

Mine Inerting Information

The following is a listing of sources for inerting gases and generators that MSHA is aware of. The list may not be exhaustive. Where costs and benefits are provided, they are estimates only and could vary substantially. They are provided only to provide a rough cost/benefit analysis. The links below are provided for informational purposes only. MSHA does not endorse the products or companies nor is it responsible for the accuracy of the information contained on the referenced web sites. The information has been provided by the product manufactures/vendors and should be verified by the end-user prior to use.

The term "scfm" is used throughout the specifications. It is defined as "standard cubic feet per minute" and is the volumetric flow rate of a gas corrected to "standardized" conditions of temperature, pressure and relative humidity, thus representing a precise mass flowrate. However great care must be taken, as the "standard" conditions vary between definitions, and should therefore always be checked. The "standard" conditions are usually defined as 1 atmosphere of absolute pressure (e.g., 101325 pascals, 1.01325 bar, or 14.7 psia), some temperature (e.g., 68°F) depending on the "standard" used, and some relative humidity (e.g., 36%, 0%) depending on the "standard" used.

- **Weatherford International, Ltd. Inert Gas Generator**

515 Post Oak Blvd., Suite 600
Houston, Texas 77027
Phone: 713-693-4000
Fax: 713-693-4300
<http://www.weatherford.com>.

Nitrogen Production Units

Weatherford provides membrane nitrogen production units (NPU) for use during extended inertization of coal mines during fires and in sealed areas following isolation of fire areas both east and west of the Mississippi River. The NPUs are highly mobile.

The primary use of the NPUs is for drilling purposes. Availability of NPUs depends on existing contracts and first-come first served basis. The NPUs have 92-95% utilization rate. They are generally transported from one job site directly to the next. Daily availability of an NPU can vary from as many as 4 to as low as zero (the case today). If a unit is available, it can be delivered as quickly as one day to as long as 3-4 days. NPUs are available from capacities of 1500 scfm to 3000 scfm. Both provide nitrogen quantities at 95% purity (standard rating). An air compressor package is used with the NPU and

can provide discharge pressure up to 200 psi without a booster. Boosters (for up to 5000 psi discharge pressure) for the air compressor package are not generally needed for mine inertization.

Contact: Dennis Wood (800) 423-3419 or cell (307) 277-2122

Cost Information

- Total daily cost for 3000 scfm NPU is approximately \$11,000 (\$10,000 - \$12,000).

Liquid Nitrogen

Cryogenic nitrogen pumping/storage units have been used for inertization of coal mines during fires. Generally, the cryogenic units are for intermittent use (60 minutes – 3 or 4 hours at a time). Standard capacity rating is 16,667 scfm at 10,000-15,000 psi. However, the pump operation can be for extended periods of time if operated below the maximum rating (1/3). Two or three additional backup units would be used to provide continued availability and allow for maintenance/pump rebuilding. The storage tank on the unit is 2000 liquid gallons and equates to 186,000 scfm nitrogen gas. Tanker transports provide the liquid nitrogen to the site. Transports hold an estimated 3 times the storage tank capacity (not sure exactly). The availability rates of the cryogenic units are similar to that of the NPUs.

Contact: Barry Ekstrand (713) 693-4477

Cost Information

- Cost is on an hourly basis.
- Pricing lists (2005) for cryogenic nitrogen pumping/storage units at pressures of less than 5000 psi and a capacity of 4000 scfm was approximately \$2800 for the first 2 hours, \$588 per hour thereafter.
- Cost of a tanker transport to be on-site was \$550 for the first 2 hours, \$275 per hour thereafter.
- Delivery charge is additional.
- Cost for nitrogen gas was \$0.05 per scf.

- **PHOENIX First Response Jet Engine**

25 Allegheny Square
Glassport, PA 15045
877-PHNX (7469)-911
800-516-4266 ext. 39
fax: 412-664-7717
<http://phoenix1response.com/>

The main application of the Phoenix inert gas generator (jet engine) is fighting fire hazards and extinguishing fires in closed spaces like:

- interiors of hulls,
- excavations,
- underground tunnels,
- warehouses or underground garages, etc.

