

Incident at waidhan, India

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Brief Description of the Incident

- ▶ A massive explosion at Waidhan Industrial Estate involving bulk emulsion plants of M/s IDEAL Industrial Explosives Ltd and Rajasthan Explosives and Chemicals Ltd. Several other neighboring units had also suffered extensive damages
- ▶ The explosion occurred at 1845 hrs on 5th July 2010
- ▶ 18 persons were killed, 6 missing and 42 injured



Background on Waidhan, Madhya Pradesh

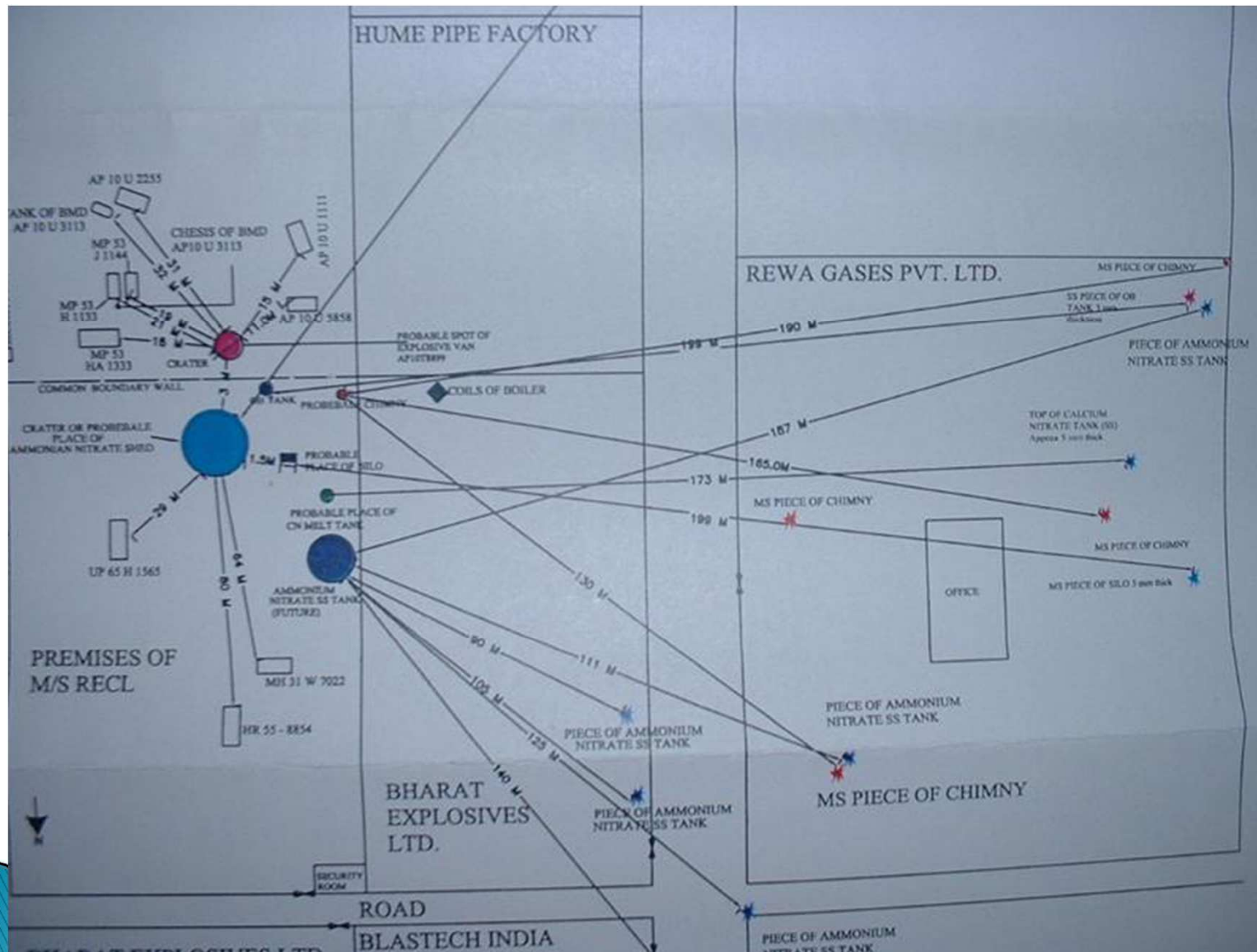
- ▶ Waidhan, Madhya Pradesh located in the northern part of India
- ▶ It is the base for 14 units manufacturing and supplying non-explosive emulsion matrix to the nearby open cast coal mines of NCL, a subsidiary of Coal India Ltd
- ▶ This cluster of coal mines form one of the largest opencast mines in India and consume around 120000 tons of bulk explosives annually
- ▶ The matrix delivered to mine site in Bulk Delivery trucks are converted into explosives while loading into the boreholes by means of gassing
- ▶ Most of the base units are bunched together in the Industrial Estate at Waidhan as they are considered non explosive units and do not conform to distance separation as per explosives rules

