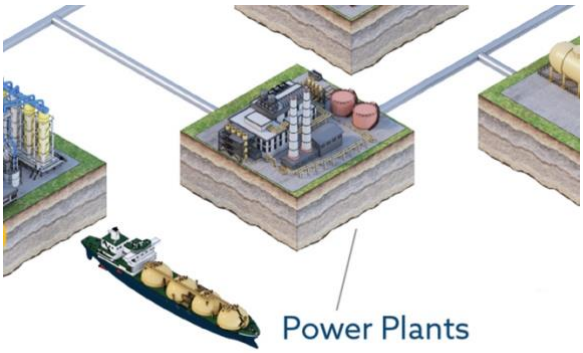
Section 6:
ZEVAC® for Power Plants



Problem Description

Due to their cost, efficiency, and ease of construction, Natural Gas Power makes up a large part of the United States electrical grid. As of 2022, natural gas made up almost 40 percent of all energy production in the US, which even outnumbers the energy production from oil and coal-powered plants. It's essential this flow of energy remains uninterrupted, as any downtime can lead to extensive power outages that can affect the lives of the customers served.

Unfortunately, as with any plant or station, maintenance is required as parts begin to break down and technologies advance. This maintenance often requires areas of the plant to shut down. As with other maintenance within the natural gas system, the gas must first be vented into the atmosphere before work can begin. Since these power plants are often compact, any venting can put the surrounding areas at risk, with a single spark having the potential to cause an incident. Due to the potential of extended downtime, many plants may delay or rush maintenance, again increasing the risk of a potential incident. The venting of gas can also lead to increased repair costs, both due to the loss of product and the man-hours required to report emissions released.

ZEVAC is a safe and effective alternative to venting for use during maintenance projects within these plants. Whether through the use of a portable unit or the installation of a permanent one, ZEVAC can mitigate any potential risks of gas loss, allowing a greater part of the plant to function while repairs are being made. This reduces downtime, loss of product, and eliminates reporting costs, which often offsets the costs of the units themselves. By employing the use of ZEVAC, energy providers and customers can remain confident that power produced from these plants will remain consistent and uninterrupted, regardless of the level of maintenance and repair needed.

Illustrated Checklist and Diagram – Portable Install

Prior to using a ZEVAC system, it is important to identify the procedural steps needed to take place to have a successful drawdown at a compressor site. These major procedural steps include:

1. Identification of isolation valves for intake and discharge points.
2. Close valves to isolation segment to be depressurized.
3. Connect ZEVAC unit to the pipeline connections using flex hose and appropriate fittings and the air compressor. Ensure the whip checks are in place and open isolation valves. Purge air from the ZEVAC hoses and equipment before beginning recompression.

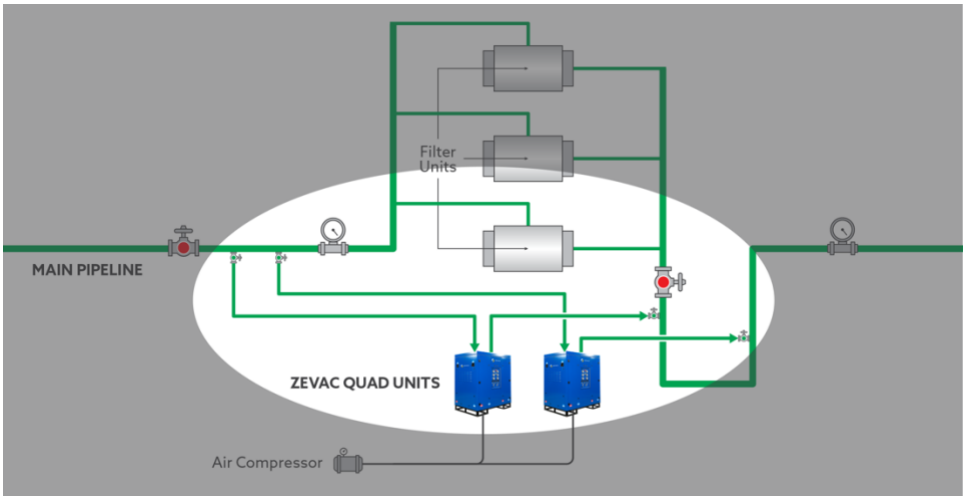


Figure 37: *Diagram of power plant drawdown (Image 1 of 4)*

4. Record starting pressure of the intake segment and the discharge portion of pipe.
5. Turn on ZEVAC equipment and air compressor to begin drawdown.

6. Monitor pressure at the discharge point and intake section to ensure that discharge does not cause over-pressurization of the discharge side pipe system and that intake does not go below desired pressure. **Note:** The Under Pressure Cut Off Switch (UPCO) and Over Pressure Cut Off Switch (OPCO) are designed to ensure the unit shuts off before reaching MAOP or desired draw down pressure.

