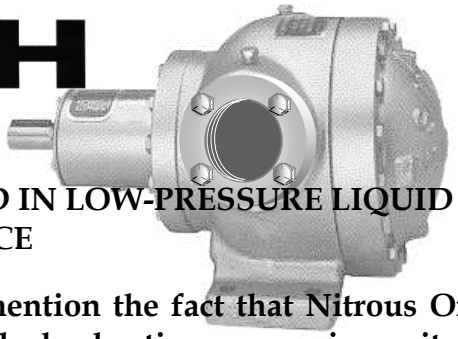
SMITH PUMPS



SMITH PUMPS UTILIZED IN LOW-PRESSURE LIQUID NITROUS OXIDE BULK TRANSFER SERVICE

GENERAL. Chemistry references mention the fact that Nitrous Oxide, "N_2O", is a colorless gas that is obtained usually by heating ammonium nitrate. Its uses are further described as mainly in anesthesia and in preparation of food aerosols, such as those used for whipped cream. N_2O is sometimes referred to as "Nitrogen (I) Oxide" or "Azote Protoxide". It is easily condensed as are Cl_2, NH_3, CO_2, and SO_2 . In accordance with the popularly described nature of N_2O, upon preparation of the same, great care must be taken to avoid an explosion caused by heat.

Actually, liquefied Nitrous Oxide is listed as a highly confirmed oxidizing agent. ***One of its chief characteristics is that it readily yields free Oxygen through heat gain decomposition. Therefore, contaminants could cause violent combustion within the confines of the tank and piping system.*** **Since there must not be any substances inside the pump, which could oxidize in this manner, many special precautions are taken in the production of Smith N_2O pumps and accessory items.** ***All Smith pumps for liquid N_2O bulk transfer are manufactured specifically for handling this particular liquefied gas.*** **Safety practices, specialized components, and meticulous cleanliness are used in the fabrication of these pumps. When shipped, they have very clean, dry interiors. Special procedures insure no traces of flammable residue or debris. All components are thoroughly cleaned with an *approved* degreasing agent that is not harmful to the environment but has characteristics similar to the outdated "Freon® TF" solvent, which leaves no residue and completely evaporates prior to assembly.** ***All Smith Nitrous Oxide pump parts in contact with the fluid, such as the casings, gears, bushings, shafting, and mechanical seals, are exclusively fabricated, or purchased particularly for N_2O service. Only chemically compatible, low-permeability o-rings are used. Even the casing sealant is use-specific. In order to insure that the pump interior remains chemically and work-related compatible, Smith liquefied N_2O pumps cannot be utilized for other liquids.*** **Such precautions should also be taken in the construction and exclusive use of the transfer system only for handling N_2O.[1]**

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[1] ***Avoid dangerous situations. Always follow all applicable safety regulations. The system should never be used for N_2O as well as other liquids, since these may deposit combustible residues. A very thorough, use-specific, design engineering study must be done prior to constructing any N_2O transfer system. Specially-prepared components and procedures are required. Smith N_2O pumps may look like standard pumps, but there are such radical internal differences between the Smith N_2O units and all the others, that only pumps specifically constructed for N_2O can be safely utilized in this service. For example, as is the usual case due to the Smith pump's design-specific nature, although the normal physical transfer characteristics of liquid N_2O are practically the same as those of liquid CO_2 handled under average low-pressure conditions, Smith CO_2 pumps are definitely not compatible with Nitrous Oxide.***

The application limits stamped on all Smith N_2O pump tags read as follows:

Maximum Case Pressure: 400 PSIG
Maximum Discharge Pressure: 400 PSIG
Maximum Differential Pressure: 50 PSIG

Due to the inherent nature of low-pressure liquid Nitrous Oxide bulk transfer, especially in mobile systems, Smith pumps are purposely designed with *a high margin of resistance, for safety*. The theoretical design criteria for Smith N_2O pumps call for capabilities beyond the normal temperature and pressure ranges as specified on the pump tags (above).

