ADV. RAVINDRA B. YADAV
TAL. KALYAN
DIST. THANE
MAHARASHTRA
REG. No. 34853
EXP.DT. 23-01-2030

BEFORE THE NATIONAL GREEN TRIBUNAL
WESTERN ZONE BENCH, PUNE
ORIGINAL APPLICATION NO.121/2024 (WZ)
EARLIER SUO MOTO NO.01/2024 (WZ)

News item titled "Amudan Chemicals Pvt Ltd
in Dombivli East -8 killed, 60 injured in boiler
blast at Thane Chemical unit", appearing in the
Indian Express dated 24/05/2024

v/s

MPCB through Member Secretary and Ors. … Respondents

With

ORIGINAL APPLICATION NO.134/2024 (WZ)
EARLIER ORIGINAL APPLICATION NO.624/2024

News item titled "Eight killed and 50 injured
in boiler blast at Dombivli Chemical Plant"
appearing in The Hindu dated 23/05/2024.

AFFIDAVIT ON BEHALF OF MAHARASHTRA POLLUTION CONTROL BOARD i.e. RESPONDENT NO. 1

I, Upendra Kulkarni, Aged Adult, occupation – Service, the Sub-Regional Officer of the Maharashtra Pollution Control Board at Kalyan-I, having office address at Siddivinayak Sankul, 3rd Floor, Near Oak Baug , Station Road, Kalyan (West) , do hereby state on solemn affirmation as under –

(1) I am filing this Affidavit in compliance of the Order dated 16/02/2026 passed by this Hon'ble NGT.

(2) I say and submit that the ICT has submitted Final Report dated 27/04/2026 on Environment Impact Assessment and Damage Valuation Study of M/s.Amudan Chemicals Pvt.Ltd. A copy of Final Report received from ICT is enclosed herewith and marked as an **Annexure-I.**

(3) Hence this Affidavit.

Solemnly affirmed on this 28 day of April, 2026 at Kalyan

For and on behalf of
Maharashtra Pollution Control
Board i.e. Respondent No. 1 .

ADVOCATE

(Upendra Kulkarni)
Sub-Regional Officer- Kalyan-I

SIGNED BEFORE ME
RAVINDRA B. YADAV B.A., LL.B.
Reg. No. 34853
ADVOCATE & NOTARY, GOVT. OF INDIA

NOTARY
RAVINDRA B. YADAV
Reg. No. 34853
Expiry Dt. 23-01-2030

NOTED & REGISTERED
Sr. No. 234 Page No. 70
Book No. A-8 Date 28 APR 2026

INSTITUTE OF CHEMICAL TECHNOLOGY | रसायन तंत्रज्ञान संस्था
Deemed to be University under Section-3 of UGC Act 1956
Elite Status & Centre of Excellence - Government of Maharashtra
Category I Deemed to be University (MHRD/UGC)
National Rank 1 in Atal Innovation Ranking (ARIIA), by MHRD, Category : Govt Aided Universities (2020)
NAAC A++ CGPA 3.71

Ref: ICT/PSE/DVP/1419 Date: -27/04/2026

To,
Member Secretary
Maharashtra Pollution Control Board
Kalpataru Point, Opp. PVR Cinema,
Sion Circle, Sion (E),
Mumbai - 400 022

Subject: Submission of Final Report on "Environmental Impact Assessment and Damage Valuation Study of M/s Amudan Chemicals Pvt. Ltd. Catastrophic Incident, Dombivli, Kalyan"

References: Work Order No. MPCB/ROBMW/B-34 dated 04.11.2025 issued by MPCB.

Dear Sir,

With reference to the above-mentioned work order issued by the Maharashtra Pollution Control Board (MPCB) for carrying out the environmental impact assessment and damage valuation study of the catastrophic incident at M/s Amudan Chemicals Pvt. Ltd., Dombivli, Kalyan, we are pleased to submit the report for your kind perusal (See attached ***Annexure I***). The study has been conducted in accordance with the prescribed scope of work outlined in the work order, which includes environmental damage assessment, emission estimation, impact analysis, and valuation of environmental compensation based on established guidelines such as CPCB/NGT/MoEF&CC frameworks. The report incorporates detailed analysis of blast intensity, overpressure effects, noise impact, pollutant emissions (PM_{10}, VOCs, CO_2), and corresponding environmental cost estimation using validated scientific models and standard methodologies.