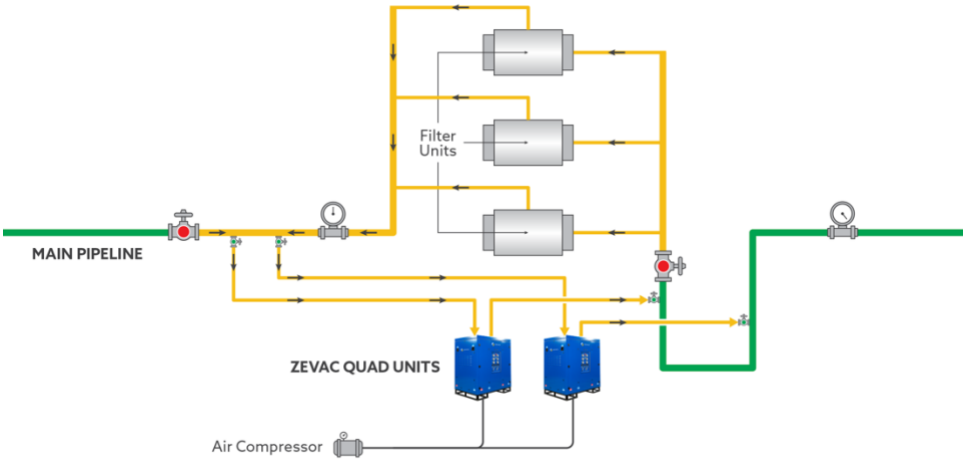


Figure 38: *Diagram of power plant drawdown (Image 2 of 4)*

7. Once desired pressure is reached, stop ZEVAC equipment and air compressor.
8. Record final pressure readings in intake section and discharge section of the pipe.

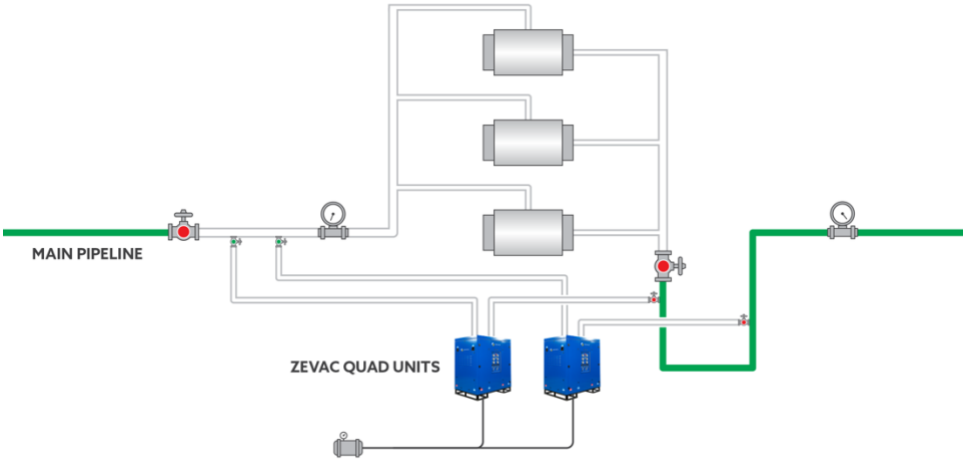


Figure 39: *Diagram of power plant drawdown (Image 3 of 4)*

9. Close isolation valves, depressurize and disconnect ZEVAC and air compressor equipment.
10. Proceed with required maintenance.

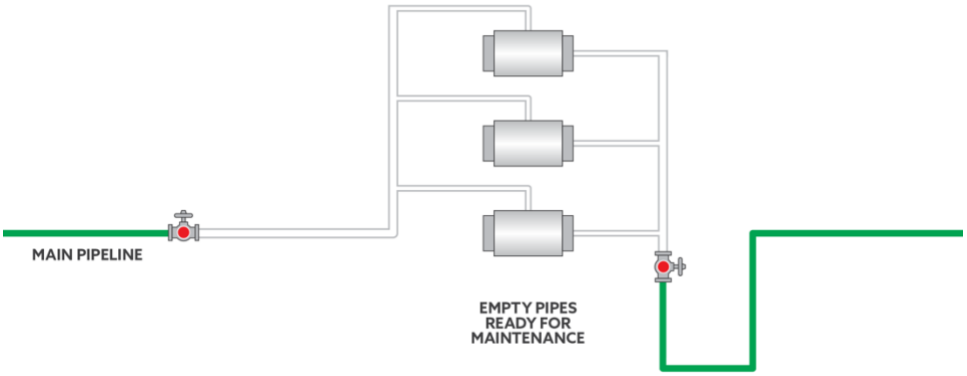


Figure 40:*Diagram of power plant drawdown (Image 4 of 4)*

Case Study: Power Plant

About the Project	
Who	Invenergy – Hardee Power Station Outage
What	Replacement of unit isolation valves
Why	Reduce emissions and shorten purge in busy area
Where	Residential areas, heavy traffic, and pedestrian use
When	March 2023

In March of 2023, Invenergy planned an outage at the Hardee Power Station, located in Bowling Green, Florida. The outage was planned to replace unit isolation valves within the plant, typically requiring the pipeline to be blowndown back to the next mainline valve. This process would generally result in a loss of product and a greater amount of downtime, leading to increased costs overall. Fortunately, by using just two ZEVAC quad units, the gas present was able to be drawndown from within the plant and associated piping, compressed, and reinjected into the system further upstream.