Basic Precautions. Always maintain a high level of cleanliness in the transfer system. Be sure that the pump has "flooded suction" at all times; in other words, the Net Positive Suction Head Available (NPSHA) at the pump inlet line connection, must always be high enough to prevent the liquid from cavitating ("flashing") as it enters the pump. All pumped fluids should be free from abrasive pollutants, especially in mobile systems where certain amounts of pumped N_2O may continuously recirculate back to the supply tank through the bypass system. Do not allow moisture into the pump. Never totally vacate the supply tank with the pump. Never run the pump "dry". *Be sure that the pump inlet line is short and properly sized to accommodate initial liquid flow acceleration when the pump first starts.*

As a good "rule-of-thumb", the inlet line to the pump should always be at least the same size as the pump inlet port. Our small capacity pumps have 3/4" FNPT inlet and outlet connections, medium capacity 1-1/2", and high capacity 2", 2-1/2", and 4" threaded, or equivalent-sized flanged connections. The pump should be as close to the supply source as practical, preferably in such a manner that the horizontal leg of the inlet line is no more than 10 - 12 feet long in a stationary system, and no more than 5 - 6 feet long in a mobile system. Always construct the piping in a safe manner, with due regard for applicable safety regulations. Read and understand applicable authoritative and engineering references. Consult with the N_2O manufacturers, and with the fabricators of other equipment used in the installation for greater insights into proper system design, use, and maintenance. Consult with the factory if there are any questions. Avoid potentially dangerous situations.

Keep in mind that the amount of available gravity head pressure is a variable, as is the amount of vapor, which may be carried by the liquid flow into the pump. These factors depend upon (1) the liquid density; (2) the liquid column height; (3) the liquid temperature, which can be affected by a wide variety of factors in an artificially refrigerated environment; (4) the liquid's natural vapor pressure at the time the transfer is made; (5) the size, length, and condition of the inlet line and all of its components; (6) the physical size and shape of the pump supply tank; (7) the operational procedures followed at the site; and (8) the drive speed of the pump.

We can state in this technical bulletin that for most Smith N_2O medium to high capacity bulk transfer models used under average conditions, the minimum NPSH requirement at the pump inlet connection is usually somewhere between 1 - 2 feet. Never the less, with variables such as those previously mentioned, any attempt to express an exact minimum gravity head requirement without first completing a study of the piping system and environmental conditions, could be very misleading.

<u>Pump Drive Speed</u>. If the pump must be left running for more than two consecutive hours, it should not be driven at, or very near, its maximum design speed. If the differential pressure can be kept below 40 PSID, the pump may be run as slow as 750 RPM. In most cases Smith pumps driven between 1100 - 1500 RPM give the best results: well-installed pumps still develop the maximum recommended differential pressure without cavitating, their service life is greatly prolonged, and they will not produce excessive noise.[2] See Catalog "CP-1", Technical Bulletins "AL-17A", "AL-97", "206", and others, for additional *general* information.

<u>The Smith Shaft-Seal Assembly</u>. A very unique and practical feature of the Smith Nitrous Oxide pump is its pre-tested integral shaft, ball bearing, and seal assembly ("shaft-seal assembly"). This assembly has many advantages over conventional two-piece mechanical seals. It is manufactured completely in-house to our own specifications. It is of a very adaptable three-piece design, which cuts the surface speed of the mating seals to half that of a two-piece seal. The net result is prolonged mechanical shaft seal life, with proportionally less frictional heat generation.[3]

<u>Differential Pressure Capability</u>. The Smith pump is quite capable of developing much higher differential pressures than the maximum stamped on the pump tag, "50 PSID". However, based on many years of experience with N_2O cold storage installations, maintaining this limitation helps to insure system operational safety and pump longevity. If higher-than-normal differential pressures are required, contact the factory for additional information *prior to installing the pump*.

