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QUESTAR Gas

Operations Engineering - System Planning and Analysis

Feeder Line 12 Replacement Size Analysis

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Scope

Feeder line 12 is a high-pressure QGC pipeline that runs from approximately 3330 south and 1100 west to North Temple and Redwood Road (See figure below). Large sections of this line were originally installed using reconditioned steel pipe. Questar Gas is planning to replace feeder line 12 in 2010 as part of its current Feeder Line Replacement program. This document explores the capacity and operational requirements of this line and analyzes the costs and benefits of different replacement pipe diameters.

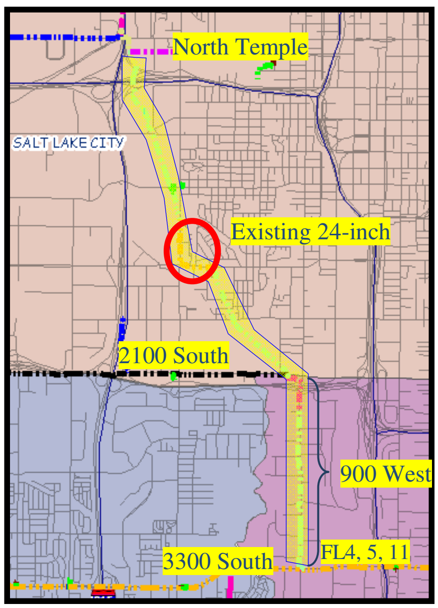

Figure 1: Feeder Line 12 in Salt Lake City

Table 1: Current Feeder Line 12 Length and Diameter

Nominal Diameter	Approximate Length (ft)
14-inch	227,850
16-inch	1,840
20-inch	2,160
24-inch	4,400

Discussion

Historical Considerations

The sections of FL 12 that are scheduled to be replaced currently consist of 14-inch O.D. pipe that extends from 3300 South to California Ave (1300 South) and from 1100 South to North Temple. The segment of FL 12 between 1300 South and 100 South was previously replaced in 2007 with 24-inch O.D. pipe. The diameter of this portion FL 12 was chosen as 24-inch to accommodate projected customer growth and capacity restraints. The Company's potential long term plan for FL 12 is to have a 24-inch belt line from Payson to the North Temple station. Upsizing FL 12 will allow it to be "smart pigged" (internally inspected) as required by 49 CFR 192. 927. To comply with this requirement, two pig launcher/receiver stations will be installed.

System Considerations

The North Temple regulator station reduces pressures from the Northern high pressure (HP) system (operating pressure of 440 psig) and delivers modest amounts of gas to the Central HP system (operating pressure of 350 psig). In the future, with possible new gate stations from Kern River, Questar Pipeline and/or Ruby Pipeline in the North, FL 12 would become a major trunk line into the Central system. The system was therefore analyzed, in a focused model, to determine the effects of different size replacements of FL 12 in relation to system requirements allowing North Temple station to flow as much as possible. The results of these analyses are shown in Tables 2-6.

Table 2 contains the results of 10 years of future growth allowing North Temple to flow as much as it can. The simulation assumes the future improvements north of the North Temple station could provide adequate capacity to make this assumption valid. Table 3 makes the same assumptions as Table 2 but projects 20 years of growth. Each table lists the resulting pressures and station flows for each possible replacement plan. The growth rate used in these tables and throughout the analysis is the 2009 IRP rate of 1.04%. Higher growth rates will yield identical results at less time into the future.

Table 2: 2020 Projected System Results

2020	Minimum Pressure Results (psig)					Average Flow Results (MMCfd)				
	Mag Corp	Payson	West Jordan	Hunter Park	Snowbird	North Temple	Riverton	Little Mountain	Hunter Park	Payson
As is	319	318	153	345	216	100	136	130	211	148
16"	320	319	156	348	219	111	134	126	206	148
20"	322	322	161	353	224	137	130	118	194	148
24"	323	323	162	354	227	158	127	111	183	148

In table 2 the results show that the size of FL 12 directly affects the amount of gas required by the Central gate stations. There are also improved pressures at every system key point with larger diameters as well as reduced flow from gates. It follows that a 24-inch replacement will allow gate station improvements to be delayed longer than they would be with smaller diameter pipes.

Table 3: 2030 Projected System Results

2030	Minimum Pressure Results (psig)					Average Flow Results (MMCfd)				
	Mag Corp	Payson	West Jordan	Hunter Park	Snowbird	North Temple	Riverton	Little Mountain	Hunter Park	Payson
As is	313	352	45	339	189	105	142	138	222	191
16"	315	353	53	342	193	117	140	134	217	190
20"	317	354	66	349	200	145	135	125	206	187
24"	319	354	74	353	204	167	132	118	196	186

With the additional 10 years of growth it becomes more apparent that the larger diameter replacements will be more effective. While the pressures at West Jordan are below operational limits, the difference in pressure between the current arrangement and 24-inch is more distinguished. Also the gas flow that can be expected through the North Temple station is even greater in the 20 year projection.

