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Chapter: 4

PREPARED DIRECT TESTIMONY OF

KEVIN M. LANG

ON BEHALF OF SOUTHWEST GAS CORPORATION

(SOUTHWEST GAS' HYDROGEN BLENDING DEMONSTRATION PROJECT)

BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF CALIFORNIA

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TABLE OF CONTENTS

I. PURPOSE 1
II. BACKGROUND 1
   A. Objectives 3
III. PROJECT DESCRIPTION 3
   A. Demonstration Project Scope 3
   B. Demonstration Project Timing 5
IV. PROJECT GUIDANCE 7
   A. Pipeline Safety Management System (PSMS) API 1173 7
   B. Risk Identification and Assessment 7
   C. Reporting 9
V. DEMONSTRATION PROJECT COST ESTIMATE 9
VI. CONCLUSION 11
VII. QUALIFICATIONS 12

CHAPTER 4

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I. PURPOSE

The Southwest Gas Corporation's (Southwest Gas or the Company) hydrogen blending demonstration project (Project) aims to establish critical knowledge complimentary to the other joint utility Applicants' demonstration projects while uniquely targeting hydrogen blending in extremely cold weather conditions in Northern California. Literature research has uncovered hundreds of hydrogen blending projects at various stages around the globe, yet many knowledge gaps about hydrogen blending in natural gas systems still exist regarding safety, system integrity, and reliability. Southwest Gas has a responsibility to ensure that new constituents introduced to the system are compatible with the materials and equipment of each unique system while maintaining the consistent reliability of the distribution network for the communities served by Southwest Gas. Southwest Gas proposes a demonstration project to close knowledge gaps that will focus on establishing an optimal percentage blend and developing policies and procedures for different percentages of hydrogen blends in extremely cold climates. The goal of Southwest Gas' Project is to establish an optimal percentage blend of hydrogen, using empirical data obtained from this demonstration, that will be compatible with the natural gas systems in extreme weather conditions such as that in Northern California.

II. BACKGROUND

Gaseous hydrogen has different properties from natural gas, including higher flammability and lower energy content per volume. As a result, determining the optimal percentage blend in extremely cold areas, which dictates higher heating demand, is further affected by the physical properties of hydrogen in cold temperatures. Understanding how much hydrogen can be blended in these areas will serve as a threshold to discover the optimal percentage blend in this extreme end of the weather spectrum in California. Discovering the limit of how much hydrogen can be blended into Southwest Gas' system and which training activities, operating policies, and procedures need to be adjusted to accommodate hydrogen blends is critical to maintaining the system's safety, integrity, and reliability.

The Truckee Town Council adopted Resolution 2017-58 on November 28, 2017, which set a goal of an 80 percent reduction in greenhouse gas (GHG) emissions by 2040. Southwest Gas has committed to employing new technologies to decarbonize its natural gas pipeline to assist the Town of Truckee in achieving the town's GHG reduction goal. The Town of Truckee is an ideal location to gain understanding of how hydrogen blending affects the existing natural gas system on the extremities of cold weather conditions in California. The Town of Truckee is a mountain community located in the northern Sierra Nevada Mountain Range at an elevation of 5,817 feet[1]. For eight months of the year, the average low temperature is below freezing. The average high and low temperatures of Truckee, California can be observed in the table below.

Average Temperatures (Fahrenheit) in Truckee, CA						
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**
Average high in °F	41°F	44°F	49°F	55°F	64°F	74°F
Average low in °F	14°F	16°F	21°F	24°F	31°F	36°F
Avg snowfall in inches	41”	44”	34”	16”	4”	1”
	Jul	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Average high in °F	83°F	82°F	75°F	64°F	49°F	40°F
Average low in °F	41°F	40°F	34°F	27°F	20°F	15°F
Avg snowfall in inches	0”	0”	1”	4”	19”	38”
Source: usclimatedata.com						

[1] United States Geological Survey, National Elevation Dataset.

Southwest Gas' Project is designed to test, analyze, and report the hydrogen blending process at a high altitude, cold weather climate. Moreover, the scope is unique as it contemplates testing the technology on commercial customers with different natural gas appliances including a back-up natural gas generator, a range, gas lights, radiant heaters, furnaces, boilers, and water heaters.

