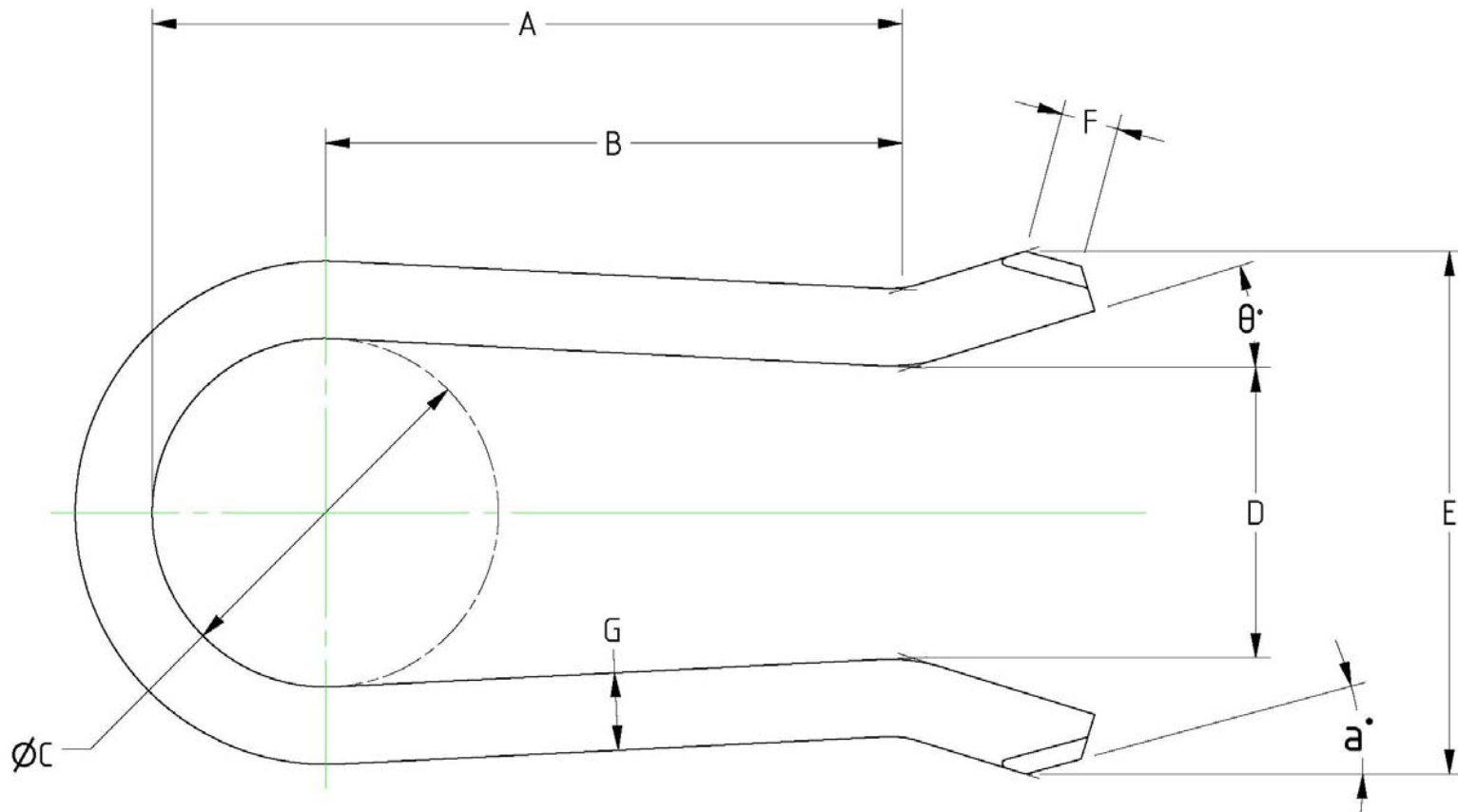


# STAPLES



1800- pre war

Coal extracted by pick & shovel

Post Second World War

Hydraulics used in mines for control systems

**1946** Kelle Patents **first Staple** based on **12 Mpa** (1750 psi)

1950's – 1970's

Development of low seam Longwall type mining, using 6 leg supports

Staple technology (Stecko) adopted in longwalls

1970's – 1990's

Roof support designs improved to 4 & 2 leg shields

1979 Greenwalt Patents 'D' section staple

Hydraulic pressure increased from 20 Mpa (3000 psi) to **35 Mpa** (5000 psi)

