Staple Retention and Outcomes

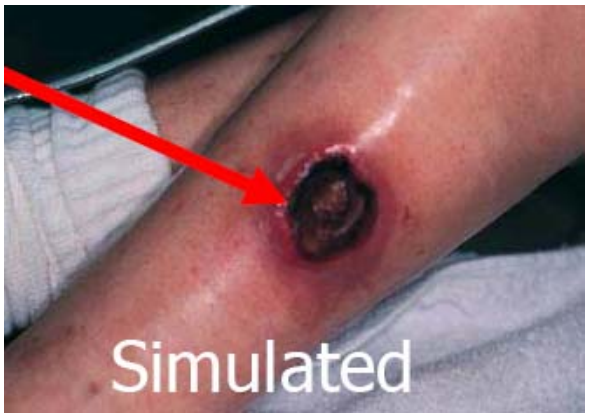
Longwall Hydraulic Hazards Workshop

Staple History

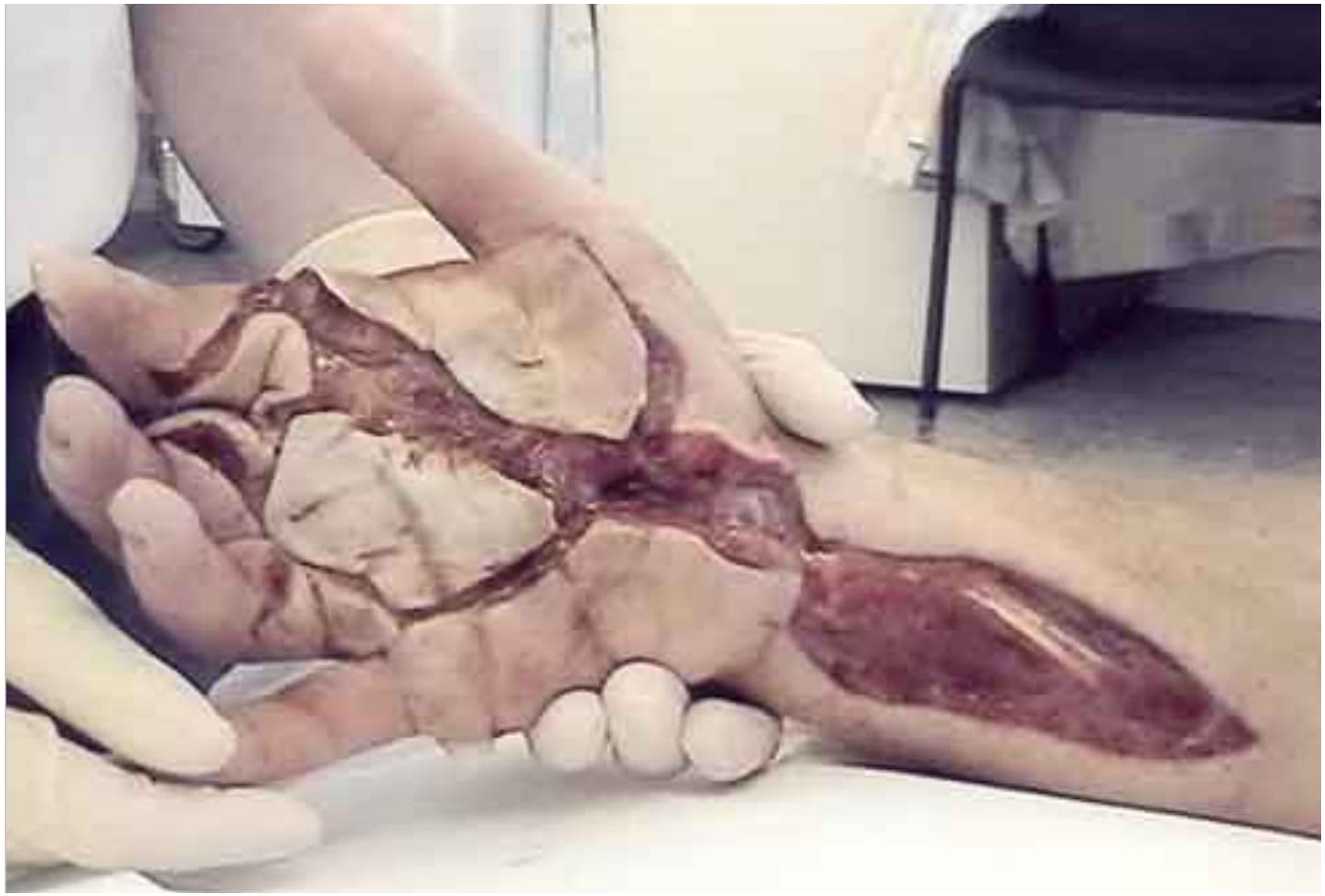
- **Original Patent Filed in 1956 by Stecko Company**
- **Originally used for pressures of around 125 bar**
- **Readily accepted by Industry as very easy to change hoses underground.**
- **Primarily only used on Longwall Mining systems**