Weather Conditions

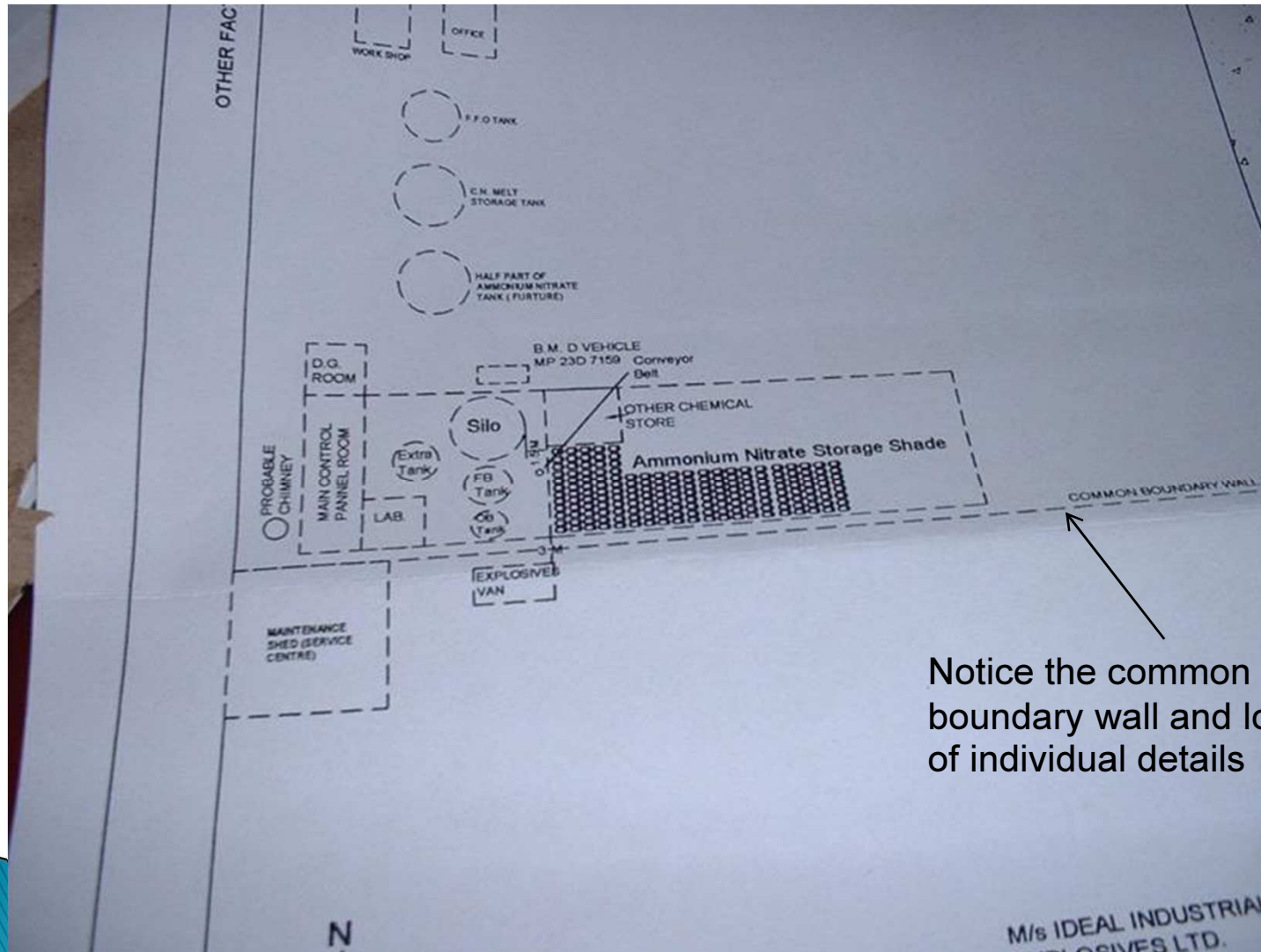
- ▶ It was typical monsoon weather –
 - Temperature around 27°C
 - Humidity above 70%
 - Slight rain
 - Lightning and thunder in the skies but far away from accident site