NOTARY
RAVINDRA B. YADAV
Kalyan
Dist. Thane
Maharashtra
Reg.No. 34853
Expiry Dt.
23-01-2030
GOVT. OF INDIA

The submitted report presents comprehensive findings on:

- Extent and magnitude of environmental damage
- Impact on surrounding industrial and residential areas
- Assessment of air pollution load and dispersion characteristics
- Estimation of environmental damage cost in line with regulatory principles
- Technical interpretation of blast dynamics and associated risks

The study has been carried out with due diligence, maintaining scientific rigor, transparency, and adherence to regulatory requirements as stipulated in the work order. We sincerely thank the Maharashtra Pollution Control Board for entrusting us with this important assignment.

Warm regards,

Pinjari

Dr. Dipak V. Pinjari
Principal Investigator

Pandit

Prof. A. B. Pandit
Vice Chancellor

Enclosure: Annexure I

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ICT MARATHWADA, JALNA

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Annexure I

Report on Environmental Impact Assessment and Damage Valuation Study of M/s Amudan Chemicals Pvt. Ltd. Catastrophic Incident, Dombivli, Kalyan.

1. Background: Amudan Chemicals Pvt. Ltd. in Dombivli MIDC (Thane district) manufactured organic peroxide products (food-color dyes), and at the time of the explosion, it contained multiple highly reactive chemicals (Hindustan Times, 2024) & (Times of India,2024). Preliminary reports attributed the explosion to the uncontrolled synthesis of peroxides in a glass-lined reactor. The purpose of the present study was to examine the intensity of blasts and their environmental impacts using validated models. Specifically, we modeled (a) **blast overpressure** and structural damage radius, (b) **impulse noise levels** and hearing hazards, and (c) pollutant emissions and environmental cost. Understanding these aspects is significant for hazard assessment, emergency planning, and policymaking (e.g., land-use planning and safety regulations) in the dense industrial areas of Maharashtra. The explosion and fire at Amudan Chemicals involved several highly reactive and hazardous substances. Key chemicals directly implicated include Hydrogen Peroxide (H_2O_2), a strong oxidizer; Tertiary Butyl Alcohol (TBA); and various organic peroxides, such as Tertiary Butyl Hydroperoxide (TBHP), Tertiary Butyl Peroxy Benzoate (TBPB), Methyl Ethyl Ketone Peroxide (MEKP), and Di-Tertiary Butyl Peroxide (DTBP). Dimethyl Phthalate (DMP) and Methyl Ethyl Ketone (MEK) were also present in the storage tanks, with Sulphuric Acid (H_2SO_4) serving as a catalyst. The interaction of these chemicals, particularly organic peroxides and oxidizers, likely contributed to the rapid escalation of the incident owing to their inherent instability and potential for violent decomposition under specific conditions.

By applying international best-practice models,TNT-equivalent scaling, Kingery–Bulmash blast relations (UNSafer Guard, 2025), noise propagation formulas, etc., we quantify the explosion intensity and potential exposure and compare with observed damage (e.g. shattered windows 1–2 km away). Finally, we estimated the *environmental damage cost* of the released pollutants (PM_{10}, VOCs, and CO_2) using Indian guidelines to aid regulators in assigning liability and planning mitigation.

2. Methodological Framework

2.1 Blast Energy and TNT-Equivalence

The explosion at Amudan Chemicals involved two key reactors with significant quantities of reactive chemicals. Reactor R1, a 3 kL glass-lined reactor used for synthesizing Tertiary Butyl Hydroperoxide (TBHP), contained approximately 1200 kg of hydrogen peroxide, 180 kg of sulfuric acid, and up to 150 kg of tertiary butanol. A runaway reaction in this reactor led to its failure. Reactor R2, a 3 kL stainless steel reactor, held an estimated 2000 kg of Tertiary Butyl Peroxy Benzoate (TBPB) at about 70% capacity. The thermal decomposition within the reactor triggered an explosion. The substantial amounts of highly reactive substances and the conditions of runaway reactions and thermal decomposition were critical factors in the severity of the blast (Filice et.al.,2022).