Is this Problem New?

- 150 reported cases in 50years up to 1984 in the UK (approximately 150,000 people working in underground coal mines
- It has been estimated there are up to 400 incidents a year in NSW
- In 1984 Roof supports average operating pressure was approx 125bar, in 2007 it is 330bar with HPset operating at pressures around 420bar



Possible Result



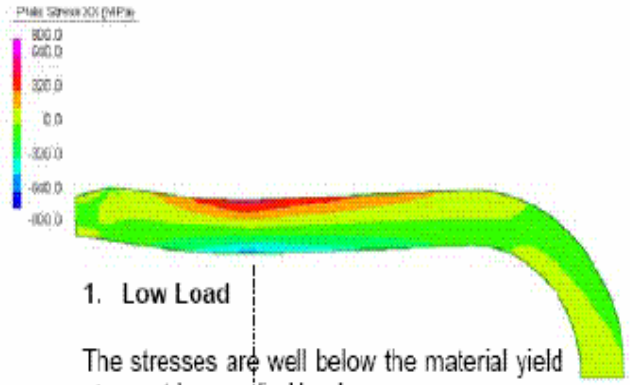
Incident History

- 2001 – Brittle Failure due to excessive hardness (>52HRc)
- 2003 – Small quantity of loose staples (low strength)
- 2004 – Stainless Steel staples falling out of fittings on new longwall.
  - Material determined to be too soft (although complies with DIN standard).
  - DBT replaced 38,000 staples underground.
- 2005 – Loose staples found during Quality Audits

DBT's Approach

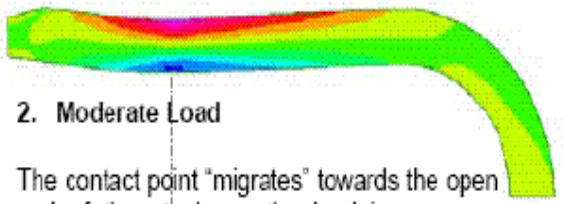
- **DBT dedicated a quality manager to investigate staple retention – 3 months full time.**
- **Deliverables were:**
  - *Collate of all DBT Australia knowledge with regards to Staple designed and manufacture;*
  - *Investigate Staple design, manufacture and recommend preventative actions;*
  - *Develop a standard DBT Staple supplier specification.*
- **Produced a 900 page report that collated all known information on staple retention.**
- **A significant amount of unique research was conducted:**
  - **FEA & Strain Gauge testing to understand elastic – plastic zones.**
  - **Insertion / removal tests to understand the effect of repeated use.**

FEA



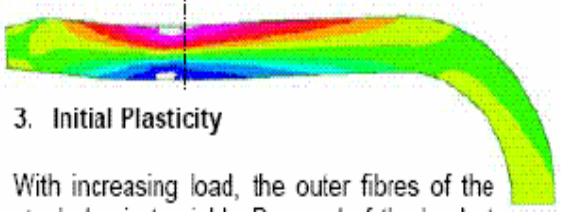
1. Low Load

The stresses are well below the material yield stress at low applied loads.



2. Moderate Load

The contact point "migrates" towards the open end of the staple as the load increases – effectively stiffening the staple against further load increases.



3. Initial Plasticity

With increasing load, the outer fibres of the staple begin to yield. Removal of the load at this time would result in minimal (probably no detectable) permanent deformation.