1988 Hinksman Patents 'Super Stecko'

In-bye Pantec / main gate drives increase pump flow requirements

Guaranteed set at **42 Mpa** (6000 psi)

1990's to date

Electro- hydraulic controls

Out-bye pump stations + Monorails (increased flow)

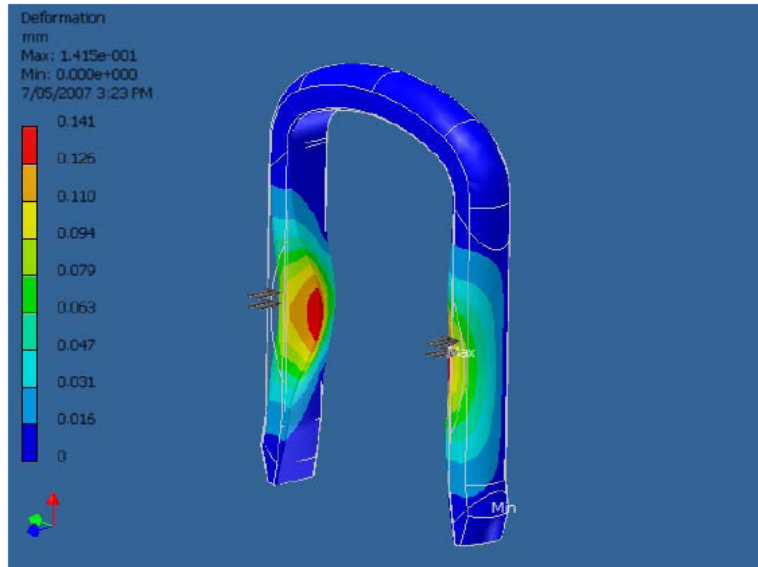
Yield valve pressures raised to **52 Mpa** (7500 psi)