A. Objectives

To complement the programs led by the other Applicants, Southwest Gas' Project objectives aim to:

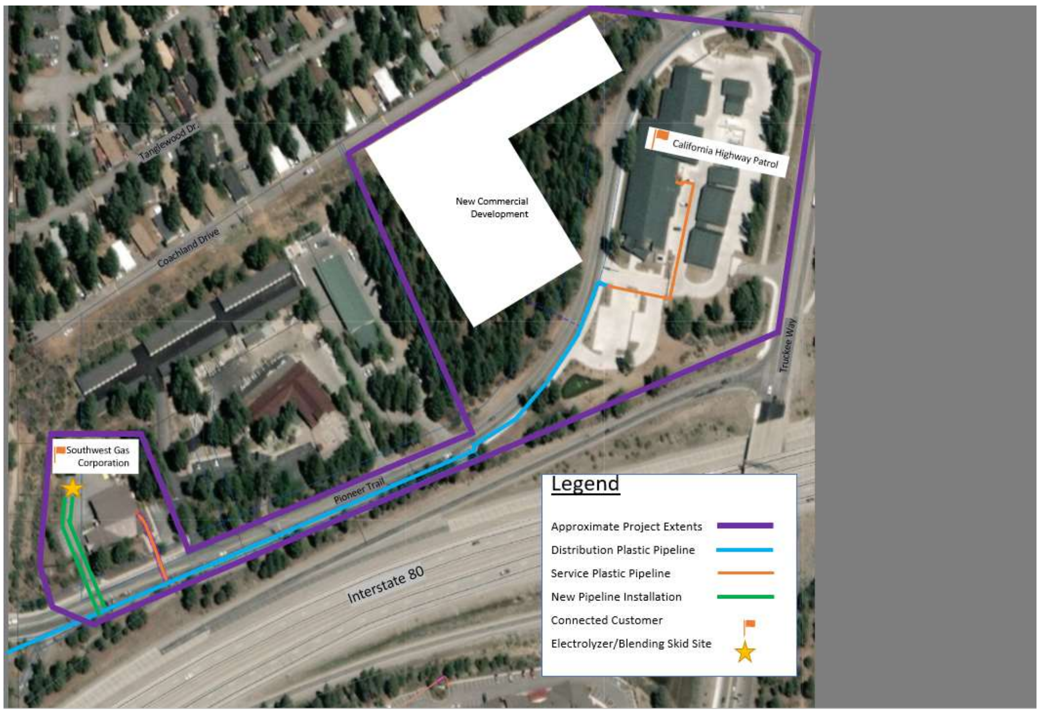
- Recommend optimal hydrogen blending percentages based on system considerations including, but not limited to, sensitivity of system materials, safety and operational equipment, end-user application, and changes in supply demand caused by substantial changes in seasonally cold weather.
- Recommend changes to Southwest Gas' operations and emergency response manuals including applicable policies, operational, and training procedures to accommodate hydrogen blending.

III. PROJECT DESCRIPTION

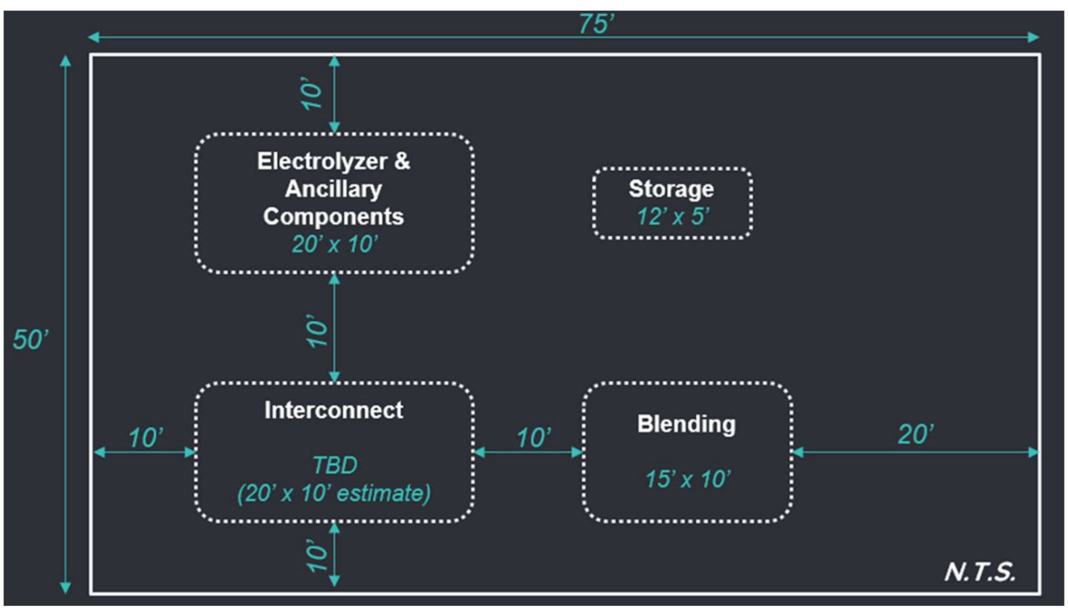
A. Demonstration Project Scope

- Generation of hydrogen from an electrolyzer for an 18-month project duration
- Flow of hydrogen-blended gas through plastic pipelines, steel house lines and end-user equipment for an 18-month project duration
- Increasing hydrogen blending from 5% up to 20% percentage by volume over an 18-month project duration