Site Plan of Area Involved



Layout of IDEAL and RECL Units



Damage Details

- ▶ Maximum damage was along the common wall between IDEAL and RECL
- ▶ The entire bulk matrix plant of RECL was totally destroyed except its security guard room
- ▶ The bulk matrix plant of IDEAL did not suffer damage
- ▶ Adjoining plants of Bharat Explosives, Humepipe factory, Blastech India suffered damage
- ▶ Up to 350 m from location of accident, asbestos roofing of several units were blown away



Damage Details *Contd.*

- ▶ Human casualty was significant - 18 died, 6 missing, 42 injured
 - In RECL 9 died, 3 are missing, 3 injured
 - In IDEAL 6 died, 11 injured immediately; 3 died later
- ▶ The injuries suffered by the humans were in conformity with the damage expected by receipt of intense pressure. Some damage due to burn and missile penetration was also observed



Damage Severity and Location

PHOTO 8



BLAST EFFECT OF EXPLOSIVE VAN EXPLOSION

PHOTO 10



ON ACCOUNT OF BLAST

PHOTO 5



RECL DAMAGED BMD SYSTEM LOADED WITH NON EXP MATRIX VEH NO. UP 65 1565 PARKED NEAR AN STORE



Photograph-11 Splashes of matrix in M/s Bharat Explosives P. Ltd.

Quantity of Matrix/Explosives Involved

- ▶ RECL
 - Ammonium Nitrate 14000 kg (recovered 1000 kg)
 - Non explosive matrix 12000 kg (recovered 4000 kg)
- ▶ IDEAL
 - Non explosive matrix 51530 kg (recovered)
 - Ammonium Nitrate 1100 kg (recovered)
- ▶ Cord relays 2300 numbers
- ▶ Copper electric detonators 230 numbers
- ▶ 0.21 million meters of detonating fuse(10g/m) equivalent to 2 tons of PETN(no trace)

Composition of Non-Explosive Emulsion Matrix

Oxidizer Blend

Ammonium Nitrate	70%
Calcium Nitrate	8%
Sodium Nitrate	2%
Water	20%

Fuel Blend

High Speed Diesel	28%
Furnace Oil	56%
SMO	16%

Emulsion Matrix

Oxidizer Blend	93%
Fuel Blend	7%

Process Used

- ▶ The process used for manufacture of non-explosive matrix is well known and well established.
- ▶ Temperature of OB and FB are kept at around 80°C well below that used for making emulsion explosives.



Test Results

- ▶ After the incident ,extensive testing for booster and cap sensitivity of the left over matrix and new material of same composition made in the laboratory confirmed the insensitivity of the matrix to these stimuli. No evidence of complete or partial detonation was found
- ▶ Other safety tests conducted also showed the insensitivity of the matrix. These tests were
 - Burning test
 - Drop test
 - Heat test
 - Friction sensitivity test



Probable Cause Analysis at RECL

► Scenario A: Initiation due to malfunctioning of roto pump

- At the time of explosion, pumping of matrix was going on from silo to bulk truck, hence dry running is not the cause. There was no overpressure seen as indicated in the high and low pressure switches installed in the pump line. The hopper of the rotopump was 30 cm below the outlet of silo
- The matrix being pumped proved to be nonbooster sensitive when tested and hence it was not explosive in nature
- Shaft of the rotopump was recovered intact from field - hence explosion would not have taken place within the pump
- *Reasonable conclusion - pumping by rotopump of matrix is not the source of initiation or cause of explosion*



Probable Cause Analysis at RECL

Contd.

