Explosion of Primary Explosive during Weighing Process

Detonator Plant, Kayaku Japan Corporation
Miyazaki, Japan

1. Brief description of the accident

1.1 Date and time: Wednesday, 20, August, 2008, at 14:24.
1.2 Accident location: Detonator Plant, Miyazaki, Japan
1.3 Short description: The explosion occurred in the primary explosive weighing room and spread to the adjacent room where the 2nd inner tube is placed in position. About 400g of the primary explosive in the hopper of the weighing device, 300 electric detonators in the weighing room exploded. The 200 electric detonators in the adjacent room waiting for the insertion of the 2nd inner tube also exploded. Exploded amount was approximately 0.7Kg.
1.4 Injuries: No injuries
1.5 Damage: The devices, chain-conveyors, windows etc of the weighing room and the insertion room were damaged.

2. Company

2.1 Company name: Kayaku Japan Corporation
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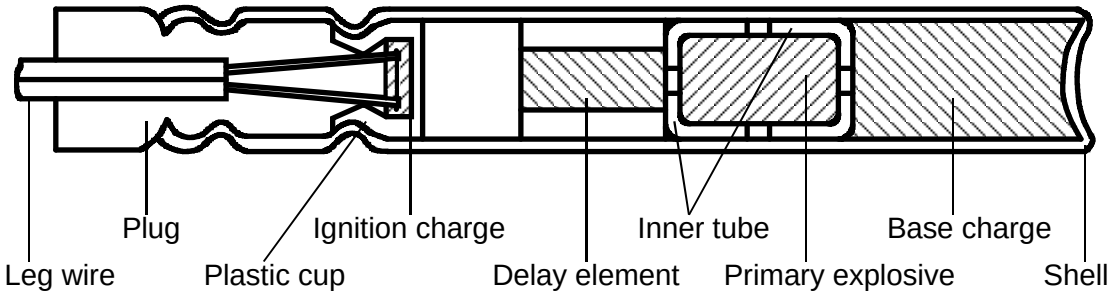
3. Process outline

The electric detonator bodies (electric detonators without fuseheads) are assembled in a remotely operated automated process consisting of the following steps: Plating of 100 copper shells onto a plate; weighing and dispensing the 1st PETN base charge (0.2g); pressing of the first charge; weighing and dispensing the 2nd base charge (0.2g); insertion of the 1st copper inner tube for confinement; pressing of the second charge and the 1st inner tube; weighing and dispensing the primary explosive comprising 0.2g of a mixture of DDNP and potassium chlorate; insertion of the 2nd copper inner tube; pressing of the primary explosive and the 2nd inner tube; insertion of the delay element and final pressing. (See figure 1 below for a sketch of a typical assembled electric detonator)

A chain-conveyor links the different stages of the process with certain operations taking place in dedicated rooms that are connected by hatch measuring 160mm x 230mm in reinforced walls which separate the rooms. When the conveyor is stationery the hatches are closed with steel shutters. All the rooms are equipped with a “soft” wall that can blow out in the event of an explosion. Additional precautions are taken within each room to prevent the sympathetic detonation of the plate with the charged detonator shells.

A daily and monthly cleaning schedule as well as a preventative maintenance program exists for the process.

Figure 1: Sketch of a typical assembled electric detonator



4. Weather and Temperature of the date

4.1 Weather: Fine

4.2 Ambient Temp: 32 degrees of Celsius

4.3 Humidity: 52% RH (Nobeoka Local Metrological Observatory, at 14:00)

4.4 Site Temp: 28 degrees of Celsius inside the weighing room at the accident

4.5 Site Humidity: 65% RH inside the weighing room at the accident

5. Sequential outline of the accident

1. A supervisor and the operators checked all devices in the loading process. No abnormalities were found and operation was started. Operators were checking the status of machines by remote controlled TV-monitor.
2. When a series of the process was smoothly going on, an explosion occurred in the weighing and insertion room at 14:24.

   At that time, operator of weighing process was going to other room to check the weight of primary explosive, operator of insertion process was setting inner tube on the insertion plate. Operators were evacuated immediately after the explosion.

6. Injuries / Damages

6.1 Injuries: No injures

6.2 Damages: The weighing device, chain-conveyor, lights, ceiling, window, and roof of the weighing room and insertion device, chain-conveyor, lights, and window of the insertion room were damaged.