4. Full Plasticity

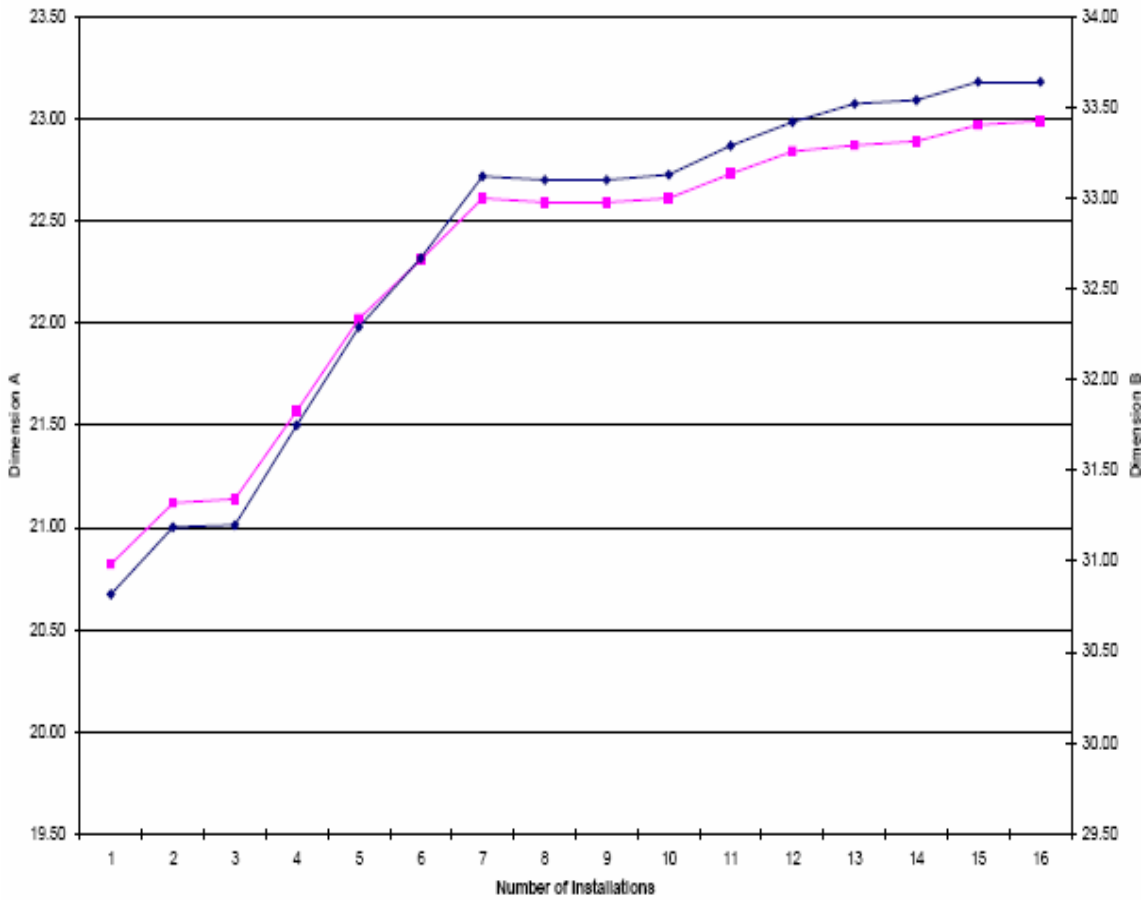
Load increasing beyond that shown in 3 yields material deeper into the staple section. Ultimately, full plasticity is reached and no further load can be reacted. Some elastic recovery will occur when the load is removed, but some permanent deformation will exist.

