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Operations Engineering - System Planning and Analysis

QUESTAR Gas

Feeder Line 17 Replacement Size Analysis

	Initials	Date
System Analysis Performed by: Mike Platt	MP	4/2/12
Capitol Cost Estimates Performed by: Seth Plaizier	SPP	4/3/12
IHP System Analysis Perform by: Will Radford	WR	4-2-12
High Pressure Design Supervisor: Michael Gill	MLG	4.2.12
Director of Operations Engineering: Brad Hasty	BH	4.3.12
General Manager of Engineering: Kim Blair	CKB	4/5/12

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Prepared For: Kim Blair – General Manager Engineering
High Pressure System Analysis Performed by: Mike Platt
Intermediate High Pressure System Analysis Performed by: Will Radford
Capital Cost Estimates Completed by: Seth Plaizier

Scope

Feeder Line 17 (FL17) is scheduled for complete replacement by 2012 as part of the feeder line replacement program. This analysis considers the effects of installing different pipe sizes as well as alternate methods of gas delivery.

Figure 1: Schematic of Feeder Line 17

Replacement Route Options

Replacement in Place

An in place replacement of the existing FL17 was considered first. This original route poses many construction problems, as the line now traverses through a densely populated residential area where access is difficult. The expected additional costs due to construction issues make this option undesirable. Other options, subsequently considered, are hydraulically identical in the High Pressure (HP) system as well as maintain the Intermediate High Pressure (IHP) system requirements.

Reroute Option 1

Beginning at the same location as the current FL17 line, Reroute Option 1 runs south on Hill Field Road and then west on Antelope Drive. A short tap line will be installed to the Laytona 1 regulator station (LT0001). The total length of main line installed will be approximately 10,000 ft. as well as an additional 1,400 ft. of tap line. In order for this option to maintain system functionality, a section of the old FL17, from Layton 1 (LY0001) to Layton 6 (LY0006), will be converted to IHP. In addition, the following IHP regulator stations will be retired: LY0003, LY0006, and WA1409.

In order for the IHP system to sustain minimum required pressures during peak-day conditions, LT0001 must stay operational. Installing only a high pressure tap line from FL18 to LT0001 would be approximately half the distance of replacing FL-17 entirely. The remaining half is a relatively small section of feeder line to install that will provide two-way feed for a large number of customers. Not replacing the line would diminish the reliability of gas delivery on the IHP system.

Another requirement to sustain the IHP system without loss in delivered pressures in this option, necessitates 720 ft. of the recently installed 12-inch section of FL17 will be converted to IHP main. An additional 460 ft. of 12-inch steel main will be installed and will continue north another 3,500 ft. as 8-inch plastic. The total cost of the IHP improvements required, including a new regulator station to feed it (replacing LY0001), is approximately $524,000. While this is not a direct replacement of FL17, it will allow all functions of FL17 to be recovered at the minimum cost.

Reroute Option 2

The north half of this option is identical to Option 1. The second half will continue running south on Hill Field Road. The estimated total length of this option is about 11,900 ft. Option 2 also requires the same amount of tap line and sections of the old FL17 to be converted to IHP.

Reroute Option 3

This option moves the northern most point of FL17 to the intersection of Highway 193 and Fort Lane (shown in the appendix). The IHP conversion, previously mentioned, is required for this option to be viable. The total length of main needed for this option is approximately 13,800 ft.

System Analysis

Currently, FL17 is regulated down (250 psig from 471 psig) from northern system pressures for integrity purposes. This prevents the feeder line from delivering any substantial amount of gas from Sunset gate station to the rest of the Northern system. Once FL17 and some sections of Feeder Line 18 (FL18) are replaced, the HP regulator stations feeding FL17 and FL18 will be retired since regulation will no longer be required, thus increasing the opportunity to deliver more gas from Sunset station.

The analysis first focused on 2010 projected peak model loads and evaluated system pressures for a range of replacement pipe sizes. The pressure and flow results for this model are shown in Table 1 below. The current size of FL17 is 10-inch. Upstream, FL18 is 12-inch and 14-inch. These are represented on lines 4 and 5 of the table. It is not common industry practice to install 10-inch or 14-inch diameter pipe. Regardless of the pipe size chosen, the 2010 pressure results would be nearly identical, with a 5 psig swing from 10-inch to 24-inch at the critical pressure (GSL Minerals and Little Mountain Power Plant) in the Northern system. It is important to note that the system will operate within limits without any FL17 replacement in the short term shown on the first row.