(1) Neighboring district: None

(2) Weighing and insertion room: Partially destroyed (See Photos 1 and 2)

Photo 1: Outside View of the weighing room

Photo 2: Outside view of the insertion room

7. Analysis and reason for the accident

The explosion occurred at the end of an operation just prior to the conveyor indexing to the next position. Therefore, all devices were stationery and all shutters were closed.

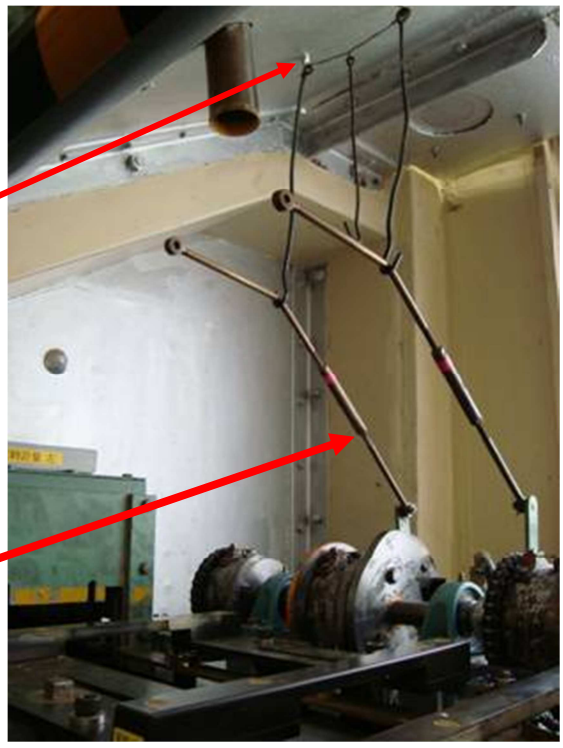
The investigation and Fault Tree Analysis showed that the explosion was initiated at the weighing device and suggested impact from a falling object as the most probable cause.

On examination one of two bolts (about 6mm diameter, 20mm long and weighing about 32g) that is attached with a ring under the steel cover of the weighing device was found on the floor. These bolts were used for suspending the two arms of the weighing device during routine cleaning by the operator. The arms are attached to the hopper and move back and forth during the weighing operation. 80% of the cross-section of the fallen bolt had rusted away causing it to fall onto the plate of weighing device which initiated the primary explosive. (See Figure 2 below)

Figure 2: The hopper arms assembly

Location of the bolts from which the arms are suspended during cleaning. The photograph also gives an indication of the inaccessibility of the bolts which made it difficult to detect their condition.

The hopper with the primary explosives is gripped between the two arms which move during the weighing operation. Note the weighing device would be directly beneath the bolts.



The primed detonators in the plate that exploded were on the chain-conveyor. With the explosion the chain-conveyor slightly lifted the shutters that were unlocked at that moment in anticipation of the next indexing move. (During operations such as pressing, the shutters are locked by the cam that would prevent them from being opened. The cam moves to allow the shutters to lift just prior to indexing of the conveyor.) The hot particles from the explosion got through under the shutters and initiated the detonators in the next room.

8. Action to prevent recurrence of the accident

The actions are carried out to prevent recurrence of the accident as follows.

a. The bolts on the weighing devices were removed.
b. The method for cleaning the weighing device was revised as a result of the bolts being removed.
c. All other processes in the plant were checked for unnecessary parts (bolts, nuts and so on).
d. We knew about the bolts above the weighing device and planned to incorporate appropriate protective measures. However, there was no action taken. To be honest nobody expected these bolts could cause an explosion and did not check them for corrosion. As a result of this incident we revised our inspection standards and schedules especially for old equipment with special emphasis on corrosion.
e. Wherever possible, non-corrosive materials must be used for critical parts and equipment.

9. Leaning points

This is a process that was established about 40 years ago. While scheduled maintenance took place regularly, the bolts in question did not receive any attention. One of the reasons was that the bolts were inaccessible and therefore difficult to see and check. The following learning points may be relevant particularly with regard to the maintenance of old pieces of equipment:

a. A simple check is not enough to prevent an incident. Thorough inspection including that of very small parts is necessary.
b. In the design of machinery and equipment key components should be accessible for checking and routine maintenance
c. The practice of lacing nuts and bolts that can fall into explosives should be considered wherever possible
d. Where there is the possibility of corrosion, non-corrosive material should be considered when appropriate and maintenance schedules should incorporate checks or replacements of components that can corrode.
e. Redundant components and materials should not be retained in the workplace but eliminated
f. The effectiveness of the design and placement of barricades should be reviewed.
g. Old plants periodically require a total review of the operation, design, maintenance, Operating Instructions and training of personnel.