Strain Gauges

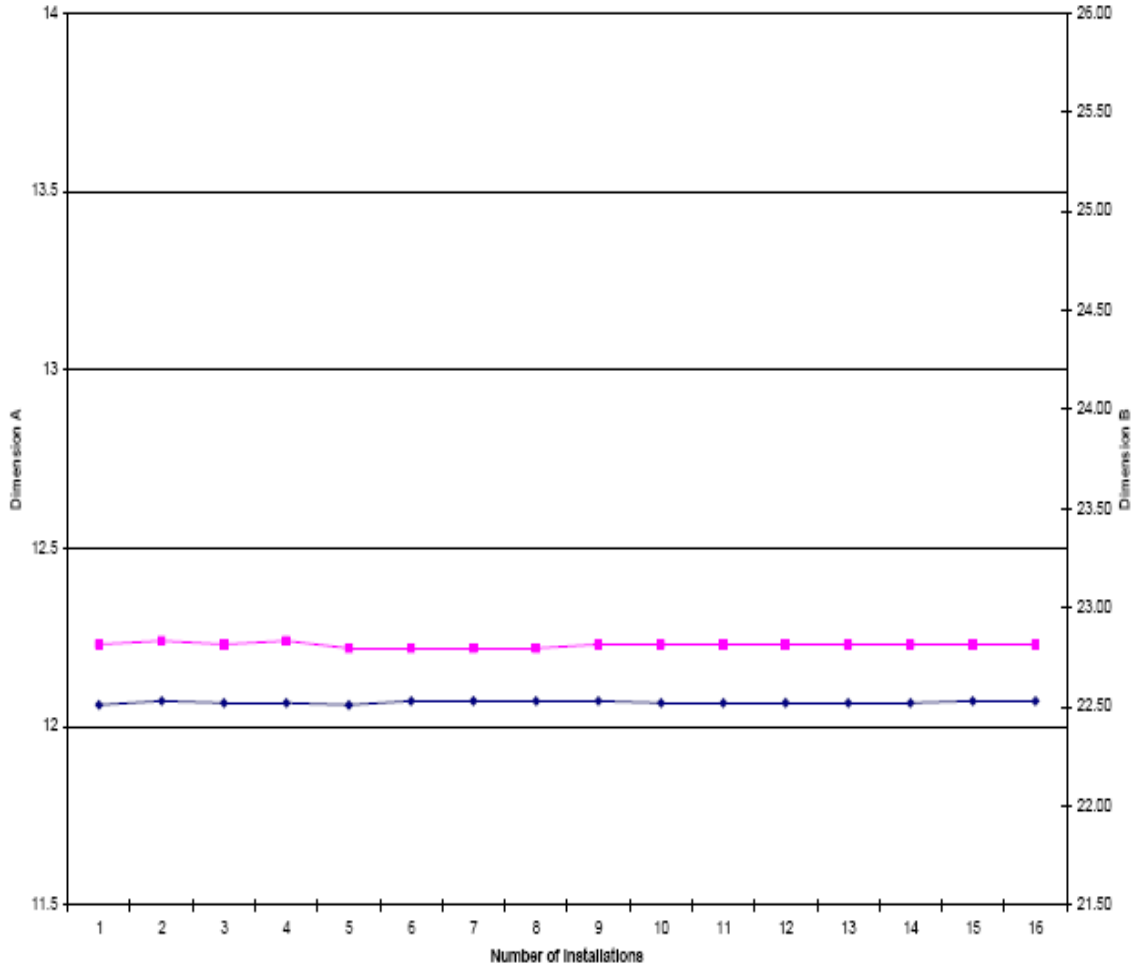
Root Cause

- **The root cause of staples not retaining in couplings is LOW HARDNESS (<38 HRc)**
- **Staples with insufficient hardness plastically deform during insertion**
- **Repeated insertions lead to a change in geometry and ultimately loss of retention**

Dimensional Growth
(Low Hardness)



Dimensional Stability
(Correct Hardness)



Other Causes

- Geometry of delivered staples varies widely compared to standard
- Stapled finish varies widely (notches etc.)
- Generally considered as a simple consumable

Safety Initiatives

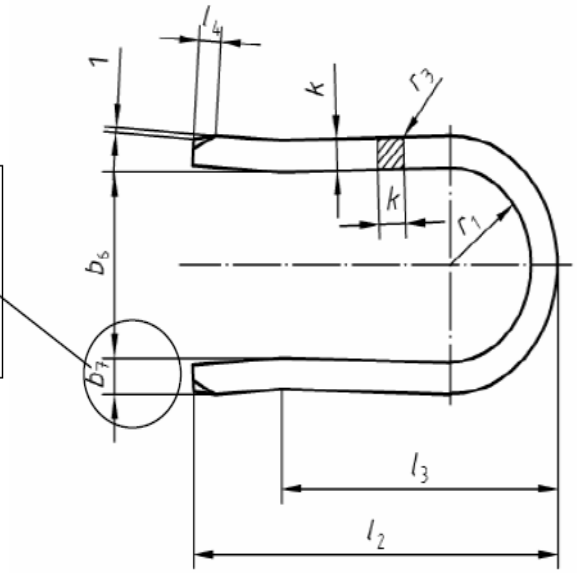
Longwall Hydraulic Hazards Workshop

New DBT Stainless Steel Staple

- Determined from Research that a new staple was required that:
  - Had the appropriate hardness.
  - Was corrosion resistant.
  - Had improved geometry for retention.
- Is already is use at some sites (eg: Ashton)
- DBT is currently replacing all stock with the new Stainless Steel staple
- These will be the ONLY staples available from DBT
- End users will be notified by Technical Bulletin