DN63, 35 Mpa (5000 psi) Monorail supply

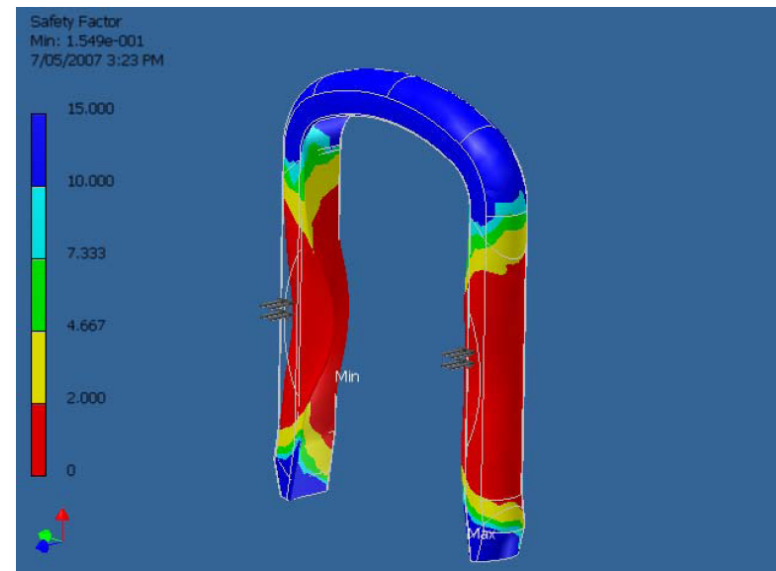
# Known Staple limitations

FEA & FMEA

Deformation



FOS



anything  Parker  
Possible.™

STANDARDS	DN	A ± 0.5	B ± 1.0	C ± 0.5	D +0.5 -0.0	E +0.5 -0.0	F +1.0 -0.0	G SQUARE	G WIRE Ø	H ± 0.25	a	θ ref.
BS 6537 SQUARE SPRING	10	38	19	14	12.5	22.9	3	3.93 4.07	NA	4	10°	8°
BS 6537 SQUARE S/S	10	41	26	14	13	25	3	3.93 4.07	NA	2.5	15°	20°
BS 6537 ROUND S/S	10	37	18	14	11.8	24.2	3	NA	4.78 4.72	NA	20°	10°
STANDARDS	DN	A ± 0.5	B ± 1.0	C ± 0.5	D +0.5 -0.0	E +0.5 -0.0	F +1.0 -0.0	G SQUARE	G WIRE Ø	H ± 0.25	a	θ ref.
SAE J1467	10	NA	NA	NA	NA	NA	NA	4.07 3.93	4.78 4.72	NA	NA	NA
STANDARDS	DN	A	B ± .25	Ø C	D	E	F ± 1.0 - 0.0	G SQUARE	G WIRE Ø	H	a	θ ref.
NCB 638	10	37	18	14.13 13.87	12.30 11.80	24.7 24.2	3	NA	4.78 4.72	NA	20°	10°
STANDARDS	DN	A + 0.2 - 0.0	B + 1.0 - 0.0	C	D ± 0.5	E ± 0.2	F MIN	G SQUARE	G WIRE Ø	H ± 0.25	a	θ ref.
DIN 20043	10	38	26	14	12.5	22.9	3	4	NA	-	NA	NA

TOLERANCES ARE DIFFERENT FROM NCB 638 & DIN 20043

Nominated Working Pressure (bar)

**FOS**

Material

380

1140

**3:1**

070A72 heat treat to 45+/-5 HRC, UTS 1480 to 1520 Mpa

380

1140

**3:1**

420S37, UTS 700 to 850 Mpa

380

1140

**3:1**

UTS 700 to 850 Mpa

TOLERANCES ARE DIFFERENT FROM NCB 638 & DIN 20043

Not specified

Corrosion resistant Steel or Spring steel

TOLERANCES ARE DIFFERENT FROM BS 6537, SAE J1467 & DIN 20043

280

Not specified

Not specified

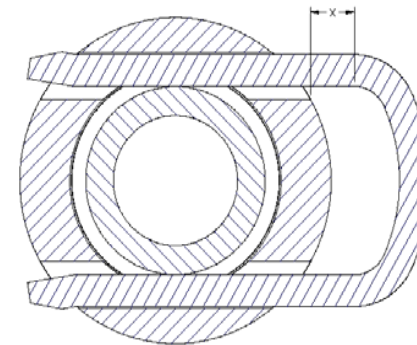
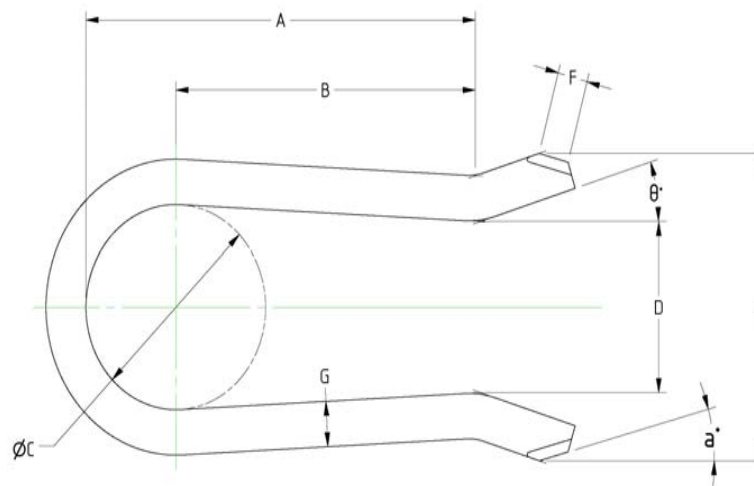
TOLERANCES ARE DIFFERENT FROM BS 6537, SAE J1467 & NCB 638

