EXPLOSION IN DETONATOR ASSEMBLY HOUSE

Rahul Guha (Sr. General Manager, Technical at Solar Industries India Ltd.)

DATE AND TIME OF INCIDENT

Sunday, 24 March 2013 at 15.10 hrs.

INCIDENT LOCATION

Company name:

Economic Explosives Ltd. (EEL) - a 100 % subsidiary of Solar Industries India Ltd.

Company facility:

In the Filled Shell Store of Detonator assembly building (D11)

Process Outline:

The explosion took place in the filled shell store. In this room the activities carried out are as follows:

- Bring a case of filled shell from the magazine into the filled shell store (filled shells are detonators loaded with PETN/ASA and delay elements, to be issued to assembly operators)
- Open the case (a case may contain from 1,500 to 4,000 nos. of filled shells, depending upon the type of product. They are placed in cardboard cartons, each carton containing 100 detonators.)
- Take out a carton and place it on the antistatic rubber lined table.
- Remove the adhesive tape used for fixing the carton cover onto the container.
- Note down the batch number of the filled shells in the carton.
- Hold the carton in one hand and visually inspect the detonators in the carton for any defects or foreign matter in the shells. In case of any abnormality, remove the suspect detonator and make a note of it.
- Replace the lid of the carton, but do not re-tape, and place the carton in a wooden carrying box kept on left hand side of the table.
- When 4 such cartons are placed in the carrying box, it is manually carried to the detonator assembly hall by the same operator.
- One carton is issued to each operator in the cubicles.

The layout of the building is given in Appendix 1

DESCRIPTION AND IMPACT OF THE INCIDENT

On 24.03.13 at around 3.10 pm, Director EEL, Controller of Explosives, Govt. of India, Dy.Genl.Mgr. –Prodn. (EEL) & Dy.Genl.Mgr. R&D (EEL) were attending a meeting in the conference room of administrative building, when they heard the sound of two explosions, in a span of less than two seconds. The first one was of lower intensity followed by the second one of larger intensity. They immediately rushed out & found heavy smoke coming out of the entrance to the D11 building in which explosions had occurred. In the meanwhile an ambulance had reached the site and one operator who was thrown out of the building and had suffered serious injuries, was moved into the ambulance. Along with this operator, two other operators who suffered injuries were also moved by the same ambulance to the hospital in Nagpur. It was later reported that the operator who was seriously injured, had passed away on the way to the hospital.

Out of the other two injured operators, one operator was released from the hospital a couple of days after the incident. The second injured operator had suffered 28 - 30% burn injuries & was released from the hospital after 3 weeks.

Examination Of The Site Of The Incident

Building no. D11 was licenced to carry out assembly operation of detonators and had a licenced capacity of 61,000 detonators and a man limit of 60 operators and 4 supervisors. This limit was further subdivided to store 30,000 detonators in the filled shell store, in which the explosion had taken place. At the time of the incident there were 26,916 detonators in the filled shell room.

The concrete roof of the filled shell room was fully blown off and nearby rooms at the entrance of the building, consisting of shock tube store, packaging material store, supervisors office and some areas in the crimping hall suffered severe structural damage. All the wooden racks, table etc. in the filled shell room had been charred. There were two craters of about 60 x 30 cm size on the floor in south east corner of the room where two cases of filled shells were kept. The anti-static rubber covering on the floor of the room was observed to be burnt out in the area where the table was located.

Numbers of detonated and undetonated detonator shells were visible, lying on the floor of the building and in front of the filled shell store. All crimped and uncrimped detonators in the crimping cubicles under operation, were lying unaffected as such, but 5 cubicles (not in operation) near the entrance to the crimping hall, in east direction, showed damage due to heat radiation from the explosion. Not much damage to the civil structure was visible in the case packing area.

Information Gathered

On 24.03.13 production in the second shift (2.30pm to 11.00pm) was started as usual in D11 building. There were 20 operators in the building on the day & Sri Gunwanta Damdar was assigned to inspect and distribute filled shells to the operators in the crimping cubicles. Sri Sohan Halmare was assigned for Cord Relay packing & Sri Suresh N Hul was deputed to shift Nonel crimped detonators to the packing area. Sri Raju V Shirsagar was assigned for packing of crimped Nonel detonators.

At 3.10pm when Sri Damdar was in the process of placing a carton of filled shells in a carrying box, the explosion took place and he died on the spot. His body, intact, but in charred condition, was later recovered from the filled shell room in a face down position. The upper part of his body lay inside the room at the entrance to the room and lower portion of his body outside the entrance to the room, with his legs pointing towards the main entrance door (East direction).