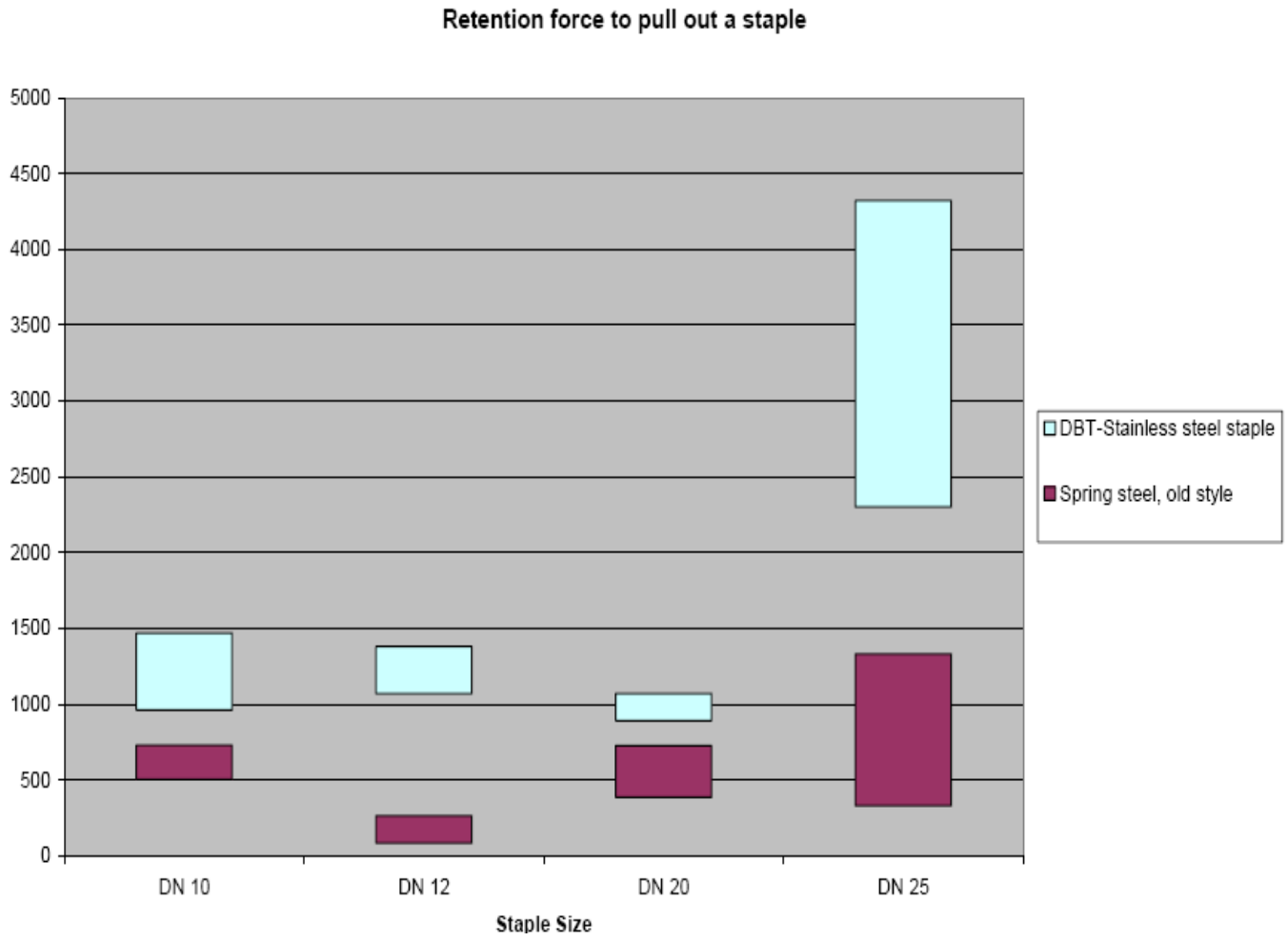
New DBT Stainless Steel Staple

DBT staple shows here a larger dimension in comparison to a DIN-staple



Retention Testing

