

## A SERIES OF PRESS INCIDENTS AND THE RESULT OF THE ROOT CAUSE INVESTIGATION

Jaroslav Konarik (Austin Detonator s.r.o.), [jaroslav.konarik@austin.cz](mailto:jaroslav.konarik@austin.cz)  
Antonin Kovarik (Austin Detonator s.r.o.), [antonin.kovarik@austin.cz](mailto:antonin.kovarik@austin.cz)

### DATE OF INCIDENTS, CLASSIFICATION

Saturday, 12 May 2012, explosion  
Thursday, 9 August 2012, explosion  
Friday, 24 August 2012, explosion  
Tuesday, 28 August 2012, near miss (high potential)  
Tuesday, 18 September, explosion

### INCIDENTS LOCATION

**Company Name:**

Austin Detonator s.r.o.

**Company Facility:**

Press Building 221, Vsetin, Czech Republic

**Process Outline:**

Pressing is a step in detonator manufacture. It occurs in the Press Building (221) where the process (pressing) employed by the one press operators can be outlined as follows:

- The operator puts 100 pieces of iron delay elements (containing the primary charge) and 100 pieces of aluminium shells containing pressed PETN base charge into the loading line plates (see Figure 1) and



Figure 1: Delay elements before pressing into shells

- Transfers the loaded plate into the press room through a blast door and the door closed/secured.
- Delay elements are pressed into shells in the separate cubicle.
- Operation pressing is recorded with CCTV.
- The press equipment is remote-operated by the operator, being situated behind the reinforced wall.

- Pressing takes 5 seconds and is always accompanied with considerable friction.
- During the manufacture of detonators there can be up to 18 steps involved in the various loading and pressing operations.
- The detonators with a different nominal delay require a different size (=length) of delay element. In total we are able to manufacture up to 18 different lengths of the delay elements at the loading line. But always one length at the same time.
- The shortest delay element is about 7 mm long and the longest one is almost 42 mm long (length of the final step 18).
- The operators work in two shifts.

### **DESCRIPTION OF INCIDENTS:**

From May 12th to September 20th 2012 four explosions and 1 near miss were reported during pressing of delay elements. 3 – 100 – 3 – 100 detonators respectively exploded during explosions.

“3 – 100 – 3 – 100” means:

- 3 pcs exploded during 1st explosion
- 100 pcs exploded during 2nd explosion
- 3 pcs exploded during 3rd explosion
- 100 pcs exploded during 4th explosion

### **IMPACT OF INCIDENTS:**

Explosion of 100 detonators: The loading line was out of operation for 3 days, the exhaust roof and doors were totally destroyed after the explosions, material damages were about \$10.000

Explosion of 3 detonators: Only the tool had to be replaced. The roof over the room and the door were in good condition. Damage was insignificant in these cases.



Figure 2:  
Explosion of 3 detonators



Figure 3:  
Explosion of 100 detonators

### **LIKELY CAUSE OF INCIDENT:**

The analysis of the videos played an important part in the investigation. Without the videos it would be very difficult to investigate the cause of explosions. It was shown from records that the pressing speed was several times higher when the explosion occurred than in normal operation.

However, this did not explain why all 4 explosions happened to the same shift (No 1) and only at step 18. The same batches of delay elements, shells and explosives had been manufactured in the next three loading lines (basically identical) without

problems. Why did no explosion occur during shift No 2 using the same press and tools?

A lot questions but no clear answers. The investigation team checked 27 possible causes (sensitivity of explosives, metal parts, design, human factor ...) but all causes were ruled out. We also checked the press equipment several times without success. After the first explosion we replaced the "old design" valve of the hydraulic unit with a "new design" valve to save press time during reverse running.

After much hard work we observed that after the third explosion half of a screw blocked the valve in the hydraulic unit. This piece of broken screw must have worked loose over 40 year's operation. The blocked valve changed the pressure drag and raised speed of the press equipment. Then the piece of loose screw disappeared again into the hydraulic system after equipment returned to the base position. The screw was now in the hydraulic system and it was only a matter of time until it found its way back into the valve and cause another blockage - and possible explosion.

Three months after the first explosion we dismantled the "old design" valve and we found the other piece of the screw inside.

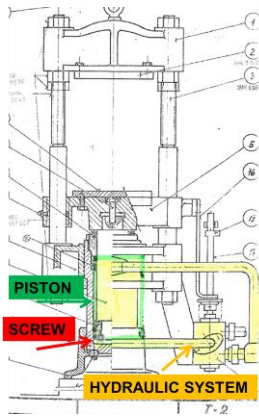


Figure 4:  
Diagram of press



Figure 5:  
Layout of press

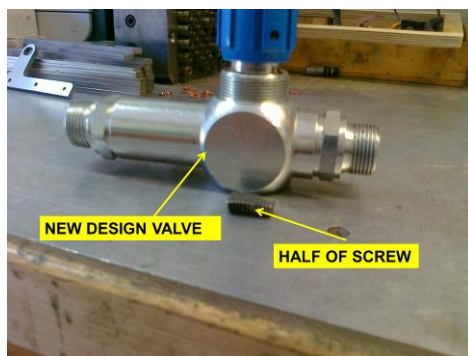


Figure 6:  
New design valve and screw

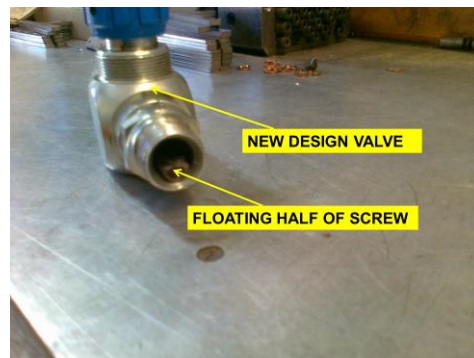


Figure 7:  
Screw into new design valve

**ACTIONS TO PREVENT RECURRENCE:**

The investigation took almost 4 months and in the meantime we took 20 technical and organization measures.

The explosions stopped once we had:

- removed the lost screw,
- reinstalled the old design valve
- slightly widened the inner diameter of shell to reduce friction between the shell and delay element.

**TAKE HOME MESSAGE**

- a. A screw costing 2 cents can cause damage more than \$10.000
- b. Always check all possible root causes. Nobody expects or is looking for hidden fault when the equipment is maintained and reliably operated more than 40 years
- c. Use CCTV to monitor operations where-ever it is possible. It costs little money and you could receive priceless information about the operation.