Sri Sohan Halmare was entering into the building through the main entrance and was about 2 metres inside, when the explosion took place & he was thrown outside about 6 metres from the main entrance. He died on the way to the hospital.

Sri Hul was collecting crimped Nonel detonators from the cubicles in the assembly hall, and was near cubicle nº A6 when he was knocked down as a result of the shock wave from the explosion and suffered minor injuries. He was released from hospital after 2 days.

Sri Shirsagar had just entered the crimping hall & was moving towards the packing area. He was about 5 metres inside the assembly hall, when the explosion took place. On hearing the sound he turned & hence suffered 28-30% burn injuries on his face & hands. He was released from hospital after 3 weeks.

The building supervisor Sri. Kishore advised that in the filled shell room there was a stock of 26,916 filled shells including one packed case of 1,500 filled shells (1,200ms) and one case containing around 500 to 600 filled shells (3,800ms) were placed on the floor in the south east corner of the room (two craters were visible at this location). One partially filled case of 500ms filled shells was lying on the floor near the left side of the table. The remaining filled shells were kept in open trays on the wooden racks provided against two walls of the room.

LIKELY CAUSE OF INCIDENT

The investigation team debated the different scenarios which could have led to the explosion and these are presented below-

i) Sabotage: Explosion due to sabotage is ruled out since this was a working building & only one person was present in the filled shell room. CCTV camera placed inside the main entrance pointing towards the filled shell room confirms this.

ii) Heat/Fire: No evidence of any fire from any source & hence ruled out.

iii) Lightning strike: It was a clear and sunny day, hence this possibility is also ruled out.

iv) Spark from electrical short circuit: Flame proof light fittings were installed inside the room, hence sparking due to electrical short circuit was ruled out.

v) Static discharge: The operator was working bare feet and wearing cotton clothing. The working table had conductive rubber top and the foot rest at the table bottom had an aluminium earthing strip. The continuity of this earthing is regularly checked. Additionally humidity in the building is maintained above 50%, hence there is a low possibility of any explosion taking place due to discharge of static electricity. Also the operator does not touch the detonators, but only holds the paper carton in his hand, for examination. Hence the possibility of any discharge of static electricity when touching detonators was ruled out.

vi) Friction: Since there was no handling of loose detonators by the operator, ignition due to friction was ruled out.

vii) Impact: The possibility of an ignition due to impact was debated in detail. The two possibilities for impact to take place are either a heavy object falling on the carton of detonators lying on the table, or detonators falling down and impacting on a hard surface. The first possibility was ruled out as there was no heavy object above the table which could fall down and impact on the detonators. Also had this been the case then the flash from the explosion on the table would have been caught on the CCTV camera. Nothing of this sort had been observed.

The second possibility of impact due to falling of detonators on a hard surface was ruled out as the flooring of the room was of soft anti-static rubber. However a possible scenario emerged during the deliberations, and that was of the wooden carrying boxes (weight around 2.5 kg) falling on detonators which had earlier fallen down just before the fall of the carrying box. The drop height from the table top would be around 1 metre & in such a case the detonators could explode due to impact.

In order to simulate this theory, trials were carried out with dummy detonators in a building of similar design, to study the possibility of an ignition taking place due to impact. Based on the Standard Operating Procedure and the movements of the operator recorded in the CCTV, the following trial was carried out.

It was assumed that the operator after removing the adhesive tape on a carton, was placing the carton in the carrying box placed on the edge of the left hand side of the working table. Since the tape had been removed, while moving the carton (weight around 800 g) the bottom half of the carton started falling down with the cap remaining in his hand. As a reaction the operator tried to arrest the fall of the carton and in the process he dislodged the carrying box. The fall of the carton could not be arrested and the detonators spilled out of the carton & the heavy carrying box fell on the spilled detonators leading to the explosion.

That the explosion had initiated at the floor level could be gauged from the fact that the bones on the legs of the operator were severely crushed. Also the position of the body, as observed after the blast, indicated that the person was thrown towards the room entrance by the shock wave from the explosion which must have hit him on the legs, and also from the left side where 500ms & other Long Delay Series filled shells were on the racks.

According to the two operators working in A1 & A2 cubicles, they at first heard a sound like bursting of individual detonators, followed by a larger sound of explosion & then a big explosion, which indicates that the first explosion could have been due to impact of carrying box on detonators spilled on the floor (as simulated in the trials).

This transmitted to the 500ms filled shells lying in a case at the base of the table & subsequently to the rest of the detonators in the room, which was the big explosion.

ACTIONS TO PREVENT RECURRENCE

i) No operation shall be carried out in the filled shell store. It would only be used as an issue room.

ii) Crimped detonator inspection and counting will be done in the packing hall, in addition to the wrapping operation being carried out there.

iii) Removal of gum tape from cartons & recording batch details would be done in an adjacent room.

iv) Reduce the explosives limit in different sections of the crimping buildings.

v) Filled shell store & distribution room should have a weak wall to act as a blow-off panel.