530

1320

**2.5:1**

Spring steel  
DIN EN 10270-1 S/S to DIN EN 10083-1 or 1.4310



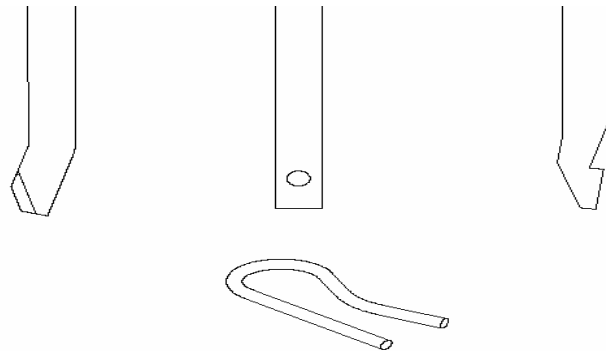
anything **Parker**  
Possible.™

# Staple retention (Walk-out)

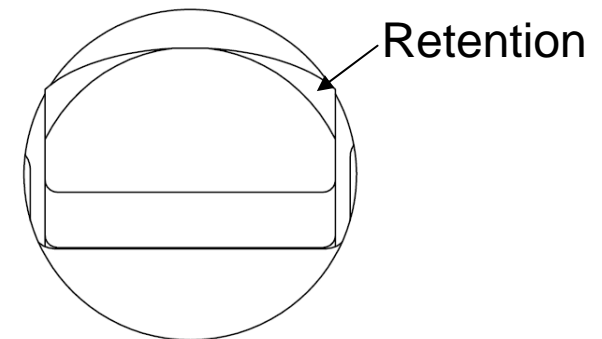
Recognized as major problem (particularly when mixing 4 known staple lock standards, SAE, DIN, BS & NCB )

Staple walk-out also prevalent with mixed source Super staple lock, as there are no standards.

(Retention methods being used: Kinked leg, 'R' clips, Wire ties, Ratchet leg, Bands, Clamps etc)

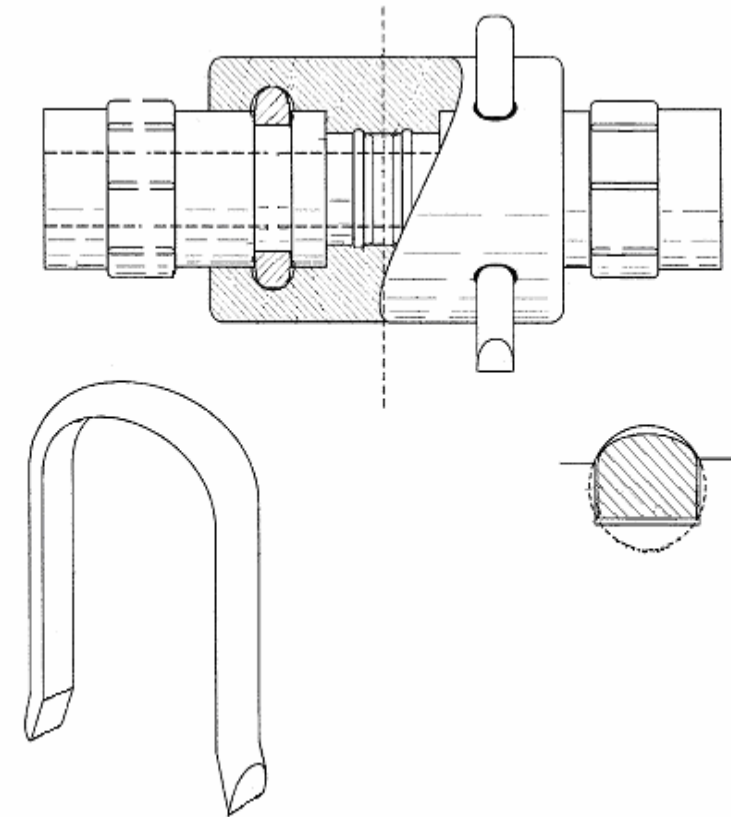


## Staple End view



# 35 MPa Staple standard

**PROPOSED ISO SUBMISSION** Based on DIN 20043 / SAE 1467 / NCB 638 / BS 6537



350 bar Staple-lok fittings for hydraulic power-transmission circuits, primarily used in mining applications.