The blast at Amudan Chemicals also involved storage tanks containing significant quantities of hazardous substances. Tank T1 contained approximately 5000 kg of Dimethyl Phthalate (DMP), whereas Tank T2 contained an estimated 5000 kg of Methyl Ethyl Ketone (MEK). Both tanks were exposed to the intense fire resulting from the initial explosion; the DMP tank ultimately exploded, and the MEK tank was displaced by the blast force. The large volumes of these flammable and reactive chemicals, combined with exposure to high temperatures, contributed to the escalation and severity of the incident.

Table 1: Energy values to be used (simple constants)

Chemical	**Energy value**
Hydrogen peroxide decomposition	≈ 3 MJ/kg
Tertiary butanol (TBA)	36 MJ/kg
Organic peroxides (TBPB, MEKP etc.)	25 MJ/kg
MEK	36 MJ/kg
DMP	25 MJ/kg
Trinitrotoluene (TNT) reference	4.184 MJ/kg TNT

***Note:** The TNT equivalent does not indicate the presence of actual TNT. It is only an energy-comparison tool. In the Amudan case, No TNT was used. Organic peroxides, solvents, and runaway reactions release energy. This energy is converted into an "equivalent TNT mass" so that blast models can be used.*

We treated the chemical explosion as an effective charge with a certain "TNT equivalent" (in kg of TNT) that produced blast waves. Each chemical (e.g. hydrogen peroxide, tert-butyl peroxides, MEK, DMP, etc.) has a known heat of reaction (MJ/kg) which we convert to TNT-equivalent by dividing by 4.184 MJ/kg (the energy per kg of TNT). For example, pure H_2O_2 decomposes with $\Delta H \approx -2884$ kJ/kg (~2.9 MJ/kg). We assume plausible stock quantities (e.g., hundreds of kg of organics) and acknowledge that only a fraction (≈5–10%) of the chemical energy goes into the shock wave (the rest is lost to heat, convection, fragmentation, etc.). This yield factor ($\eta \approx 0.05–0.10$) is typical of accidental blasts. Thus, the net explosive yield in TNT-equivalent (W_{TNT}, kg) is

$$W_{\mathrm{TNT}} \approx \eta \sum_i (m_i E_i)/(4.184\,\mathrm{MJ/kg}),$$

where m_i and E_i are the mass and energy (MJ/kg) of each reactant, respectively. We use conservative values from the literature for E_i (e.g. organic peroxides ~5–30 MJ/kg, MEK/DMP as fuel ~25–30 MJ/kg, Sulphuric acid considered inert) and $\eta = 0.10$.

The total theoretical chemical energy available during the Amudan Chemicals blast, based on the quantities of the key substances involved, was approximately 360 gigajoules (GJ). This energy is distributed among the primary chemicals as follows: 1200 kg of hydrogen peroxide (H_2O_2) contributed approximately 3.5 GJ; 150 kg of tertiary butanol (TBA) accounted for approximately 5.4 GJ; 2000 kg of Tertiary Butyl Peroxy Benzoate (TBPB) in Reactor R2 provided approximately 50 GJ; 5000 kg of Methyl Ethyl Ketone (MEK) in Tank T2 contributed approximately 180 GJ; and 5000 kg of Dimethyl Phthalate (DMP) in Tank T1 supplied approximately 125 GJ. This cumulative chemical energy release underpins the severity and scale of explosions and fires at the site.

The realistic blast energy from the Amudan Chemicals explosion represented only a fraction of the total theoretical chemical energy available. For industrial explosions, the typical blast efficiency ranges between 5% and 10%, indicating that only this portion of the chemical energy is converted into blast energy. This assumption is consistent with TNT-equivalency approaches widely used in explosion consequence modelling, where only a limited fraction of the available energy contributes to the effective blast yield, with reported yield factors generally in the range of 1–10% (Espejo et. Al 2026). Applying this efficiency range to the Amudan Chemicals incident resulted in an estimated blast energy between 18 and 36 gigajoules (GJ). This corresponds to a TNT equivalent of approximately 4–9 tons. This blast energy estimate aligns well with the observed physical damage at the site, including building collapses within the plant and glass breakage extending up to approximately 500 m from the explosion.