System redundancy allows operation to continue during crises and through major changes in configuration. Recent analyses have been completed concerning the effects of losing a gate station during winter months. While this analysis does not reflect normal operation, it is advantageous to have a high pressure system capable of sustaining damage and continuing to operate while emergency maintenance is performed. Redundancy also allows major system changes to be done with minimal impact on system operation.

Table 4 represents the system in 2010 without Hunter Park station. The proximity of residential housing in the area and potential UDOT conflicts (Mountain View Corridor), that may require the removal and relocation of the Hunter Park station, have been considered. The results in Table 4 show that if the station is no longer flowing, a 20-inch or 24-inch O.D. pipe for FL 12 will allow system pressures to be maintained above minimum operating pressures. An important note is that the current pipe diameter cannot sustain the system without Hunter Park gate station longer than 8 hours on a peak day.

Table 4: 2010 Projected Peak Day System Results without Hunter Park Gate Station

		Minimum Pressure Results (psig)								Average Flow Rate (MMCfd)			
2010	Time (hours)	Mag Corp	Riverton	Payson	West Jordan	Hunter Park	Little Mountain	Snowbird	North Temple	Riverton	Payson	Little Mountain	North Temple
As is	8	280	320	288	114	278	350	193	354	187	133	218	131
16"	48+	274	322	285	126	282	333	195	354	184	134	193	151
20"	48+	294	339	301	160	303	333	213	354	169	134	170	189
24"	48+	305	349	310	178	314	333	224	354	158	134	154	216

Another scenario considered is an outage of Little Mountain station, which is possible in the event of an earthquake or other catastrophic event. This scenario is considered assuming some excess gas flow would be possible through Porter's Lane as a result of gas from Coalville (QPC) having one less pipe to deliver to. As shown in table 5, the resulting pressures are not affected by increasing the size of FL 12 from its current configuration.

Table 5: 20°F Contingency Results with Little Mountain Out of Service

2009	Minimum Pressure Results (psig)				Average Flow Results (MMCfd)				
	Mag Corp	Preston	West Jordan	Proctor & Gamble	Riverton	Porters Lane	Payson	Hunter	North Temple
As is	323	270	274	283	100	160	134	155	28
16"	323	270	274	282	100	160	134	155	28
20"	323	269	274	281	100	160	134	155	29
24"	324	269	274	281	100	160	134	155	29

It has also been proposed that a 720 psig corridor from North Temple to Riverton Gate station could be beneficial to the system. The 2007 replacement of a portion of FL 12 was sized with this possibility in mind. In Table 6, model results of this situation projected to 2030 are shown. Within the corridor, the pressures in West Jordan (WA05090) show a 42 psig improvement by increasing the pipe size from its current configuration to 24-inch O.D. Other pressures within the corridor vary widely with different replacement sizes while pressures out of the corridor are fairly constant.

Table 6: 720 psig Corridor from North Temple Station to Riverton Gate

2030	Minimum Pressure Results (psig)					Average Flow Results (MMCfd)				
	Mag Corp	Payson	West Jordan	Hunter Park	Snowbird	North Temple	Riverton	Little Mountain	Hunter Park	Payson
As is	341	354	573	644	220	149	160	71	247	170
16"	341	354	590	670	220	158	154	71	245	170
20"	341	354	610	701	220	175	146	71	236	170
24"	341	354	615	712	220	189	144	71	224	170

Financial Considerations

A preliminary cost analysis was conducted to determine order of magnitude cost differences between installing 16-inch and 24-inch O.D. pipe. This analysis showed that QGC labor costs and contractor installation costs were roughly the same for the different pipe sizes. The main difference was the material cost of 24-inch O.D. pipe vs. the cost for 16-inch O.D. pipe. This cost difference has been calculated at approximately $40/lf. Over the entire scope of the project, the total difference in cost would be about $1,000,000. This $1,000,000 will provide approximately an extra 50 MMCfd to be delivered through North Temple (Tables 2 and 3), which will be advantageous because it will allow improvements to the Central system to be delayed, such as a new Kern River Gate that will cost about $3,000,000 when needed.

It appears that installing 16-inch O.D. pipe at the new sections, and leaving the existing 24-inch O.D. pipe in place would save QGC approximately $1,000,000. However, this configuration would require the installation of two additional pig launcher/receiver sites at each end of the existing 24-inch O.D. line or replacement of the existing 24-inch pipe. Instead, if the line was installed at with a uniform pipe size, i.e. matching the section existing 24-inch O.D. pipe that is currently in ground, QGC would not need these pig launcher/receivers installed. The estimated cost to install two pig launcher/receiver sites is between $800,000 and $1,000,000. This cost offsets the additional cost to install the 24-inch O.D. pipe.

Conclusions

The benefits of the incremental capacity for the additional costs of 24-inch will afford customers higher pressures and longer utility from the line. A 24-inch pipe will allow significant amounts of additional gas to be delivered from the Northern high pressure system. Installation of 24-inch pipe will continue to build the backbone of the planned piggable trunk-line from North Temple to Payson gate station. Installing 24-inch pipe will ultimately provide additional incremental capacity that will be required in the future at a relatively low cost when compared to other potential replacement diameters. The optimal diameter pipe for the replacement is 24-inch given the historical, system operation, system integrity (piggability), and financial considerations.