Basic Technical Data

Mixture flow rate 12.79 lb/s (15008 cfm)
Mixture pressure at the generator outlet approx. 20.3 psi
Mixture velocity at the generator outlet approx. 55080 ft/min
Mixture temperature at the generator outlet approx. 140° F
Contents of water vapor, by volume 60%
Contents of oxygen, by volume less than 2%
Contents of CO, by volume less than 0.2%
Core fuel consumption 276 lb/h
Afterburner fuel consumption 1235 lb/h
Water consumption 22046 lb/h
Mass of the generator in the basic version approx. 661 lb
Dimension of the generator approx. 3.28/3.28/13.12 ft

- **Tomlinson Boilers "Low Flo" Inert Gas Generator**

PO Box 6648
Wetherill Park NSW 2164
Telephone: (+61 2) 9681 4177
Facsimile: (+61 2) 9681 1152
Email: sydney@rcrtom.com.au

The Tomlinson "Low Flo" Inert Gas Generator produces a gas that will not support combustion. The Oxygen in the air is burnt in the boiler changing the oxygen to carbon dioxide. A by-product of the combustion process is heat which the Tomlinson Boilers Inert Gas Generator reduces to approximately 68°F above ambient. The Tomlinson "Lo-Flo" Inert Gas Generator is also capable of inerting

large volume sealed areas of underground mines thereby eliminating the risk from any potential explosion hazards that may exist at the present or in the future.

Typical gas output:

Volume 1093 cfm
Nitrogen 75%
Oxygen 2%
Carbon Dioxide 12.5%
Temp 113°F
Discharge Pressure up to 67,196 psi
The unit can be transported using a standard Prime Mover.
Configuration - Tri axle low loader.
Overall length 60.20 ft.
From Articulation point to rear 58.73 ft.
Overall width 8.2 ft.
Height 14.6 ft.
Track width 7.81 ft.
Weight over rear axles 37,831 lbs.
Weight over prime mover 19,775 lbs.
Total Weight of Trailer 57,607 lbs.

Fuel Connection to Unit-Wiggins quick fill system
Usage 35.663 -36.984 gal /hour Diesel
Inert Gas Connections - 2 available - 150mm Table E
Flange or 100mm Cam
Lock Male
Water inlet for liquid ring sealing pump - 2" camlock
Water return from liquid ring sealing pump - 2"
camlock

Electricity 415V, 50 Hz, 3 phase & neutral
(Motor/gear ratio changes needed for U.S.)
Rated capacity of total of all equipment
At maximum capacity 220 Amps/Phase

A quantity of water is required at a head of 11.5 ft. to the inlet of the liquid ring sealing pump - this water is returned to the storage tank and the PH is lowered over the course of operation required water to be changed frequently will depend on size of storage.

- **BJ Process and Pipeline Service Nitrogen Pumping Service**

BJ Process and Pipeline Services (BJ PPS), a division of BJ Services Company, has extensive experience in supplying nitrogen services for mine fire and inerting operations. With multiple locations throughout the United States BJ can supply nitrogen services rapidly and cost effectively to areas with mining operations.

BJ offers both conventional cryogenic nitrogen services and membrane nitrogen services. Cryogenic nitrogen services involve transporting liquid nitrogen to location and pumping into the mine, as a gas, via BJ's high rate nitrogen pumping units. Membrane nitrogen services involve compressing ambient air and processing through a BJ membrane unit. The membrane discharges nitrogen with anywhere from 95% to 98% purity. The level of purity is controlled by BJ and is a function of the discharge rate. The suitability of each technology depends on the required flow rate and pressure. For inerting sealed areas, BJ can work with the client on a monitoring service to allow repressurization to compensate for pressure leakage.

Contact: Will Petrea

Sales Engineer
BJ Process & Pipeline Services
802 Stone Creek Pkwy, Suite 2
Louisville, KY 40223
(502) 412-2453 (22) Office
(502) 836-0163 Cell
(502) 426-9704 Fax

- **Halliburton**

Halliburton domestically does not operate membranes. However, they do have a wide variety of pumping and storage equipment as well as a Liquid Nitrogen supplier in a Joint Venture with (Praxair).