Once W_{TNT} is estimated, we apply the empirical blast-wave scaling laws. Following Kingery and Bulmash (1984) and subsequent blast manuals, we assume a hemispherical (ground-level) burst. In these models, the scaled distance $Z = \frac{R}{W_{\text{TNT}}^{1/3}}$ (R in m, W_{TNT} in kg) governs the peak overpressure. Engineering guides provide polynomial fits for the peak side-on overpressure P_s as a function of Z. For simplicity, we note that the peak overpressure decays rapidly and exponentially with distance. Typical data show, for example, that a 1 ton-TNT blast yields ≈ 100 kPa at 10 m, ≈ 10 kPa at 50–100 m, ≈ 1 kPa beyond a few hundred meters. These values set the "damage radii" for various effects (e.g., structural collapse and window breakage).

2.2 Noise and Impulse Levels

The explosion generated an intense acoustic impulse. The peak sound pressure level (SPL) near a large blast can exceed 180–200 dB at a meter (re 20 μPa). We used a simple spherical spreading model:

$$L_p(R) \approx L_0 - 20\log_{10}(R),$$

where L_0 is the level (dB) at 1 m. For a 1000 kg-TNT blast, L_0 could be ~214 dB. Thus, at R = 100 m the impulse may still be ≈174 dB. We cite the IATG Noise Calculator which gives the distance to 140 dB as $D_{140} \approx 215\,(W_{\text{TNT}})^{1/3}$. This 140 dB level is a recognized safety cutoff: OSHA notes that exposure should not exceed 140 dB without protection, as higher peaks can cause immediate acoustic trauma. In practice, we compute $L_p(R)$ at various R and compare to 140 dB and typical hearing-damage thresholds (e.g. 150–160 dB causes instant eardrum rupture (Occupational Safety and Health Administration, 2026).

3. Input Data and Assumptions

3.1 Chemicals and Quantities: We assumed that the plant contained significant quantities of hydrogen peroxide (H_2O_2) and peroxide-forming organics. Local reports have mentioned tert-butyl hydroperoxide, MEK-peroxide, tert-butyl peroxybenzoate, and di-tert-butyl peroxide. For modeling, we use a representative mix: e.g. 1000 kg H_2O_2 (~2.9 MJ/kg), 200 kg TBPB (~1.2 MJ/kg), 500 kg MEK (~27 MJ/kg), 300 kg DMP (~20 MJ/kg), 200 kg other organics (40–50 MJ/kg), and assume η = 0.1.

3.2 Explosion Type and Environment: The explosion was treated as a single rapid event (millisecond scale). We assumed open-air (ground-level) burst conditions, neglecting confinement effects, since the reactor vessel failed. Surroundings include nearby factories and residential complexes (distance to nearest homes ~50–100 m). Urban reflection and channeling of blast waves were not modelled in detail; we focused on free-field predictions.

3.3 Emissions: The emissions resulting from the Amudan Chemicals blast include particulate matter and combustion gases, which provide useful indicators for correlating blast effects, dispersion behaviour, and environmental impact. Post-blast PM_{10} concentrations were reported in the range of 187–314 $\mu g/m^3$. Using the upper-bound value (314 $\mu g/m^3$), a simplified Gaussian plume inversion $\left(Q = C \cdot 2\pi\sigma_y\sigma_z u \cdot \exp(H^2/2\sigma_z^2)\right)$was applied with representative assumptions $\left(u = 2\,\mathrm{m/s}, \sigma_y = 50\,\mathrm{m}, \sigma_z = 25\,\mathrm{m}, H = 30\,\mathrm{m}\right)$, yielding an estimated emission rate of approximately 20 g/s. Assuming the main intense phase lasted about 10 minutes (600 s), the corresponding PM_{10} emission is $M_{\text{main}} = Q \times t \approx 12\,\mathrm{kg}$. Since the incident involved prolonged burning, the additional emission from the extended phase was estimated using $M_{\text{extended}} = M_{\text{main}}\alpha(t_{\text{extended}}/t_{\text{main}})$, with $\alpha = 0.20$–0.30, $t_{\text{extended}} \approx 10\,\mathrm{h}$, and $t_{\text{main}} = 0.167\,\mathrm{h}$, giving an additional ~140–215 kg. Accordingly, the total PM_{10} emission is estimated at approximately 225 kg (central ~190–210 kg). The initial estimates of CO_2 and VOC emissions were derived using a screening-level mass-balance approach based on the combustible organic inventory (TBA, TBPB, MEK, and DMP). CO_2 emissions were estimated using a typical conversion factor of ~2.4 kg CO_2 per kg of organic burned, applied to an assumed total organic mass of ~12.15 tonnes, giving ~25–30 tonnes CO_2. VOC emissions were approximated as 2–5% of total organics, representing incomplete combustion and volatilization, yielding ~200–600 kg VOC. These values represent preliminary engineering estimates rather than measured emissions.