The Project scope includes commercial accounts with a peak hour load of approximately 17 MCFH. This load is based on two existing customers, Southwest Gas' Truckee Operations Center, and California Highway Patrol office, depicted in the image below, and a new commercial development of up to 16 customers expected to be constructed in 2022/2023.



Project Site Map



Plot Plan of Electrolyzer and Hydrogen Blending Site

B. Demonstration Project Timing

PHASE & ACTIVITY	DESCRIPTION	ESTIMATED DURATION
1. Planning, Design, Construction and Commissioning	Hydrogen equipment is procured; system is designed, constructed, permitted, and commissioned on campus; pipeline system replacement and inspections and any necessary remediation are conducted; stakeholder engagement commences.	21 months
2. Testing and Demonstration	Hydrogen is blended in system on a testing schedule; data is collected; periodic inspection of equipment and pipelines; samples of pipelines and components are collected	21 months (18 months live blending, + 3 months asset inspection & validation)
3. Decommissioning & Equipment Removal, and System Restoration	Hydrogen equipment is removed from location and location restored;	5 months
4. Knowledge Sharing	Data from pilot is interpreted and disseminated; a public report will be released	9 months

1. Planning, Design, Construction, and Commissioning

1. Upon approval of the application, Southwest Gas will design and construct a pipeline that will feed natural gas into the blending skid at the Truckee Operations facility to feed the building and the connected California Highway Patrol office downstream of the isolated distribution system.
2. Southwest Gas will work with an Engineering Procurement Construction (EPC) firm to engineer, procure, construct, and commission the hydrogen production facility, storage and blending skid at the Company's Truckee operations facility.

2. Testing and Demonstration

1. Increasing percentages of hydrogen will be blended in system on a testing schedule; data will be collected quarterly; periodic inspection of equipment and

pipelines will be completed; and there will be annual project status updates to the California Public Utilities Commission (CPUC.)

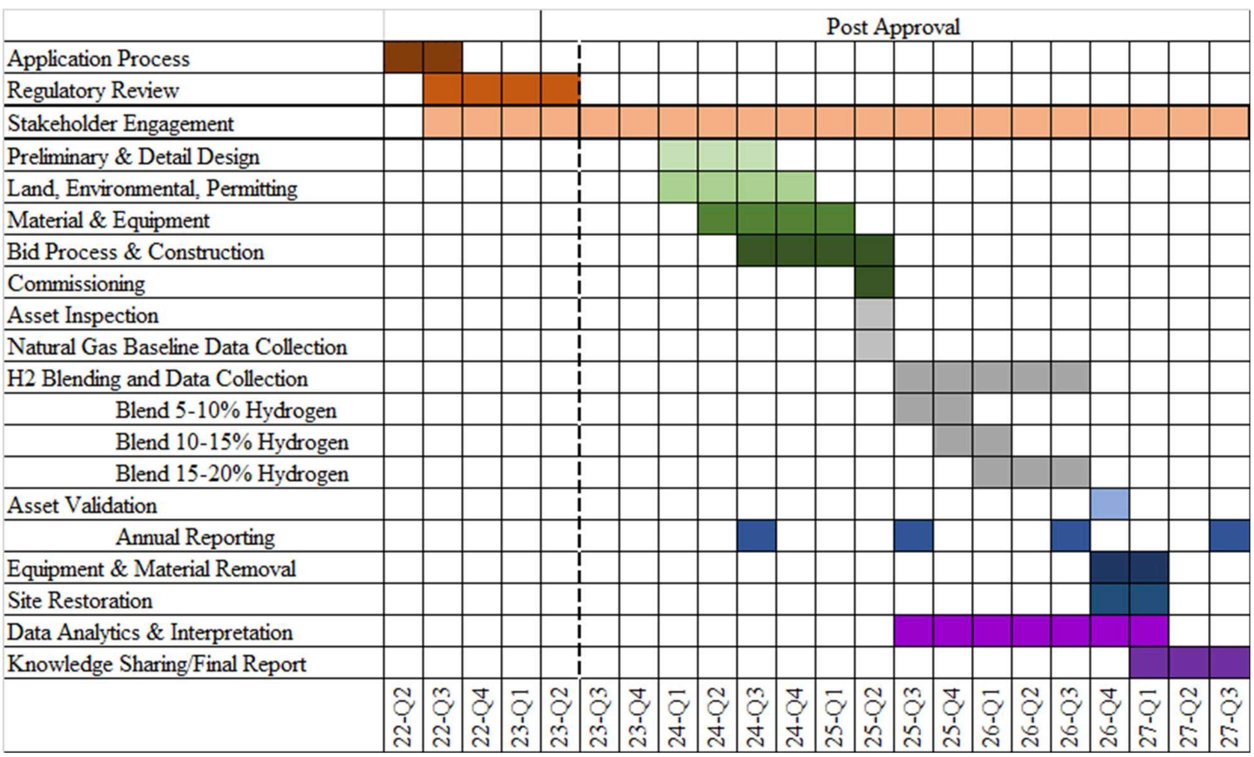
2. Southwest Gas will work with a firm to complete asset inspection, analysis, and reporting of findings.