Equipment available is as follows:

- Flameless Trailer Pump units capable of <150 to 1500 scf/min, 500 to 5600
- SCF/MIN, 500 to 6000 SCF/MIN (with computer automated Gas Temperature control)
- Flamed Trailer Pump units capable of 800 to 12000 scf/min
- Mobile storage trailers that hold 7200 gals of LN2 and High volume on site storage
- tanks that hold 12,000 gals of LN2. These are Horizontal storage tanks we

- mounted on trailers to provide temporary on site storage in remote areas.

Contact: Brent Voisin

Sr. Technical Specialist
Nitrogen Services, Wellnite
110 Capitol Dr.
Lafayette, La. 70508
Office (337) 572-4784
Mobile (337) 849-3620
Fax (337) 572-3911
E-Mail Brent.Voisin@Halliburton.com
<http://www.halliburton.com/>.

• **Schlumberger**

Schlumberger provides high pressure (~10,000 psi) nitrogen gas from the surface. The operator is responsible for providing the borehole into the mine.

Contact: Peter Rottler

Schlumberger
Charleston, WV
office 304-353-9304
mobile 304-553-5775
<http://www.slb.com>.

• **Superior Well Services**

Corporate Office: Indiana, PA
Superior Well Services has eight nitrogen crews of approximately three to four employees each, a fleet of 24 nitrogen pump trucks, and 18 nitrogen transport vehicles. Six service centers provide bulk nitrogen delivery; they have no nitrogen generation plants. Service centers are in Vernal, UT; Cleveland, OH; Norton, VA; Cottondale, AL; Kimball, WV; and Mercer, PA.

Mobile Self Contained Nitrogen Pumping Unit

These units are capable of pumping at pressures of up to 8,000 psi and at gaseous nitrogen discharge rates from 60,000 scfh to rates in excess of 600,000 scfh. The mobile truck mounted units are equipped with 3000-gallon capacity liquid nitrogen storage tanks. Superior uses electronic controls and advanced hydraulics to develop modern, fired nitrogen pumpers. The truck power plant is used to power the liquid high pressure

pump. An auxiliary diesel engine is used to power the direct-fired vaporizer. This results in a safer, simpler and more efficient fired nitrogen pumping unit. This type of equipment enables Superior to offer one of the widest ranges of nitrogen pumping services available in the industry.

Nitrogen Transport

Superior has a range of mobile nitrogen transports available. Transports range from 280,000 to 560,000 scf. Some transports can deliver product at 1,000,000 scfh. Transports use tank pressure and hydraulically operated booster pumps to transfer liquid nitrogen to the pumpers.

Inerting/Purging Services

Nitrogen inerting, lowering explosive limits or purging is the replacement of an atmosphere of undesired composition in an enclosed vessel with another atmosphere of preferred composition. The atmosphere preferred is typically an inert gas, such as nitrogen. Purging is typically required to prevent fire or explosions where flammable or explosive materials are present. Purging is also required to avoid unwanted reactions between materials being handled and the atmosphere.

Pumping Rates: Superior can provide up to 12,000 scf/min per pumping unit at discharge temperatures of 100F.

Pumping Pressure: Pumping units are capable of pumping pressures of 8,000 psi.

Product Capacity: Pumping units and product transports have unit capacities of 280,000 scf.

Contact: Rusty Hite, Nitrogen Manager, Mercer, PA

Office: (724) 475-4881 Cell: (724) 541-8329

Central Dispatch: (888) 287-3797

<http://www.superiorwells.com/>

• Praxair

Cryogenic nitrogen pumping services are available.

Contact: Praxair Services, Inc.

By Phone/Fax By Mail

Tel.: 1-800-PRAXAIR

Fax: 1-800-772-9985

1585 Sawdust Rd., Suite 300

The Woodlands, TX 77380

Regional Locations:

Burlington, NJ (Philadelphia)
Institute, WV (Charleston)
Griffith, IN (Chicago)
Salt Lake City, UT
Tulsa, OK

• CUDD Services

Contact: <http://www.cuddpumping.com/cpscontacts.html>

• Parker-Hannifin Corporation

Nitrogen Generation Systems Supplier
Parker Hannifin Corp.
Filtration and Separation Division
4711 Hollins Ferry Road, Suite 112
Baltimore, MD 21227
Tel: 800 343-4048
Fax: 978 556-7501
<http://www.parker-nni.com>