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[2] It is not necessary to always run the pump at or near its maximum design speed as stamped on the tag. It should be noted here that the noise produced by a Smith pump is directly proportional to its RPM. If a silent running pump is desired, all that usually needs to be done is to slow it down. Contact the factory for additional details (see footnote "11").

[3] This is one of the reasons for the success of this sealing design modified specifically for use in relatively difficult N_2O liquid mediums. The same design concept can be used under all conditions within pump working limitations. With minor modification, it can withstand intermittent to continuous vacuum, thermal shock, and wide temperature / fluid viscosity ranges beyond those considered as "standard" in this service. Should the seal assembly have to be replaced, this can be done without disrupting the integrity of the "sub-assembly package" as received directly from the factory. However, we do not recommend that any parts replacement be done with the pump interior exposed to an outdoor environment. (See appropriate technical bulletins, service manuals, or contact the factory for additional information).

Limited Shelf Life. Please be advised that although great care is taken when boxing pumps for shipment, there is a very definite limit on their maximum storage time. Due to the nature of Nitrous Oxide, Smith pumps specially manufactured for this service have a very limited shelf life *even if left in the original factory crate or carton.* Once received, they should be put into service immediately. Units, which have been manufactured more than two months prior to their installation, should be returned to the factory for recertification. Failure to follow this recommendation can lead to rapid failures, and mechanical seal leakage.[4]

Limited Useful Service Life. Most Smith pumps usually last for several years. Handling liquefied Nitrous Oxide in its cold storage state, is a relatively difficult application. Pumps in this service tend to wear out more quickly than those in other similar services, and therefore require preventive maintenance at regular intervals before they lose efficiency due to excessive wear. When the pump can no longer be properly repaired in the field, remove it from service immediately, and replace it under our "Exchange Plan". See Bulletin "AL-1" for additional information.

Piping Installation. *We cannot be responsible for the design and use of the piping systems in which our low-pressure liquefied Nitrous Oxide bulk transfer pumps are installed. We can only make general installation recommendations*. However, we can state that low-pressure liquid N_2O transfer systems should only use *approved* Schedule 80 heavy-duty steel pipe, hoses, fittings, and other equipment, specifically prepared for this service. Safety considerations must be taken very seriously.

Be sure to consult with the other equipment manufacturers, and be sure to follow their instructions. Nitrous Oxide system engineering requires trained specialists in this particular field. Be sure that the piping installation is engineered, constructed, and cleaned properly by qualified personnel, and that all safety codes, pertinent authoritative references, and manufacturer's design recommendations are followed.

Bypass Valve. If the pump builds up an excessive "differential" pressure, a bypass valve installed in the system should open and allow enough of the liquid pumped to return to the storage tank to relieve the pump strain. The discharge should enter the

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[4] It should also be noted that the replacement shaft-seal assembly, which is sold separately as a repair item, also has the same limited shelf life. If the Smith mechanical shaft-seal assembly for Nitrous Oxide cannot be utilized within two months from its date of manufacture, *it should not be used in the pump*. It should be returned to the factory, and exchanged for another one.

If the mechanical seal should fail while the pump is in service, the pump should immediately be stopped, *carefully depressurized,* and properly removed from the piping system, in the appropriate manner as prescribed by applicable liquefied gas safety codes and company procedures. *Care must be taken to prevent subsequent entrance of moisture into the pump interior and piping when this is done*. Seal assembly replacement must be accomplished in a clean, dry, protected indoor environment only. Every precaution must be taken in the meantime to insure no entrance of moisture, debris, or other contaminants into the pump interior and the corresponding piping system.

pump supply tank in such a way as to dissipate absorbed heat before recirculating back to the pump inlet, thereby automatically preventing overloading without overtaxing the pump. This avoids bushing, gear, and mechanical seal breakdown due to lack of required cooling effects from the pumped fluid. The bypass valve limits the differential pressure, and should be set at no higher than 50 PSID, which is the maximum recommended differential pressure for the Smith N_2O pump. Smith N_2O bypass valves are ideal for these applications, and are easily adjustable to lower settings for longer pump life.