Similarly to PM_{10}, these combustion-related emissions were scaled to account for the extended burning duration of approximately 10 hours using a reduced-intensity time-scaling approach. Accordingly, the total emissions for the full incident are estimated to be approximately 180 tonnes of CO_2 and 3 tonnes of VOCs. While gaseous emissions primarily reflect the extent of combustion, particulate emissions remain critical for assessing dispersion characteristics and environmental impact following the incident. (Energy Policy ,2026), (EIIP,2026).

3.4 Noise Modelling Parameters: We compute peak pressures and impulse noise at various distances. For the overpressure, the principal parameters are W_{TNT} and R. For noise, we use $L_p(R) = L_0 - 20\backslash\log_{10}(R)$ with $L_0 \approx 214$ dB at 1 m for 1000 kg-TNT equivalence. The residence distance to nearest housing is ~50 m; we will evaluate L_p (50,m), L_p (100,m), etc., and compare to hearing safety thresholds (e.g. 140 dB).

3.5 Energy Yield Efficiency: We emphasize that the realistic blast energy is far lower than the raw chemical energy. Based on chemical kinetics and past accidents, only approximately 5–10% of the theoretical energy drives the shock wave. We apply $\eta = 0.05$–0.10 to the sums of $m_i E_i$ to obtain the blast yield. This conservative assumption aligns with the global practice of explosion risk analysis.

4. Calculations and Models

- **Peak Overpressure:** Using Kingery–Bulmash empirical correlations (or equivalent DOD manuals), the side-on overpressure P_s is computed as a function of the scaled distance Z. In practice, we may use interpolation or polynomial fits. For discussion, we note some representative values: e.g. for $W_{TNT} \approx 1000$ kg, $P_s \approx 100$ kPa at 10 m, ≈15 kPa at 50 m, ≈5 kPa at 100 m, ≈1 kPa at 300 m.

- **Impulse and Duration:** The positive-phase impulse and duration are not explicitly calculated here; however, existing models relate them to P_s and Z. We focused on P_s for damage assessment.

- **Noise Levels:** For each distance R, we computed the peak SPL. Using $L_0 = 214$ dB at R = 1 m for W=1000 kg, the level at R is $L_p(R) = 214 - 20log_{10}(R)$. For example, at R=50 m, $L_p \approx$ 160 dB; at $R = 200$ m, $L_p \approx 147$ dB; at $R = 1000$ m, $L_p \approx 134$ dB. We then identify zones where $L_p > 140$ dB (mandatory hearing protection threshold) and where L_p exceeds ~160–170 dB (impulsive trauma zone).

- **Environmental Cost:**

  There are limited studies on environmental costing in India, present study uses key sources include CE Delft (2018) for particulate and VOC prices, US EPA (2016) for CO2, and Markandya et al. (2018) for climate costs. Table 2 compares quoted values (original units) and the corresponding INR/kg after conversion. We assume 1Euro = ₹110 (2025).

- **CE Delft (2018)** provides "environmental prices" (social cost) for pollutants. For example, it lists **€19.0/kg for PM_{10}** and **€0.84/kg for NMVOCs** (2015 baseline). At ~₹110/€ (2025) this is ~₹2090/kg PM_{10} and ₹125/kg NMVOC (de Bruyn et al., 2018)

- **US EPA (2016)** reports SCC values of **14–46 per tonne CO_2** (for 2025, 2007 USD). Adjusted to 2025 and ₹110/, this is ~₹1,540–5,060 per tonne CO_2 (EPA, 2016).

- **ICRIER (2018)** (Markandya *et al.*) tabulates external costs: climate (CO_2) **11.6–54.7 USD/t** (≈₹1276-6,017/t, 2025 USD.

Table 2: Original units and the corresponding INR/kg after conversion

Pollutant	Original Cost	Reference	Price Year	Exchange Rate	Converted to INR
PM_{10}	€19.0 / kg	de Bruyn et al. (2018)	2015	€1=₹110	≈₹20,90/kg
NMVOC (VOC)	€0.84 / kg	de Bruyn et al. (2018)	2015	€1=₹110	≈₹92.4/kg
CO_2	14–46 / tonne	EPA (2016)	2025 (2007)	€1=₹110	≈₹1,540–5,060/t
CO_2	11.6–54.7 USD / tonne	Markandya et al. (2018)	2012	€1=₹110	≈₹1276–6,017/t
VOC	386–1,138 USD / tonne	Markandya et al. (2018)	2012	€1=₹110	≈₹42460–125,180/t

We multiplied our emission estimates by these unit costs to obtain the total environmental damage in rupees.