Forward:

This proposed standard applies to staple-lok fittings and adaptors, which are used to connect hydraulic fluid based systems. The proposed standard seeks to clarify minimum material and dimensional requirements for a 350 bar connection, whilst maintaining a 4:1 factor of safety.

The proposed standard defines

- minimum working pressure of the assembled fitting (including its staple)
- relevant testing and conformance standards
- arrangement of components & their individual dimensions
- material specifications for the components
- corrosion resistance of metal components
- identification
- minimum burst pressure
- impulse requirements of the assembled fitting

## **Section 1/. Minimum working pressure**

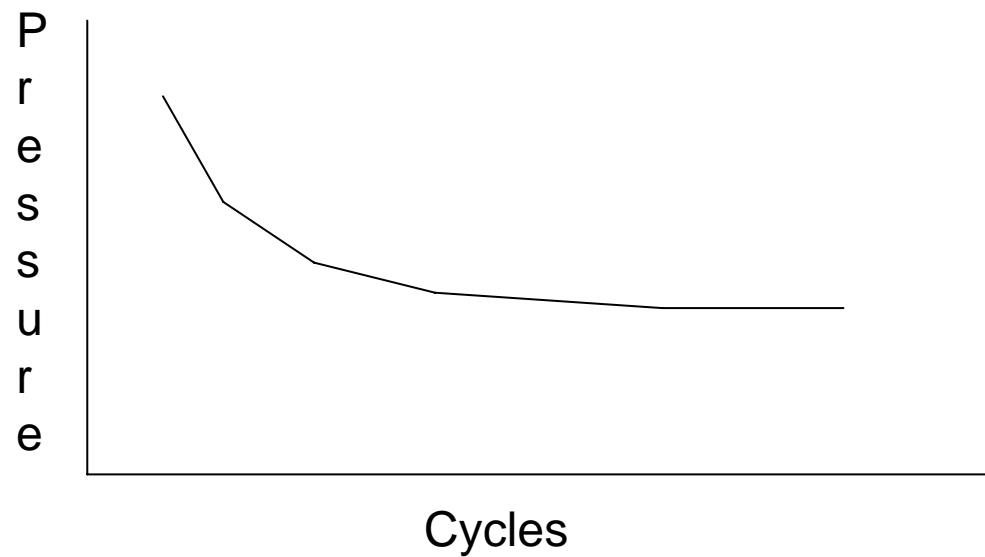
**Table 1** Minimum working pressure of the assembled staple-lok fitting based on 4:1 FOS per ISO 7751

# Cyclical testing

- Objective to create Sn curve

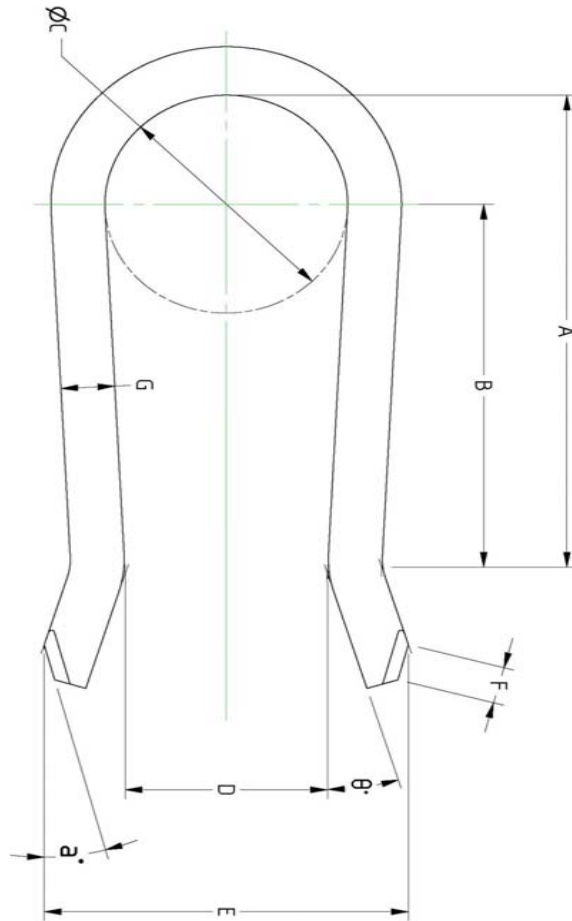
(Pressure vs cycles to  $10^6$ )