► **Scenario B: Initiation and explosion in silo**

- A huge piece of silo was found with weld joints intact, no twisting.
- The matrix in the silo was found non booster sensitive
- The matrix was found widely spread and some could be recovered.
- *Reasonable conclusion - The matrix in silo was not a source of initiation nor did it participate in the explosion. It got physically splattered*

► **Scenario C: Bulk Matrix delivery pump as source of explosion**

- Although the truck getting loaded from the silo was totally destroyed still the matrix it contained was non explosive in nature
- *Reasonable conclusion - BMD not a source but received full force of blast due to close proximity to AN storage*

Problem Cause Analysis at RECL

Contd.

- ▶ **Scenario D: Possibility of impure fuel oil/diesel being a source**
 - Matrix made was non-explosive
 - Reasonable conclusion - raw material not source of explosion
- ▶ **Scenario E: Possibility of boiler being source of initiation**
 - The Boiler was from a reputable manufacturer, Thermax
 - Boiler was operating without any problems. The manufacturer of Boiler certified that it had enough safety devices to prevent any overpressure build up which could cause an explosion
 - The body of the Boiler was flattened and compressed from outside
 - The heating coils were found intact
 - *Reasonable conclusion - Boiler is not the source of initiation, nor did it explode*

Problem Cause Analysis at RECL

Contd.

► **Scenario F: AN stored in RECL exploded**

- No fire was noticed before the explosion in the AN storage shed
- Auto ignition of AN by itself has not been established
- There was no contamination by fuel oil
- The AN was in the form of prills with oil absorbency of around 8%
- There was a crater noticed and the AN has disappeared (14 tons)
- *Reasonable conclusion – An has taken part in an explosion but it could not be established that the explosion started in the AN stockpile*

Problem Cause Analysis at RECL

Contd.

- ▶ **Scenario G: The explosives stored in the Explosives van in IDEAL near the common boundary wall exploded**
 - The van disappeared without trace except for a part of the body panel
 - There was a crater where the van stood
 - The causes usually associated with explosion of detonators and detonating fuse which were in the van are -
 - Static charge, impetus from mobile phone
 - Lightning
 - Rough handling
 - Heat
 - Shock
 - Except for lightning the other factors could all be probable causes but no persons associated with the explosion closely are alive and hence the actual cause cannot be pin pointed



Most Probable Scenario

- ▶ It is reasonable to opine that the chances of detonators and detonating fuse going off are much greater than AN by itself and hence the possibility of the AN stockpile having been detonated by the shockwave from the explosion in the explosive van is more likely event than vice versa.

Difficulties Encountered During the Investigation

- ▶ The site could not be reached by experts immediately after the explosion
- ▶ By the time the experts arrived (36 hours after explosion), the site had been disturbed for rescue operations at RECL and IDEAL
- ▶ Debris was found intact only in areas belonging to other units and was the source of information on the direction of the blast
- ▶ The size of the crater seen may not reflect the actual size as the area had been disturbed
- ▶ Witnesses gave confusing and conflicting reports

Lessons To Be Learnt

- ▶ How can you prevent the detonation?
- ▶ Do not park explosives van with explosives in non-explosive area
- ▶ Do not bunch units together without mounding
- ▶ Do not disturb the area after explosion till cleared by experts
- ▶ Some experts should be stationed nearer to the bunch of units



Acknowledgements

- ▶ Despite difficulties the statutory authorities did a fine job of investigation and considered the views of various other parties involved in this tragedy which was one of the worst of its kind in the history of bulk emulsions
- ▶ As a non controversial body Visfotak has presented this report without bias to any of the parties involved