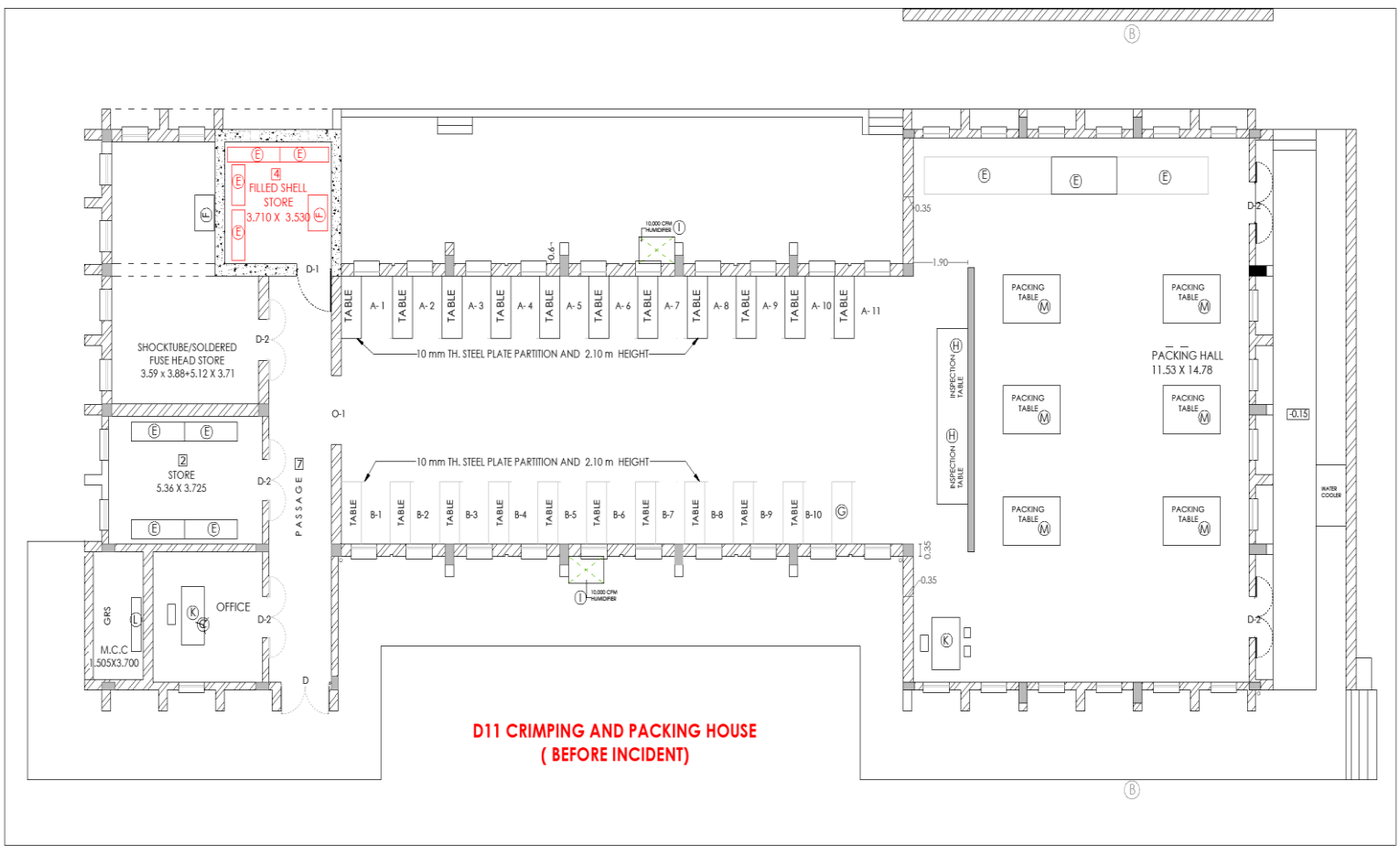
Modified building design in Appendix II

TAKE HOME MESSAGE

1. It is essential that every hazardous operation should be assessed for the risks involved in the activity.
2. Reduce manual handling operations, wherever feasible.
3. The inventory of explosives in any operation should be kept at the bare minimum, in order to reduce the impact of any explosion.
4. Thought should be given to the design of buildings handling sensitive explosives to have weak walls, so that in the event of any incident the effect of an explosion is vented away from the operating area.

APPENDIX 1

D11 BUILDING BEFORE EXPLOSION



APPENDIX II

MODIFIED D11 BUILDING