Common Impulse test



# Do's + Don'ts for Staples

Based on metallurgical evaluation



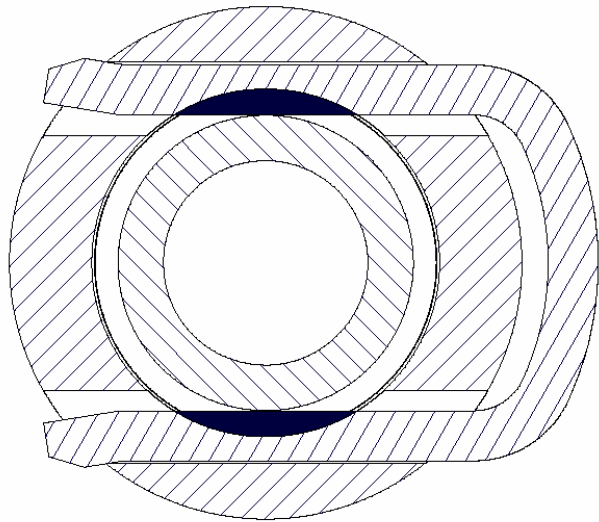
## Do's

- Understand cyclical demand
- Use staples once ONLY
- Obtain a Certificate of Conformance

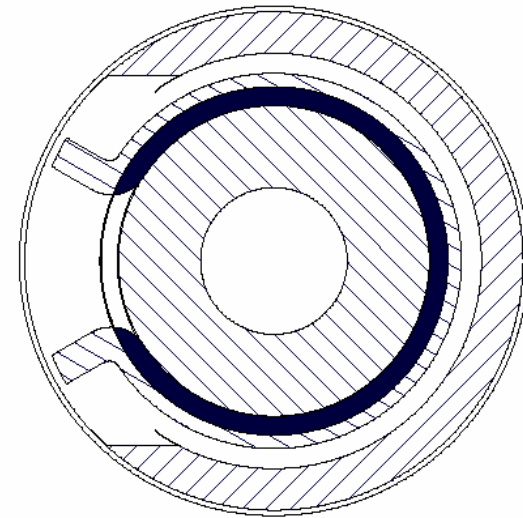
## Don'ts

- Mix & match standards
- Hardness >48 HRC
- Electroplated (Hydrogen embrittlement)
- 304 Stainless (sulphur resistance)
- Barbed legs (broaching female)
- Stamp legs

# Alternatives



**Clip-lok**  
Patented





# SAFETY ALERT

## Longwall staple failures

### INCIDENT

There have been a number of recent incidents of failed staple lock fittings with

### INVESTIGATION

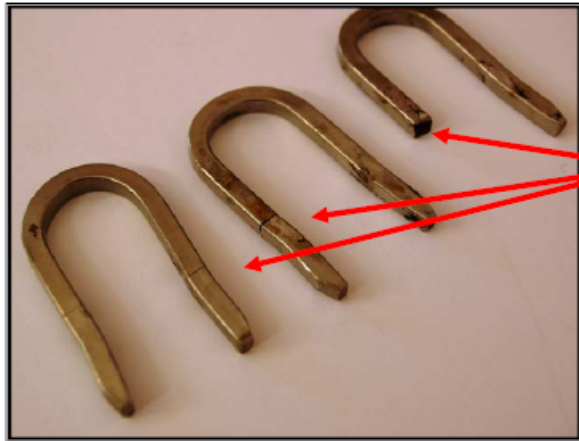
Visual audits of the longwall equipment have failed to identify any broken staples. The investigation is continuing to determine the causal factors in the incidents. General staple failure modes include, but are not limited to;

