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WHITE PAPER / **NATURAL GAS PIPELINE DESIGN IN SEISMIC CONDITIONS**

NATURAL GAS IS A SMART CHOICE FOR DATA CENTER BACKUP POWER — EVEN IN EARTHQUAKE-PRONE AREAS

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For data centers and other mission critical facilities, one rule is paramount: Keep the power on. A desire for cleaner power has shifted backup generators from diesel to natural gas, but a common myth exists with this transition — the supposed fragility of natural gas pipelines in seismic conditions. Smart pipeline design proves the myth is not true.

Natural gas usage has steadily increased over the past decade. In 2016, it overtook coal as the top source for power generation in the United States, according to the U.S. Energy Information Administration. Its benefits are clear. It's cheaper and more sustainable. And natural gas generators can be quickly ramped up and down, making them suitable for meeting peak demand and more easily integrated with wind and solar generation.

All these elements make natural gas an ideal option for data center backup power. But some operators have been reluctant to rely on natural gas to maintain 24/7 service because they're concerned about the resiliency of pipeline infrastructure — especially in earthquake-prone areas.

But well-designed natural gas pipelines have performed well in seismic conditions for decades. Having successfully installed high-pressure natural gas pipelines, often in earthquake-prone regions, we have experienced the benefit of smart design. Smart design validates the resiliency and redundancy of the natural gas grid, making natural gas generators a reliable choice for data center backup power.

DESIGNING RESILIENT NATURAL GAS PIPELINES

The key to making pipelines safer and less prone to damage during seismic events is flexibility. When the ground shakes, a pipeline needs that flexibility to move somewhat unrestricted within its trench. Encasing the pipeline in concrete restricts this movement, creating a rigidity that's susceptible to fracture. But installing a pipeline within material that won't seize up — pea gravel, geofoam or other select backfill — gives it the centimeter or so of leeway it needs.

A pipe that's too long and straight can also be a risk in seismic conditions. If the ends of the pipeline segments are rigidly fixed, longitudinal or perpendicular movement from seismic activity can cause undue stress in the middle of the pipeline. To eliminate this issue, the design may include expansion loops, which lengthen the pipeline while introducing some curve and flex. The curves allow slack in the pipeline, reducing stress concentration and protecting the integrity of the pipeline.

There may be enough gas left in the pipeline to run a generator for hours or even days after a major earthquake.

These techniques are just a few of the pipeline designs in place for new and replacement pipelines across California and other areas with high seismic activity. These same solutions are also deployed nationwide to protect against other natural events that could affect the integrity of the pipeline infrastructure, including landslides, sinkholes and soil liquification.

THE IMPORTANCE OF REDUNDANCY TO UTILITY PROVIDERS

Another misconception regarding natural gas is that utilities shut down most of the grid after a seismic event. In fact, utilities work to minimize any shutdowns, not just because it's better for their customers but because shutdowns are incredibly cost-prohibitive to their business model.

Shutting down and then powering up natural gas infrastructure isn't as simple as flipping a breaker. Before a utility can restart gas service, it must send people to every house and business affected by the shutdown. So it's in a utility's best interest to develop whatever redundancies are necessary to keep the gas flowing.

One option is to incorporate alternative pipelines to deliver gas to customers. If a pipeline suffers a leak or rupture after a seismic event and needs to be shut off, utility operators can typically microtarget and remotely shut down valves so only the smallest possible portion of the grid is affected. When that happens, the utility can often flow natural gas to customers on the affected line from the other direction.

Another redundancy is the amount of gas that remains in a pipeline even after a shutdown. Depending on line size and pressure, there may be enough gas left in the pipeline to run a generator for hours or even days after a major earthquake, keeping the facility online long enough for the pipe to be repaired or for the gas to be diverted.

POWER TO FUEL MISSION CRITICAL FACILITIES

Earthquakes are dramatic and potentially catastrophic events, but many checks and balances can be, and are, put into place to safeguard the natural gas infrastructure in this environment. Proper pipeline design can go a long way in protecting the integrity of the infrastructure. Utilities are entirely committed to keeping the natural gas grid online because it's in their — and their customers' — best interest.

In the instance of the 1994 Northridge earthquake in the north-central San Fernando Valley region of Los Angeles, natural gas service was not shut down systemwide. The utility stated that gas service was shut down for a small percentage of customers, and then restored within a few days. The magnitude 6.7 earthquake produced the highest ground acceleration ever instrumentally recorded in an urban area within North America, measuring 1.8g with strong ground motion felt as far away as Las Vegas, approximately 220 miles from the epicenter. In addition, property damage was estimated between $13 billion to $40 billion, making it one of the costliest natural disasters in U.S. history.

These assurances — in combination with the cost savings and environmental benefits that natural gas provides — make natural gas an attractive option for data center backup power. Could this solution work for your mission critical facility? As the nation's top firm for electric power generation and mission critical facilities, Burns & McDonnell brings experience and an unique perspective to data centers. We are prepared to help find solutions to maintain continuous, seamless operational efficiency.

BIOGRAPHIES

MICHAEL BELL, PE, LEED AP BD+C, is a project manager at Burns & McDonnell experienced with mission critical facilities. With data center experience in nearly every major market in North America, he brings a well-rounded perspective. Michael serves on the AFCOM board for both Denver and Kansas City, and contributes to various data center forums. He earned a Bachelor of Science in architectural engineering from Kansas State University.

DENYS STAVNYCHYI is a pipeline project manager at Burns & McDonnell. A mechanical engineer and native of Ukraine, he has more than two decades of large, high-pressure pipeline project experience, including design and construction management. Denys earned a Bachelor of Science in mechanical engineering from Ivano-Frankivsk State Technical University of Oil and Gas and is fluent in four languages.

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