<u>Pressure Gauges</u>. Always install recommended, legible, pressure gauges on both sides of the pump. These will enable the operator to readily determine the efficiency of pump operation. Do not use just any pressure gauges: be sure that the gauges are *specifically recommended for N_2O service*. Consult with the pressure gauge manufacturers for specific product application information.

<u>Strainers</u>. A properly-sized strainer should be installed in the pump inlet line. The close clearances in the Smith low-pressure liquid Nitrous Oxide bulk transfer pump require this protection. The recommended U. S. Screen Mesh nominal size is "80 x 80 Mesh", with a particulate entrapment capability of 0.006 - 0.008 (thousandths of an inch, nominal rated diameter size of solid particles). Remove and clean the screen element frequently, especially in mobile installations.

<u>Flame Arrestors</u>. We highly recommend the installation of specially-designed flame arrestors on both sides of the pump (near the inlet and outlet).[5]

<u>Electric Motors</u>. Most Smith Nitrous Oxide pumps are direct-driven by electric motors; engines are not generally recommended. Whatever driving device or devices are used, *be sure that they are properly rated for this service*. Electric motors, for example, should be of the "*Explosion-Proof*" type. Related controls, gearboxes, pulleys, belts, etc. may require special modifications. Consult with the manufacturers before considering driving the Smith pump with any of these devices. Consult with the safety authorities.

<u>Couplings, Pulleys, and Universal Joints</u>. These items must be installed on pump shafts with care. Do not drive or hammer these connectors onto the shafts. Forcing in this way damages the pump outboard ball bearing, shaft, and seal parts, as well as the internal keyways. The driving device used has to slide easily onto the shaft. If it does not, do not force it in place. Likewise, if the drive mechanism will not easily slide off the pump shaft, do not force it off by hammering or prying. Contact the manufacturer for recommended removal and assembly procedures. Do not forget to install the drive key, as otherwise the driving device will slip and cause damage to

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[5] It should be noted here that *<u>strainers are not designed to break-up flame fronts</u>*. The recommended flame-arresting device is a specialty product. Please consult with the major manufacturers and other distributors of low-pressure liquid Nitrous Oxide for additional information.

itself and the pump shaft. Tighten properly all set screws to prevent vibration and slipping during operation.

When aligning these items, follow manufacturer's recommendations. Many times standard texts can be consulted for this operation. After installation is complete, check for proper alignment once more. Also, check for interference, by turning the assembly by hand. Be sure tension is correct, and that any overhung loading is not excessive.

<u>Do Not Overstress Pump Casings</u>. All piping to and from the pump should be supported independently to minimize the forces exerted on the casings. Excessive piping-caused forces can produce excessive stress on internal working parts, resulting in excessive gear, bushing, seal, and shaft wear. Thermal expansion and contraction of an improperly designed piping system can overstress the pump connections, and also cause related problems elsewhere in the installation. Do not overly tighten any pipe connections on the pump. Pump alignment should be rechecked once the system has been charged and has cooled-down.

<u>Pump Should Be Easy to Remove</u>. The pump should be so situated that maintenance and periodic inspections as we recommend, can be easily accomplished. Care should be taken to insure adequate space to remove or adjust drives, couplers, universal joints, valves, motors, etc.. Arrange wiring conduits to have enough flexibility to permit a drive motor to *safely* be moved away from the pump, or off to one side. This will allow easy removal of the pump for repairs or replacement, as required. *The use of our flanged models is highly recommended, especially in mobile installations*.

<u>Design of Pump Inlet Line</u>. The pump should be mounted close to the supply tank, right under it, or just a few feet away. The bottom of the supply tank should be at least a few feet higher than the pump, in order to provide the correct amount of "flooded suction" (NPSHR). Never run a Smith pump without sufficient net positive suction head pressure available from the piping system.[6]

Even though low-pressure liquid Nitrous Oxide is artificially refrigerated, *it is still at its boiling point in the supply tank*. This is why a certain amount of gravity-induced pressure from the liquid column height is so necessary in preventing the pump from handling partially vaporized fluid, or from just completely vapor-locking. Such a situation leads to rapid breakdown from excessive frictional stress.