3. Decommissioning & Equipment Removal, and System Restoration

1. Hydrogen equipment is removed from site and site is restored to prior project conditions.

4. Knowledge Sharing

1. Data from the pilot is analyzed, and a public report will be released that will contain findings and recommended optimal hydrogen percentage blends based on extremely cold weather conditions.



Based on discussions with equipment suppliers surrounding the blending skid, electrolyzer, controls equipment, and contract labor, the following are time estimates associated with acquiring equipment from time of purchase.

Electrolyzer Procurement: 6 – 12 months

Blending Skid & Storage: 12 – 18 months

Construction: 12 months

This Project schedule assumes normal material procurement times. As a result of impacts from the COVID-19 pandemic, worldwide supply chain timing has been impacted. Southwest Gas cannot reasonably project at this time whether these supply chain impacts will have a negative impact on this project schedule.

IV. PROJECT GUIDANCE

A. Pipeline Safety Management System (PSMS) API 1173

Southwest Gas supports the American Petroleum Institute's (API) Recommended Practice 1173: Pipeline Safety Management System. Southwest Gas will integrate the Plan-Do-Check-Act (PDCA) model into this demonstration project. The PDCA model is a continuous loop used to plan, implement, review, and course-correct based on safety checks and efficiency. This loop is used to solve problems and manage change, including unexpected issues along the way. By implementing this 4-step model, Southwest Gas aims to conduct this demonstration program as efficiently and effectively as possible by continuously reviewing the plan and mitigating changes as they naturally arise.

B. Risk Identification and Assessment

One prominent example of risk identification, assessment, and change with the introduction of hydrogen into a natural gas system that requires a modification of our system's protocols for the safety of the community, personnel, and property, are safety procedures relating to ventilation procedures. Natural gas has a relatively short range at which it is flammable with air. The lower explosivity limit (LEL) of natural gas in air is 4%, and the upper explosivity limit

(UEL) is 14%. By contrast, pure hydrogen's LEL is 4% hydrogen in air and has an UEL of up to 75% hydrogen in air. Gaseous hydrogen is over five times more likely to ignite with air than natural gas is. The addition of hydrogen in our existing natural gas infrastructure will increase the hazardous limits of flammability. Therefore, safety policies and procedures require evaluation and solutions to mitigate risks relating to emergency response in the case of a leak in an enclosed space. This is just one of many examples of topics that a natural gas utility must consider to ensure the continued delivery of safe and reliable energy when introducing hydrogen to a natural gas distribution system. Resources are necessary to ensure policies, procedures, and training and can meet the challenge of mitigating this risk.

Other policies and procedures relating to the safety and operation of distribution gas that will be affected by the introduction of gaseous hydrogen include, but are not limited to:

Policies & Procedures relating to

- Purging & Ventilation
- Leak Detection
- Compressor Stations
- Damage Prevention
- Corrosion Control
- Integrity Management
- Electronic Instruments
- Emergency Response
- Facilities Protection
- Gas Control
- Gas Quality
- Metering
- Main & Service Pipeline Design
- Pressure/Temperature Recorders
- Odorization
- Pipe & Component Testing & Design
- Pipe Joining
- Pigging Design
- Pressure Control Design
- Process Transmitters Inspections and Calibration Procedure
- Repairs
- SCADA
- Selection of Materials
- Welding
- Tools & Equipment

Additionally, end-users may observe differences in the distributed gas that may impact end-user equipment.