Table 1: 2010 Peak Model Results

		Minimum Pressures						Station Flows				
Line	Size	Clinton	Nucor	Preston	Ogden	GSL Minerals	Syracuse	Hyrum	Sunset	Porter's Lane	Little Mountain	North Temple
1	0	205	266	266	238	194	245	85.19	66.00	107.78	168.42	24.85
2	6	206	266	267	239	195	246	85.08	66.00	107.78	168.53	24.84
3	10	208	267	267	241	197	246	84.91	66.00	107.78	168.68	24.82
4	12	208	267	267	242	198	247	84.86	66.00	107.78	168.73	24.82
5	14	209	267	267	243	199	247	84.84	66.00	107.78	168.75	24.82
6	16	209	267	267	243	200	248	84.82	66.00	107.78	168.78	24.83
7	20	210	267	267	244	201	248	84.82	66.00	107.78	168.82	24.88
8	24	211	267	268	245	202	249	84.84	66.00	107.78	168.85	24.93
		psig						*MMCFD*				

The main reason the pipe size is inconsequential in short term projections is because Sunset gate station is limited in flow. This is due to the capacity limitation of Main Line 3 (ML 3) on Questar Pipeline (QPC) which feeds Sunset. Current maximum delivery is approximately 70 MMCfd. There are no plans to increase the flow through Sunset Station, and therefore the size of FL17 in the short term will not likely affect system operation. Table 1A shows that even if regulation were removed, gas tends to flow north into FL17 from the rest of the system instead of feeding Sunset gas to the system.

Table 1A: 2010 Peak 24-inch Feeder Line 17 Flow

Case	Flow (MMCfd)
Average Unsteady-State	12 North
Steady-State	9 North

A longer term projection analysis was performed in order to determine the size effects as demand in the system grows. Table 2 displays the results of a 2020 projection based on the 2009 IRP general peak day growth rate. This projection assumes that an additional gate station has been installed in the Northern Region which will likely occur within the next ten years. The location of this assumed gate station is where Ruby pipeline will cross Feeder Line 23 (FL23). In this particular analysis, the pressure differences in pipe size had less impact than the 2010 projection.

Table 2: 2020 Peak Model Results

		Minimum Pressures						Station Flows				
Line	Size	Clinton	Nucor	Preston	Ogden	GSL Minerals	Syracuse	Hyrum	Sunset	Porter's Lane	Little Mountain	North Temple
1	0	188	343	339	237	191	241	55	66	108	182	31
2	10	195	343	339	243	198	245	54	66	108	179	31
3	12	195	343	339	243	198	245	54	66	108	179	31
4	14	196	343	339	244	199	246	54	66	108	179	31
5	16	196	343	339	244	200	246	54	66	108	179	31
6	20	197	343	339	245	201	247	54	66	108	179	31
7	24	198	343	339	246	202	247	54	66	108	179	31

One of the purposes for this particular feeder line is redundancy to the system. If Feeder Line 19 (FL19) were out of service during a peak event, FL17 and FL18 would be the only remaining pathway delivering gas from Sunset to the rest of the system. In addition, Hill Air Force Base (HAFB) is located along FL18, if Sunset and FL19 were out of service FL17 would be the only pathway to deliver gas from the rest of the system to this customer.

With redundancy as a key factor for the feeder line, an analysis was performed to check the pipe size effects with FL19 out of service. Table 3 shows the results of this analysis. While the pressures are lower without FL19, the differences in pressure results with different sizes of FL17 are minuscule. It is important to note that the 6-inch and 8-inch pipes do not allow Sunset to flow its maximum volume.