Cavitation and vapor lock must be avoided through proper piping. The pump must be at the lowest point in the inlet line. The inlet line should be so designed that vapor formed by absorbed heat can travel back to the tank when the system is not in

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[6] See Technical Bulletin "AL-17A" for additional information on this subject, and related aspects.

service. Heat gain should be minimized through the use of proper insulation, and by routing the piping away from heat sources. ***Never connect even a small line from the tank vapor phase to the liquid inlet line of the pump.***

Pump Disassembly. ***There is a specialized procedure for disassembling, inspecting, and reassembling a low-pressure liquid Nitrous Oxide bulk transfer Smith pump.*** **Haphazard methods arbitrarily applied to these operations will probably result in malfunction and product leakage to atmosphere. Before disassembly, be sure to read and understand all repair manuals and other instruction sheets. Contact the factory if there are any questions.[7]**

Periodic Inspection. Since low-pressure liquid Nitrous Oxide provides essentially no lubrication qualities, it is very important to insure that the liquid flow through the pump is always capable of absorbing, and carrying-off, frictional heat produced by the normal functional aspects of the working parts. In order to compensate for this pump-related heat gain (which is proportional to the amount of work accomplished by the pump), there must be adequate liquid flow through the unit at all times.

It should be noted that since low-pressure liquid Nitrous Oxide is handled at its boiling point, excessive internal pump wear eventually promotes cavitation. This causes excessive vapor displacement in the "solid" liquid delivered to the inlet side of the pump, thereby lowering the liquid output flow rate. The resultant flow of vapor and liquid fluid mixture, cannot properly compensate for normal friction factors. This kind of pumping inefficiency causes rapid failures. If a Smith N_2O pump is simply run until it no longer functions properly, by the time it is taken out

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[7] There is some good, basic information in Technical Bulletins "AL-17A", "AL-97", "AL-99", and "206". However, these bulletins were not intended specifically for Smith Nitrous Oxide pumps, which are *special*. As previously mentioned in this discussion, we cannot overstress the importance of *cleanliness* when any kind of repairs are accomplished. Unlike the average Smith pump which does not require such near-perfect conditions, the N_2O units should never be disassembled in an outdoor environment.

If liquid cleaning fluids are used, care must be taken to insure that their use will not lead to a violent chemical reaction in the system. Be careful. Some cleaners cannot come into contact with o-rings utilized in Smith pumps, and in Smith pump flanges, which are specialized Butyl and / or other similar synthetic compounds. See the assembly drawings and photographs of the particular model in question for the location of these o-rings. ***The degreasers (cleaning fluids) utilized must be of a type recommended by the manufacturer for cleaning pump parts 100% exposed to Nitrous Oxide liquid and vapor.*** **Once the pump is cleaned, remove all cleaning agent and residues prior to installing the pump to prevent unforeseen dangerous chemical reactions from taking place.**

Smith N_2O pumps do not use gaskets. To effect a vapor-tight casing seal, special approved sealant is sparingly applied to sealing surfaces, by hand. (See Page 12) Never reassemble the pump without first removing the old sealant, and then reapplying the recommended casing face sealant. Only apply the sealant sparingly. If excessively applied it will extrude into the internal working clearances, and cause pump failure.

of service, it usually does not lend itself to standard field repair procedure. That is due to *very extensive resultant internal damage*. This situation must be avoided.