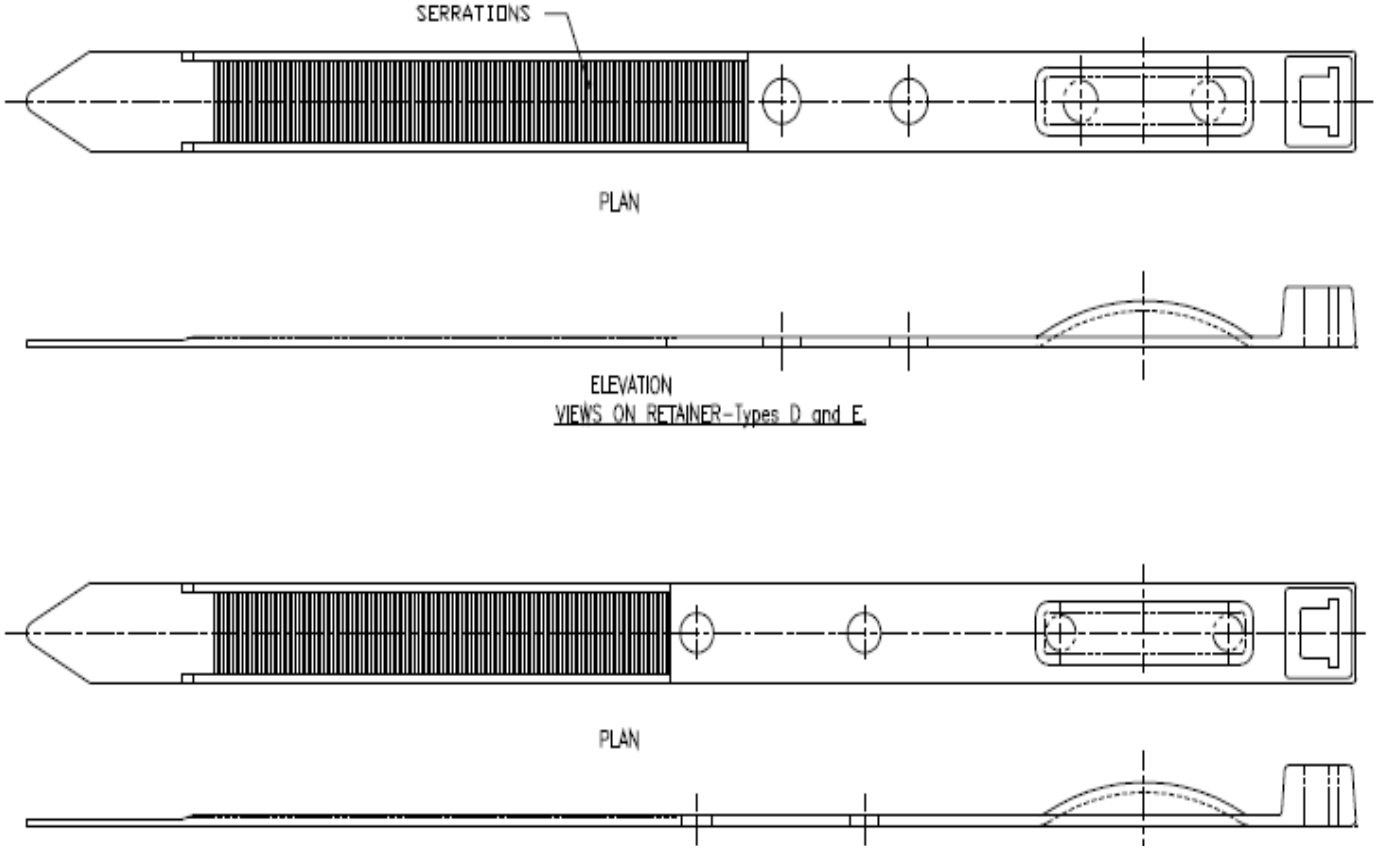
Retention Results



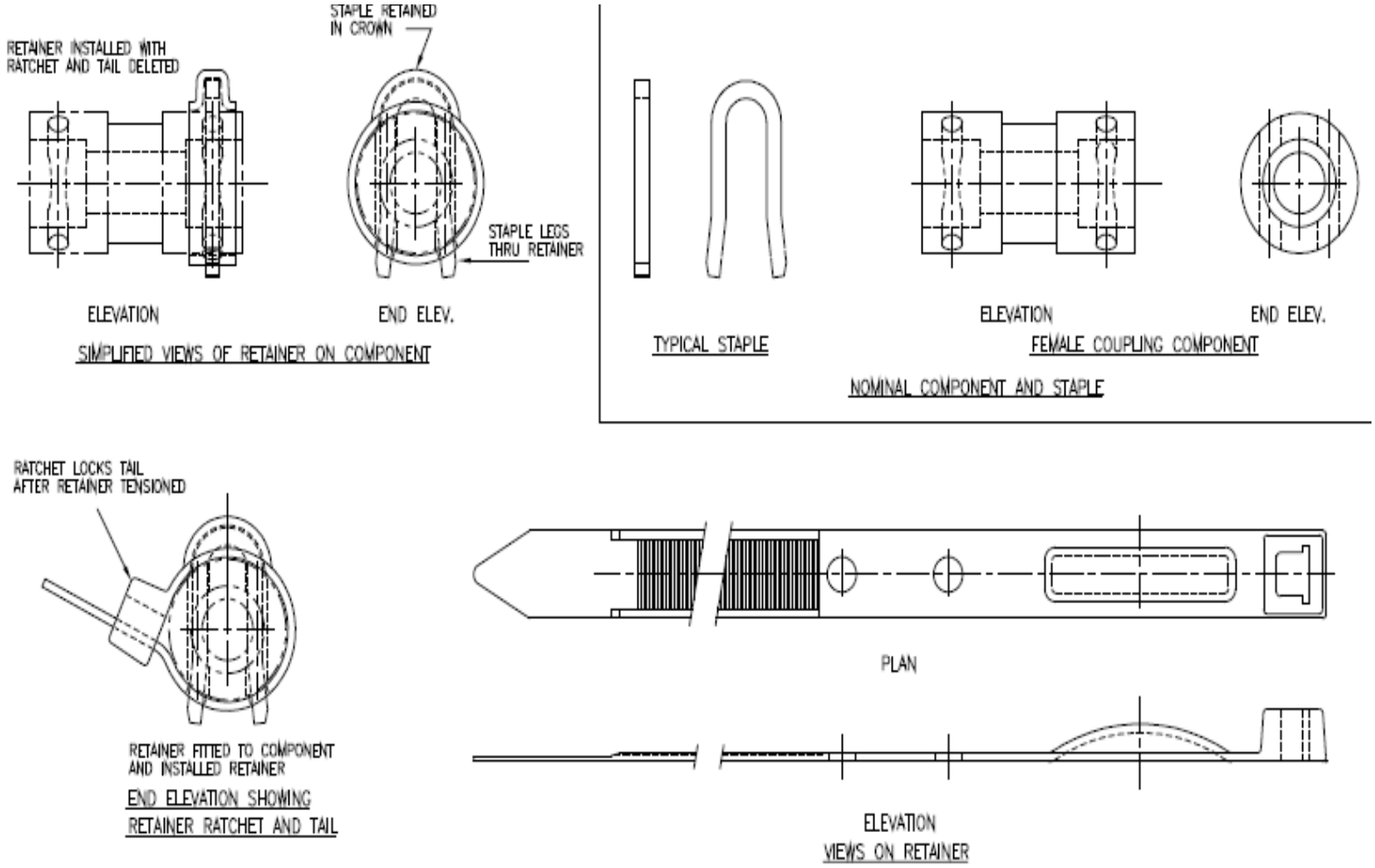
Staple Retainer

- DBT has lodged a provisional Patent for a ‘Staple Retainer’ (Application #2006906924)
- The staple retainer is similar in form to a cable tie.
- Hard barrier against unintended staple release.
- Staple legs remain visible
- We have another ‘device’ under development