Table 3: 2010 Peak Model Results - Redundancy

		Minimum Pressures						Station Flows				
Line	Size	Clinton	Nucor	Preston	Ogden	GSL Minerals	Syracuse	Hyrum	Sunset	Porter's Lane	Little Mountain	North Temple
1	6	177	257	257	211	160	226	91.98	45.26	107.78	181.14	23.74
2	8	192	261	262	224	176	238	89.59	56.26	107.78	173.68	24.80
3	10	194	263	263	225	179	239	87.16	66.00	107.78	166.60	24.99
4	12	194	263	263	225	179	239	87.16	66.00	107.78	166.60	24.99
5	14	194	263	263	226	179	240	87.17	66.00	107.78	166.61	25.01
6	16	195	263	263	226	179	240	87.18	66.00	107.78	166.62	25.03
7	20	195	263	264	227	180	241	87.19	66.00	107.78	166.65	25.08
8	24	196	263	264	227	181	241	87.22	66.00	107.78	166.69	25.14
		psig						*MMCFD*				

A comparison of replacement of just FL17 and both FL17 and FL18 was made as it was a concern that arose during the analysis. Table 4 shows the differences in delivery pressures in both cases. The comparison was only completed with a 24-inch because this would show the most extreme differences if FL18 were the limiting factor. The results again show very small differences in pressure.

Table 4: 2010 Peak Model Results – Scope Comparison

	Minimum Pressures						Average Station Flows				
Size	Clinton	Nucor	Preston	Ogden	GSL Minerals	Syracuse	Hyrum	Sunset	Porter's Lane	Little Mountain	North Temple
24	211	267	268	245	202	249	85	66	108	169	25
24 (17&18)	213	268	268	246	204	250	85	66	108	169	25
	psig						*MMCFD*				

Capital Cost Estimates

In order to determine the best route solution, costs for each option were estimated. Table 6 shows the summary of these estimates. The estimates for Option 2 and Option 3 are solely based on the cost per foot determined in the Option 1 estimate. As these are similar routes, for comparison purposes, these estimates should be fairly accurate. No detailed cost estimates were completed for these two options. The lowest cost and shortest distance are given in Option 1, which is the route that was chosen for these reasons.

Table 6: Cost Estimate Comparison

Scenario	Length (ft.)	IHP Cost	HP Cost	Cost/ft.	Total Cost
Replacement in Place	18,992	$0	$6,095,000	$320.92	$6,095,000
Option 1	10,000	$524,000	$2,849,000	$284.90	$3,373,000
Option 2	11,900	$524,000	$3,390,310	$284.90	$3,914,310
Option 3	13,800	$524,000	$3,931,620	$284.90	$4,455,620

Note: All cost estimates shown are based upon a 12-inch diameter replacement.

A possible option for maintaining IHP pressures would be to install a tap line to the regulator station Layton 6 (LY0006), instead of the IHP solution described in the second paragraph of page 3.The minimum line size is a 6-inch diameter pipe, 2,400 ft. in length. The total cost of this option is estimated to be $810,000, or $286,000 more than improving the IHP system itself. In addition to cost differences, keeping this regulator station is not recommended because of poor lot placement and right of way constraints in future improvements should the station be the primary feed into the area.

Conclusions

The optimal replacement diameter for FL17 is 12-inch. 12-inch is a standard diameter and will provide nearly identical system pressure as 20-inch. While a 10-inch replacement would provide similar system benefit, it is not considered a standard diameter, and would likely increase overall cost due to availability of pipeline components.12-inch pipe will allow Sunset gate station to flow a maximum without significant additional pressure drop and will cost much less than the next considered option of a 16-inch replacement. Standard pipe sizes less than 12-inch do not have enough take away capacity for sufficient redundancy.

The two main purposes that FL17 and FL18 satisfy are redundancy and providing feed to the local IHP system. Without FL17 and FL18, an incident on FL19 could completely remove the ability for gas to come into the QGC system from Sunset Gate Station. FL17 and FL18 afford the system an alternative that will allow flexibility for maintenance operations on nearby feeder lines as well as a larger margin than would be available in unforeseen situations.

The chosen configuration for replacement, Option 1, has the smallest length to extend main feeder line and functions identically to the current FL17 from a high pressure standpoint. The IHP conversion that will take place on the south end of the existing FL17 will replace the capacity delivered to this location at a much lower cost than installing new high pressure lines. This option was selected because it will provide the same results to the area at a cost almost $3,000,000 less than a full replacement.