Preventive maintenance **(as opposed to attempting an after-failure repair), insures highest possible pumping efficiency during the pump's useful service life, thereby maintaining more adequate flow cooling effects. Periodic inspections allow the user to know exactly when preventive maintenance must be done. This procedure also helps to prevent unexpected pump failures, an aspect which can be extremely critical, especially to the success and safety of mobile distribution operations.**

Exactly when to periodically inspect the Smith pump, is determined by actual use experience. After using the pump to transfer Nitrous Oxide for a relatively short interval before any of the working parts could wear excessively (for example, after only 100,000 USG for medium-capacity units, and after only 200,000 USG for high-capacity models), the pump in question is safely depressurized, carefully removed from the system, disassembled in a protected indoor environment, and properly inspected to determine the condition of major wear areas (such as the working sides of the gear teeth). This first inspection is done even though all indications are that the unit is still pumping efficiently. Measurements are taken, and the data is recorded in the maintenance log. If these wear signs are negligible, the next inspection can be done at double the original number of gallons. After the second inspection, if the same conclusion is reached, the original gallons pumped can be tripled for the following interval, and so forth, until finally after a determined volume of pumped product, certain internal pump parts must now be replaced. *The "preventive maintenance interval" for replacement of these same parts will now be whenever the pump has handled approximately half of this ultimate number of gallons*.[8]

When the "preventive maintenance interval" approaches, let the factory know the pump model number and serial number. Order a set of working parts at that time, as determined by the aforementioned procedure. *Do not store working parts for an undetermined amount of time. Smith Nitrous Oxide pump parts have a very limited shelf life*. Order parts when they are going to be used. If it is impractical or not economical to repair the pump, order an exchange unit from the factory.

Do not take the functional unit requiring preventive maintenance out of service until the parts are received. Upon receipt of the replacement parts kit, blow the pressure out of the pump in a safe manner. Take precautions to avoid excessive condensation of moisture within the pump and piping during this time. Carefully remove the pump from the installation, and take it to a clean, protected, indoor area. Then, remove the gear end cover. Exercise proper precautions to prevent hazards. Check

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[8] **Contact the factory for information on proper working and non-working part sizes. Follow the general clearance-measuring procedures in Technical Bulletin "AL-97".**

the pump casings and working parts for wear, as per the procedures specified in Technical Bulletin "AL-97".[9]

If the casings can be used again, before reassembling the pump, clean all parts very carefully. Do not leave undesirable residues inside the pump. Remove all old sealing compound from the faces of the gear end cover and the housing(s). Be sure there are no nicks or burrs on the sealing faces, or inside the liquid flow areas. Be sure all mating surfaces are flat. Never reassemble a Smith pump without applying the recommended sealant to the casing faces. (See Page 12) Be sure the proper amount of sealant is sparingly applied. If not sure, after properly tightening the bolts as per the procedure described in Technical Bulletin "AL-99", disassemble the pump again and observe the sealant distribution pattern against the two mating faces. Make sure the pump and sealant are at comfortable ambient temperatures above 50° F. Contact Smith Precision for additional details.

It is very important to accomplish this job, properly. *Do not continue to run a pump with worn parts, worn casings, or a leaking mechanical shaft-seal assembly*. Do not reassemble and use the pump if the casings in the areas of the working parts are worn. New working parts used in worn out pump bodies will result in inefficient performance, excessive internal friction, cavitation, and shaft seal leakage. If during the inspection procedure it is determined that the casings are excessively worn, order an exchange pump.[10]

Be sure that the internal liquid flow ports in the cover are aligned properly with the corresponding ports in the housing(s), as otherwise the pump will not function. In the case of Nitrous Oxide service, the pump will cavitate if its internal porting is mismatched. Be sure that the end cover is flat against the main housing, and contacts the complete surface. The same holds true of any other housings, which seal together in the pump assembly.
Be careful not to allow debris or moisture to be caught in the sealant before or during assembly. Debris would not permit proper contact between the two mating surfaces and may also be flammable. Be sure to tighten all bolts to the proper torque, as per the procedure described in Technical Bulletin "AL-99". Do not use lock washers, or any other similar devices, under the bolt heads. Be sure to pressure test the pump before putting it back into the system. Make sure all these procedures are accomplished safely.

