SAFETY ALERT - #04-2009
RUPTURE OF HIGH-GRADE NITRILE HOSE
RELEASE DATE: APRIL 14, 2009

Function: All Oil and Gas Operations	**Incident Date:** May 26, 2007
Location: Offshore	**Location Detail:** Floating production storage unit
Incident Type: Equipment Failure	**Country and Region:** Canada, Offshore Newfoundland

Summary

A 4" diameter N2581 Petralflex high-grade nitrile hose ruptured during normal operation.

Description of Incident:

An operator was conducting a standard chemical cleaning job when the 4" flexible hose he was using ruptured. The operator was sprayed in the face with the chemical but sustained no injury. Details relevant to the incident are:

- The hose was located on the suction side of the loop between the pump and the line filter. The hose rupture occurred during a filter switch procedure which involved a pressurized transfer (approximately 700 kPa) of remaining fluid in the inactive filter to the active filter.
- At the time of the rupture, the chemical mixture was at a temperature between approximately 75 ^{o}C – 80 ^{o}C. System pressure (monitored at the pump) was approximately 480 kPa.
- The mechanical specifications for the 4 inch diameter N2581 Petralflex high-grade nitrile hose were provided as: rated working pressure: 1000 kPa, Burst Pressure: 4150 kPa, minimum bend radius: 10 inches, Operational temperature range: -40 ^{o}C – +82.2 ^{o}C (See Figure 1).

Results of Investigation:

A detailed failure investigation confirmed that the rupture was caused by excessive flexing of the hose exceeding the specified minimum bend radius recommended by the manufacturer. Sources of excessive flexing identified include:

1. The hose configuration currently utilized to transport the hoses and the use of relatively tight "pigtails" during job site operation. For transportation purposes the hose ends were joined, which imposed a bend radius below the minimum specified by the manufacturer. This excessive flexing of the hose caused minor delaminating and tearing of the inner nitrile tube layer of the hose. (See Figure 2)
2. Prior to the failure, the centrifugal pump utilized in the system loop was replaced by a double diaphragm positive displacement pump. The varying suction pressure associated with the use of the positive displacement pump units may have caused any delaminations and tears to grow.

Because of this, the pressures required for the filter transfer procedure exceeded the remaining strength of the hose, resulting in the failure of the hose.

It is worth noting that several other hose manufacturing issues were also identified during the failure analyses which could become a factor in other service applications:

1. The partial collapse of one of the barbed nipples associated with a swaged hose termination. The collapse observed has been attributed to the incomplete penetration of the longitudinal weld on the barbed nipple.
2. The inner nitrile layer was damaged inside the ferruled termination. It is believed that the cuts were generated by the internal barbed nipple during the hose termination procedure.

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Recommendations for Preventing Future Incidents

The maximum measure of flexibility for a given hose construction is typically defined by a minimum bend radius which is specified by the manufacturer. To maintain the integrity of a hose, this minimum bend radius cannot be exceeded when storing, transporting or using the hose. The appropriate method for storing hose depends to a great extent on its size (diameter and length), the quantity to be stored, and the way in which it is packaged. Hoses should not be piled or stacked in a way creates distortions on the lengths stored at the bottom.

Figure 1

The internal diameter cannot be any less that 20 inches so as not to be below its specified mimimum bend radius during tranporation or use.

Figure 2

This photograph shows the two circumferencial tears in the inner nitrile layer and circumferencial compression wrinkles.

Source: Wayland Engineering Ltd.; Failure Investigation Of N2581; Corrugated Petrall Hoses; July, 2007

The manufacturer, Goodall Rubber, recommends that their hoses be re-inspected and retested once a year if it is in use. When being re-inspected it is important to look for visual failures such as kinks and tears in the outer and inner layers of the hose. If the visual inspection passes, then a hydrostatic test and a conductivity test are also recommended to confirm hose integrity.

Other recommendations maintaining the integrity of hoses include:

- Protect hose from high temperatures by avoiding storage near steam pipes, radiators, hot air registers, engines, etc. Good storage temperature is 2°C to 27°C.
- Store hose in a flat coil. Be sure no kinks are left in the coil. Lay it on the floor, a shelf, or a table; or store long length hose on a reel. If hose is not reelable, store it in straight lengths.
- Store hose in a cool, dry, dark, and clean place. Protect hose from ozone (O3), the active form of oxygen which is more prevalent in the atmosphere than many people think. Store away from electrical or ozone generating equipment. Paper, wood, and rags are good O3 absorbers.
- If possible, original packaging should be maintained when long storage is involved.

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