Staple Retainer



Staple Retainer

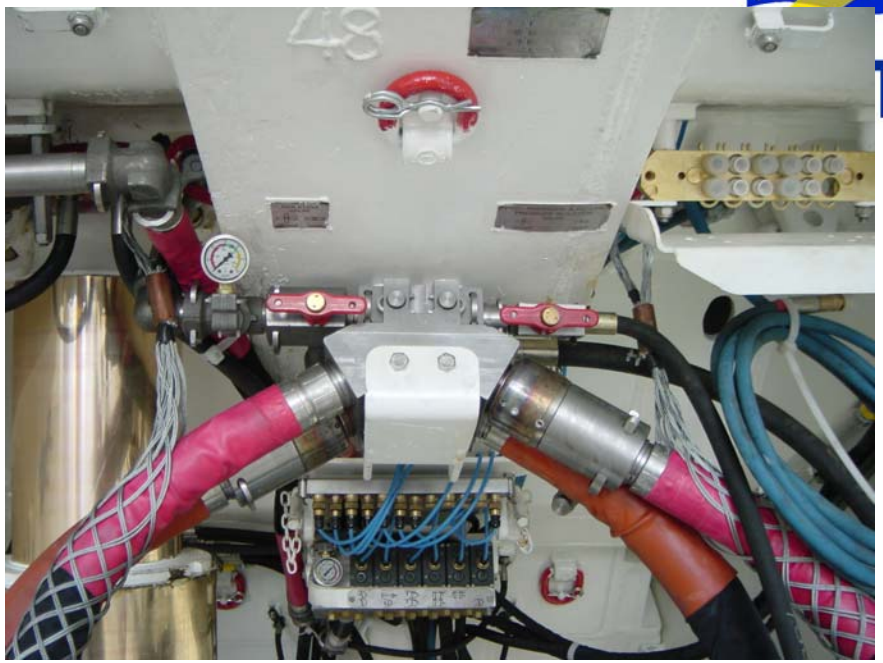


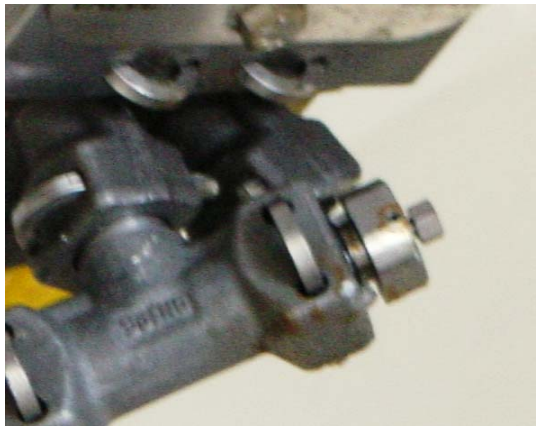
MDG41 Compliance

- MDG 41 is a guideline to aid in the design, building, commissioning, operation, decommissioning and disposal of the components that make up fluid transmission circuits at a mine site.
- This guideline was established to cover all hydraulic applications in the mining industry whether they are mineral oil or emulsion based power transmission or reticulation systems, and extends to water, fuel oil and even air systems
- The DBT Longwall for Ashton coal has been designed and manufactured with due consideration to MDG 41

MDG41

- **MDG41covers the fit, form and function of all components in the system.**
- **MDG41 covers the maintenance of the system including the replacement of parts**





- **Shield manifold shown with**
  - **Hose restraints**
  - **Pressure gauges**
  - **Lockable handles**
  - **Identification labels on canopy**

Bleed screws are present on all circuits to dissipate fluids as a final check

MDG41

- Some of the evident design variations are
  - Addition of hose diffusion sleeve in critical positions
  - Addition of hose restraints in critical positions
  - Labelled and Lockable isolation valves
  - Pressure gauges on each part of the circuit
  - Physical barriers between hydraulic components and personnel

MDG41 – Valve Labelling

MDG41 – Physical Guarding

MDG41 – Maintenance

- It is obligatory that when replacing parts in a pressure system that all new parts are equivalent and compliant
- As an example, all replacement hoses must be of the same rating, size & length, their colour code correct, that they are run in the same location as the hose being replaced.
- MDG41 requires all hoses be labeled to enable management of hoses on a site basis. This labeling must be present.
- If restraints or brackets are fitted they must be in good condition and attached securely

THANK YOU