C. Reporting

Southwest Gas will use a third party to help evaluate hazards, analyze risks, and validate compatibility of materials, equipment and procedures relating to blending hydrogen throughout the duration of the Project. A third party will perform and report a baseline and periodic analysis of the existing materials, components, and equipment of the isolated system that hydrogen will be introduced, such as but not limited to materials, corrosion, electronic instruments, supervisory control and data acquisition (SCADA), metering equipment, leak detection equipment, house lines, and end-user equipment.

Baseline, periodic examination, and analysis of the following will be completed and reported:

- Existing materials and components for the purpose of reporting all affected or unaffected topics related to system integrity
- Existing policies and procedures for the purpose of reporting recommended changes to safety protocols

Annual progress reports on the status of the project and relevant finds will be submitted to the CPUC. A final report with an optimal percentage blend based on the conditions of the project will be made publicly available at the end of the demonstration program.

V. DEMONSTRATION PROJECT COST ESTIMATE

Activity	Cost
Design & installation of new infrastructure required to support hydrogen blended pipeline (Design, Equipment, Installation)	$295,000*

Design & build hydrogen generator, storage and blending skid, labor, and equipment	$8.61 million**
Baseline readings and data collection	$1.25 million
Periodic analysis and to report concerns and unexpected changes in the system and end-user equipment	
Final Reports	
Decommissioning of Equipment	$62,500
Total Costs:	**$10.21 million**

*Cost estimates associated with installation of utility infrastructure for this project are as follows:

Natural gas (Southwest Gas, Material and Labor): $235,000

Electric and water (Tahoe Donner PUD, Material and Labor): $60,000

Total Estimated Price: **$295,000**

**Cost estimates associated with installation of an appropriately sized electrolyzer for this project are as follows:

Electrolyzer (Materials Only): $669,000

Blending Skid (Material and Labor): $969,000

Storage $92,000

Southwest Gas Metering Equipment (Material and Labor): $625,000

Hydrogen Compound Construction (Labor): $6,250,000

Total Estimated Price: **$8,605,000**

Caveats associated with the costs:

- Cost estimates were not officially bid to subcontractors. Costs are based on rough estimation from subcontractors that Southwest Gas has executed Non-Disclosure Agreements with.
- Southwest Gas has talked with several companies (both EPC and equipment suppliers) that have expressed interest in bidding on this type of project. Southwest Gas plans to bid this work out to several subcontractors should we get approved to move forward.
- These costs represent a preliminary analysis of the Project from our subcontractors. As the project progresses, Southwest Gas will be able to more accurately determine the costs associated with the Project.
- All costs shown include a 25% contingency above the estimated value.

VI. CONCLUSION

Truckee, CA, where the proposed Southwest Gas Hydrogen Demonstration Project will be located, is one of the coldest regions in California. Undoubtedly the colder climate, which leads to higher demand for energy use, will affect a blended hydrogen and natural gas system differently than in warmer climate conditions. This Project will fill in knowledge gaps that are complimentary with the other joint utilities Applicants' demonstration projects. In this way, the Applicants will have more complete information to determine an optimal percentage blend throughout the different regions in California. This concludes my testimony.

VII. QUALIFICATIONS

My name is Kevin M. Lang and I am the director/Engineering Services for Southwest Gas. I direct and coordinate engineering and technical support to the Company's five operating divisions across three states for pipeline safety code compliance; right-of-way and land rights acquisition and maintenance, material specifications and approval; environmental policies and procedures; proper energy measurement; pipeline cathodic protection; technical support of the SCADA system; project design review; hydraulic modeling support; and the training and qualification of technical services personnel. I previously oversaw the Company's Distribution Integrity Management Program (DIMP) and laboratory services under the same capacity.

I joined Southwest Gas in 2003 as an engineer in Victorville, CA. I was subsequently promoted to distribution engineer in 2005, supervisor/Engineering in 2006 and manager/Engineering in 2007. During this period, I oversaw the design of transmission and distribution facilities for new business, franchise and system reinforcements; PVC pipeline replacements; pipeline safety code compliance; MAOP studies and requalification programs; and preparation of short and long-term capital budgets.

I was promoted to director/Gas Operation Support Staff in 2011 where I directed the Company's technical skills training, Operator Qualification (OQ) training and testing, tool and equipment evaluations, operations-related procedures manuals, Incident Command System training and operation of the Emergency Response Training Facilities in Tempe and Las Vegas. I was subsequently promoted to director/Engineering Services in November of 2012.

I hold a Bachelor of Science degree in Mining Engineering from Virginia Tech and am a registered Professional Engineering in the state of Nevada with a proficiency in Civil Engineering. I currently serve on the American Gas Association's Operations Safety Regulatory Action Committee.