In order to accomplish this, two ZEVAC quads were installed and natural gas was drawndown from the following:

- 465' of 8" Pipe
- 342' of 14" Pipe
- 1512' of 18' Pipe
- Four 24" x 7' Unit Scrubber Tanks

After installation, the units were run for approximately 15 minutes (from 7:33 PM - 7:48 PM), which reduced the pressure from an initial value of 341.1 psig to 299.9 psig. Progress was then paused overnight to confirm the absence of any leaks and ensure the system's pressure remained steady. Beginning at 6:31AM the next day, the units were run for 4 hours, lowering the overall pressure of the system to 4.6 psig. Finally, the remaining pressure was vented and the replacement was started.

Through the use of ZEVAC, Invenergy was able to prevent over 80,000 SCF of natural gas from being vented into the atmosphere. The speed of ZEVAC also allowed Invenergy to remain on schedule throughout the planned outage, resulting in positive emissions reduction and keeping overall costs down.

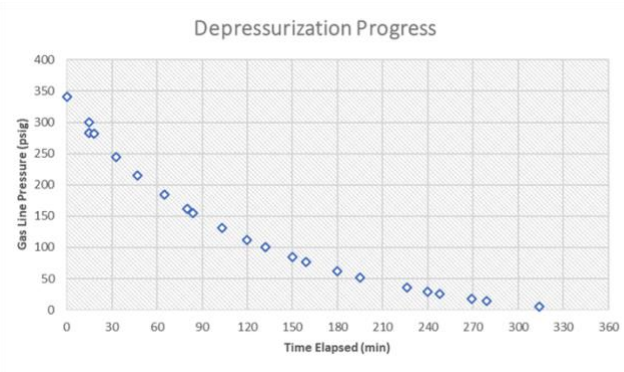
Figure 41: *ZEVAC Quad units*

***Figure 42**: Site overview*

Results, Conclusions, and Lessons Learned

Through the use of only two ZEVAC Quad units and an air compressor, the targeted gas lines at Hardee Power Station saw their pressure gradually and consistently lower over the span of about 5 hours. Due to the efficiency and reliability of ZEVAC, the system saw no depressurization during this process, allowing for a safe pressure of (4.1 psig) before the units were disconnected. Maintenance on the site was able to progress and downtime at the site was kept to a minimum. This allowed Invenergy to restore power to the site and to its customers in a more reasonable time period, something that would be tougher to maintain through venting alone.

Another favorable result of using ZEVAC was the preservation of gas and the reduction of emissions. As mentioned, Invenergy was able to preserve over 80,000 SCF of natural gas by choosing to reinject the gas upstream using the ZEVAC Quad units. This process also prevented the release of 45.6 metric tons of CO2 emissions, which allowed for a much better environmental footprint and reduced the “back-office” costs of reporting said emissions to regulatory bodies and agencies.



Time	Elapsed (min)	Pressure (psig)	% Complete
19:33	0	341.1	0
19:48	15	299.9	12%
Overnight Leak Check to make sure pressure didn't re-build			
6:31	15	282.5	17%
6:34	18	281.8	17%
6:49	33	244.2	28%
7:03	47	215.1	37%
7:21	65	183.9	46%
7:36	80	161.6	53%
7:40	84	155.1	55%
7:59	103	130.6	62%
8:16	120	112.1	67%
8:28	132	100.0	71%
8:46	150	84.0	75%
8:55	159	77.0	77%
9:16	180	61.4	82%
9:31	195	52.2	85%
10:02	226	35.5	90%
10:16	240	29.2	91%
10:24	248	26.0	92%
10:45	269	17.8	95%
10:55	279	14.7	96%
11:30	314	4.6	99%

***Figure 43:** Depressurization Progress - Hardee Power Station*

Lessons learned during this process included factors such as increasing the amount of ZEVAC units used during drawdown to increase the speed of depressurization. It was also noted that runtime could be increased in future projects to reduce the final pressure, thereby reducing any additional venting needed to clear the gas lines. However, even considering these factors, the use of ZEVAC during the project was considered a success with Invenergy.

The ZEVAC impact from the Hardee Power Station project:

<table>
<tr><td rowspan="3">45.7
Metric Tons CO2e Saved</td><td>80,382
SCF Natural Gas Not Vented</td><td>117,052
Miles Not Driven</td></tr>
<tr><td>51,146
Pounds of Coal Not Burned</td><td>15.8
Tons of Waste Recycled Instead of Landfilled</td></tr>
<tr><td>54.5
Acres of Forest Grown for One Year</td><td>755
Seedlings Grown for 10 Years</td></tr>
</table>