Customer-Owned Nitrogen Generation Systems

Parker –Hannifin manufactures a wide range of non-cryogenic generators ranging from several scfm to over 3000 scfm utilizing either Parker’s HiFluxx air separation membranes or Pressure Swing Adsorption (PSA) systems. Either system generates nitrogen gas on-site from a supply of low pressure air, readily available from a dedicated compressor or from a number of local air rental companies. After the unit is purchased, the nitrogen delivery cost is “free” other than utility costs to operate the feed air compressors and you never exhaust or need to replenish your source of nitrogen.

These onsite generators can be purchased directly from Parker-Hannifin and utilized wherever or whenever the need for inerting arises at the mine location.

Systems can be designed for permanent installation or for mobile operations, and the flexibility of membrane designs allow for low-profile units to actually be delivered and operated in the interior of the mines, or larger systems can be installed at the surface with hose or piping connections, since system discharge pressure is normally about 100 psig. The nitrogen purity can be regulated from 90 to 99+%, depending on mine purging or sealing requirements.

Nitrogen systems can be supplied with integral feed air compressors so nitrogen is available instantly for emergency conditions. In addition,

booster compressors can be supplied to charge high pressure N2 cylinders, or the clean feed air can be charged directly to fill high-pressure breathing air cylinders as required.

These systems are designed to run continuously if needed, and are ideal if long term nitrogen injection or make up nitrogen is required to inert the mine section indefinitely and prevent the incursion of air into sealed areas.

Owning the nitrogen system is crucial since rental N2 systems are limited and are not always available when needed, but rental air is usually more available. The only certain nitrogen supply is the one owned by the mine operator, always on location, and the client can choose either diesel-drive or electric drive compressors based on their own utility considerations.

**Nitrogen Generator Unit Rentals
Power Management LLC**

121 Colt Industrial Drive
Mt. Hope, WV 25880
Telephone: (304)228-9787
FAX:(304)250-0394

Contact:

Chris Davis

Telephone: (304)228-9787

On Site Gas Systems

35 Budney Rd.
Newington CT. 06111
Telephone: (860)667-8888
24-hour emergency hotline: (888)748-3429 Ext. 261
Fax: (860)667-2222
www.onsitegas.com

On Site Gas Systems Field Services has field experience in both emergency coal mine fire inerting situations as well as long and short term mine seal atmospheric inerting projects. A rental fleet of portable nitrogen systems is available for immediate deployment. These systems can be rented for short term or for extended term and provide complete inerting solutions to the situation at hand.

Customized nitrogen systems are also available.

Nitrogen volumes available: 5 scfm to 6000 scfm

Nitrogen purity available: 95% to 99.9%

Contacts:

Mike Thibou, Director- Field Services
Ph: 860-667-8888 ext. 261
Mobile: 610-334-1919
Alternate: 610-916-6928
Email: mthibou@onsitegas.com

Bob Wolff, V.P. Sales
Ph: 860-667-8888 ext. 266
Email: bwolff@onsitegas.com

• **NITRO-Lift Technologies, L.L.C.**

Headquarters:
1029 Maurice Road
Broussard, LA 70518
337-560-0249

Operations:
707 N. Kemp
Tishomingo, OK 73460
580-371-3700
www.nitrolifttechnologies.com

On-site Nitrogen Generation Units

Nitro-Lift Technologies is an industry leader in non-cryogenic membrane, type nitrogen generators. Nitro-Lift has the capability to design, manufacture and commission on-site generators, as well as provide generating services on a call-out basis. The units are designed fit-for-purpose in order to provide our customers with maximum value added. Units are readily available with capacities from 140 SCFM (200 MCF/D) to 1,250 SCFM (1,800 MCF/D) with discharge pressures up to 5,000 PSI. Units with capacities outside of these ranges are easily designed and fabricated to customer specifications. The units may be rented with operators, leased by the month or year, or purchased outright. Benefits of membrane units include control over nitrogen supply and reduced costs and logistical problems when compared with cryogenic nitrogen.

Contact:

Justin Murray
580-371-3700, or
580-371-5048