	75	45
1,350		–	45	–	–	–	–	86	53
1,520		–	52	–	–	–	–	99	61

[1] Information from Table 8-3 "Purging Principles and Practice", AGA, Cat. No. XK0775, 1975.