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[9] Always keep Smith N_2O pumps installed and under product pressure, as long as possible. Expose the pump interior to atmospheric conditions only as long as necessary to replace parts. *Do not store new or repaired Smith N_2O pumps indefinitely*. Their storage life is minimal. They should be immediately returned to service. Contact the factory if there are any questions.

[10] It is extremely important to follow all required procedures when assessing internal pump damage, and when effecting these repairs. If there is any question about any of the procedures we have been discussing, *do not continue*. *Contact the factory immediately.* Do not assume anything. Do not guess about anything. Be sure all of your procedures are safe. Follow all applicable safety regulations.

Mechanical Seal Leak Detection Port. All Smith pumps for low-pressure liquid Nitrous Oxide bulk transfer service, are provided with a small leak detection port located at the bottom of the shaft end cover, near the front of the pump where the drive shaft exits the casing. Should the mechanical seal assembly leak, the escaping product is purposely directed out to atmosphere from this "bleed port". *Should a mechanical shaft seal leak be detected, take the pump out of service immediately, and investigate the cause of the seal leak.*

In N_2O service, an apparent Smith mechanical seal failure does not necessarily mean that the only thing wrong with the pump is worn-out shaft seals. It is often a mistake, under these particular circumstances, to assume that the cause of the problem rests solely with the mechanical seal assembly. In low-pressure liquid Nitrous Oxide service, observed mechanical seal leakage is usually a symptom of another entirely different internal problem. Simply replacing the seal assembly will probably not remedy the situation, and the atmospheric discharge will continue afterward, just as before.

For example, if the working sides of the gear teeth have worn too much, the resultant pumping inefficiency and cumulative effects of friction will cause even a new seal assembly to chatter and leak, sporadically.[11]

When attempting to remove the shaft-seal assembly from the Smith N_2O pump, do so in a safety-conscious manner. Depressurize the pump very carefully, in the prescribed safe sequence. Do not ever remove the shaft-seal assembly until there is no pressure in the pump, or until outside and inside pressures equalize.

Pull the shaft straight out to avoid damage to the bushings in the housings. In high capacity units with secondary gear housings, the coupling keyway of the pump drive shaft must be at the top dead center position before the shaft is pulled out, to avoid bushing damage. If the bushings are damaged by not aligning the keyway properly first, or by pounding the shaft sideways, or by forcing it abruptly in any direction at

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[11] This is one more reason why preventive maintenance must be done on these pumps, at regularly scheduled intervals. In a typical N_2O pump failure scenario due to excessive gear wear, had the gears been replaced in time, the shaft-seal assembly would not have leaked in the first place, and the pump would have not broken-down. Very extreme casing wear occurs mostly after the pump continues to be utilized with excessive gear backlash clearance (see the table in Technical Bulletin "AL-97"). Coincidentally, most Nitrous Oxide pump failures relate to not replacing the gear set in time, a condition which is aggravated if the pump is run at, or very near, its maximum design speed.

Unlike other makes of positive displacement pumps, the Smith pump is designed for a simple, direct base-mounted connection to four, six, or eight-pole electric motors. It can be driven at any speed within the factory-determined RPM range. For most applications handling low-pressure liquid Nitrous Oxide, the best speed range falls within 1100 - 1500 RPM. One advantage in running the pumps within this speed range is that they will not produce bothersome noise that can result from 4-pole, 60Hz motor speeds (see footnote "2").

angles to the pump centerline, extremes of friction will develop inside the pump due to bushing breakage.