- Broken staples
- Cracked staples
- Physical abuse of staples
- Fatigue exceeding service life of the staples
- Overload of staples, evidence by witness marks (i.e., the staple has been overloaded past its design yield loading which has weakened the staple)
- Mechanical overload from external sources being hit by debris or excessive bending moment
- Wear of staples
- Wrong specification for staple material and dimensions
- Poor quality control of staple manufacture
- Corrosion.

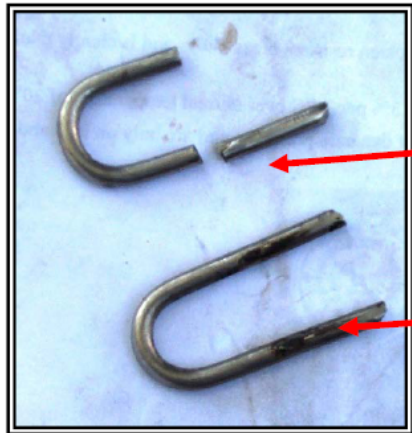


# SAFETY ALERT

## Longwall staple failures



Staple legs  
broken and  
cracked



Broken  
Staple Legs

Wear Marks



Staples worn and  
starting to wear where  
the hose is contacted

Wear marks



# SAFETY ALERT

## Longwall staple failures

### RECOMMENDATIONS

**KEY**

1. Audit staples in the high-risk areas on longwall equipment for damaged staples (outlined above in general failures). Also look for staples migrating out of position.  
**Note:** The cracked staple legs may not be visible in situ.
2. Staples should be correctly positioned and positively retained.
3. Replace a sample of the staples in the high-risk areas and have these staples inspected and tested for integrity. (Attempt to determine the staple life). This may require advice from suppliers and manufacturers in assisting to determine a wear rate for staples, given service life and location within a hydraulic system.

High-risk areas may be:

- Areas nominated by the operational risk assessment
- High-duty cycle operations
- Staples located around the walkways
- High-pressure positive set applications
- Areas where intensification is likely.

**KEY**

4. Periodically audit the face for staple condition and retention.
5. Appreciate that staples have a limited service life (undetermined). This same approach is to be used for hoses, fittings and all components.
6. Replace the staples when hoses and components are replaced (i.e., use the staples once).
7. Provide suitable levels of safety where the personnel usually operate.  
Consider a hard barrier (guard/cover) between the high-risk areas and where the personnel usually operate (both operators and maintenance personnel).
8. Provide suitable levels of safety for employees and contractors when performing maintenance.
9. Generally operate the equipment from a remote location to limit exposure (time and space between the employee and the hazard).
10. Consider a secondary means of retaining the staples (consult with the manufacturer to determine if they have alternate methods).
11. Identify the special staples in the circuit and ensure correct spares are available at the mine and that tradesmen are aware of the special staples (special staples could be the long staples that retain two or three hoses/ports or components).

**KEY**

12. Only use compatible staples and fittings. Do not mix and match different types and manufacturers' staples and fittings.

# Longwall hydraulic incidents



**255** reports over 8 years  
C.M.S. Insurance NSW

159 hydraulic hose or fitting failures  
(54 of which were fitting related)

3 of these were fatalities

Gretley – Shield cylinder Intensification (**fluid Injection**)

South Coast – LHD Accumulator fitting failure (**fluid Injection**)

Angus Place – Pump station, disconnect under pressure (**fluid Injection**)



# Hose Sleeve

Close-up view on the Hose Sleeve  
Ø0.8 mm pin hole damage



# Summary

- Audit existing staples (per DPI safety Alert SA06-18)
- Do not mix 4 known staple standards
- Support 350 bar Staple standard
- Sleeve, provides some protection from hose failures

# Thank You!



anything **Parker**  
Possible.™