In a very few cases where the shaft is unusually tight, you may have to remove the pump gear end cover and *lightly* tap on the shaft through the center gear, using a soft metal drift, pushing the shaft only along its centerline, until it releases from the drive gear(s). Driving the shaft straight out of the pump in this manner will not damage the bushings, provided the gear keys are properly aligned first. Be sure that before this is done, the drive shaft keyway is positioned at 12:00 (top dead center), as viewed with the pump mounted horizontally. This operation can be done carefully on a press. *This operation must only be done when the pump is out of the piping system, and in a clean, protected, indoor environment. Do not hammer on the drive coupling to effect this operation.*

The "bleed port", or "leak detection port", under the front end of the pump near the drive shaft exit, is protected by a device resembling an oil fill cover. Its function is not for external lubrication. The Smith low-pressure liquid Nitrous Oxide bulk transfer pump does not require external lubrication. Its prelubricated outboard ball bearing is permanently sealed. The "bleed port" serves as a pressure relief channel. Should the mechanical seals begin to fail for any reason, the product discharge will occur from this area. Mechanical seal leakage activates the secondary rotary lip seal, which diverts discharge of pumped product through the leak detection port, and away from the outboard ball bearing.

Check the condition of the protective device ("bleed cup"), which prevents entrance of debris from the external environment into the leak detection port (seal bleed exit port). If it is damaged, replace it. Under no circumstances use the pump with a blocked bleed port, and do not use the pump without a properly functioning "bleed cup". Make sure that this port is always open, and that the hinged cover of the bleed cup remains shut under its spring tension, but can be easily opened. If the exit port in which the bleed cup is installed is blocked, clean it very carefully. Do not put grease or oil in this port, as it is not there for lubrication purposes. Do not run a line from this port back to the system. Do not modify this port in any way. Leave it as it was when the pump was shipped from the factory.

<u>Installing the Shaft-Seal Assembly into the Smith N_2O Pump</u>. Slide the replacement mechanical shaft-seal assembly into place, making sure that the outer keyway is at the top. When the shaft is most of the way in, a resistance may be felt. This would mean that the inside shaft keys do not quite line up with the keyways in the gears. Turn the shaft a little, back and forth, while *lightly* pushing by hand, until the keys are felt to enter the keyways. Larger pumps have more sets of gears, and this operation may have to be done more than once. Do not hammer on the end of the shaft it will not go in. *Forcing the shaft will do extensive internal damage to the pump.*

Push the new assembly the rest of the way in, by hand only, and replace the bearing retainer plate and screws or bolts, and reconnect the drive coupling. Do not use grease or oil on the pump or seal assembly to facilitate this operation. Make sure the work area is in a clean, dry, protected indoor environment and not subject to outdoor weather conditions. Do not overtighten the fasteners. Do not undertighten the fasteners.[12] Contact the factory for additional information.

<u>Procedure for Applying Casing Sealants For Nitrous Oxides Pumps</u>. The recommended sealant application procedure is a TWO-STEP process involving two different sealants, Formula 8 Manufactured by Fluoramics Inc., and Dripstop 950 manufactured by Hernon Inc. Both sealants must be applied as per the following procedure.

1. **Casing faces requiring sealant application must be free of all organic material and must be clean and dry. Surface imperfections must be eliminated. Close examination of these surfaces must be implemented.**
2. **Apply an extremely thin coat of Formula 8 sealant to the surface to be sealed. Immediately rub off all excess sealant and make certain there are no areas where Formula 8 has been concentrated (high spots). The key in this application is simply to fill-in extremely small surface imperfections in the surface to be sealed. There should not be a thin layer of formula 8 left on the surface to be sealed. Allow 24 hours to dry.**
3. **Apply Hernon Dripstop 950 sealant directly over the dried Formula 8. Apply sparingly.**
4. **Assemble the surface to be sealed onto its' mating surface.**
5. **Torque cap screws as per Smith literature sheet AL-99**
6. **Once the pump is completely assembled, pressure test using Carbon Dioxide vapor, or approved inert gas and check for leaks. Test pressure should be at least 350 PSI.**

WARNING: Do not use any other type of sealant. The above sealants are Oxygen Compatible <u>and</u> approved for Nitrous Oxide use. Use of other sealant types may result in pump leakage, spontaneous combustion, fire, or explosion.

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[12] See Technical Bulletin "AL-99" for proper torque ratings and other aspects of the fasteners used in Smith pumps.