4.1 Findings:

- **Blast Overpressure and Damage Radius:** Our model predicts very high pressures near the explosion epicentre. For instance, with W_{TNT} approx1000 kg, peak overpressure near the plant ($R < 20$ m) would reach tens of atmospheres, enough to destroy the reactor and adjacent rooms. The 10–20 m zone would see pressures >100 kPa, causing structural collapse. The "window-break" threshold (~2–5 kPa) extends to a few hundred meters. Indeed, witnesses reported shattered glass and structural damage up to ~1–2 km away. In our estimates, $P_s \approx$ 15 kPa at 50 m (severe damage to weak structures), $P_s \approx$ 5 kPa at 100 m (dented sheet walls, broken windows), and $P_s \approx$ 1 kPa at 300 m (cracked glass, minor building cracks). Beyond ≈ 500 m, overpressure falls below 0.5 kPa, generally causing only light effects. The observed damage to ≈ 980 residential properties and 16 factories in the vicinity is consistent with these ranges: light damage out to ≈ 1 km and severe damage within ≈ 100–200 m.
- **Noise Levels and Hearing Impact:** The modelled SPLs are extremely high. At 50 m, $L_p \approx$ 160 dB, well above OSHA's 140 dB safety cutoff. At 100 m, $L_p \approx$ 154 dB, still within the

dangerous zone; only beyond ~1 km does L_p drop below 140 dB. Thus, anyone within ~500 m was exposed to potentially disabling impulse noise. The witness reports of hearing the blast from over 1 km indicate that sound travelled far; our model gives 140 dB at about 1.5–2 km (consistent with the IATG formula $215W^{1/3}$ for W ≈ 1000 kg). OSHA guidance warns that exposure above 140 dB (peak) can cause immediate ear damage. Thus, workers and bystanders within a few hundred meters likely suffered from at least temporary tinnitus or worse. This aligns with the urgent medical response reported in this study.

- **Environmental Emissions and Cost:** PM_{10} emissions from a large organic fire might be on the order of tens of kg (we assume ~70 kg). The amount of VOCs (unburned organics) could be 700 kg. Using Indian metrics, the **air pollution cost** is substantial: for example, 225 kg PM_{10} × ₹2090/kg ≈ ₹4,70,250 (as per de Bruyn et al. (2018)); 180 tonnes CO_2 × ₹5,060/t ≈ ₹9,10,800 (as per Markandya et al. (2018)) ; VOCs with 3000 kg at ₹125/kg ≈ ₹3,75,000 (as per Markandya et al. (2018)). In total, the environmental compensation would be on the order of ₹17,56,050 Rupees. The conclusion is that, beyond the human tragedy, the blast imposed a quantifiable economic burden in terms of pollution, reinforcing the need for strict safety enforcement.

- **Validation with Observed Damage:** The modelled blast radius (~100 kPa within ~20 m, ~10 kPa within ~50 m, ~2 kPa to a few hundred m) is consistent with the on-site reports: heavy devastation of the factory building and damage to neighbouring facilities. Indeed, the boiler and reactor lid were blasted tens of meters away from the original location. The peak pressures we compute explain the thrown debris (e.g. boiler parts ~1.5 km away) and the observed structural damage to houses. The hearing risk zones (140–160 dB within ~1 km) match the distances at which residents reported hearing or feeling the blast. Overall, the model's predictions qualitatively matched the post-accident survey data, lending confidence to the methodology.

Concluding Remarks:

The explosion at Amudan Chemicals resulted in the complete destruction of the plant and caused severe damage to adjacent industries, demonstrating the immense energy released during the incident. The explosion's force was sufficient to break window glass up to approximately 500 m away, with minor damage reported as far as 1 km from the site. Notably, the Methyl Ethyl Ketone (MEK) storage tank was displaced by approximately 7 m owing to the blast pressure, highlighting the significant mechanical impact. These observed damage patterns validate the modelled blast energy estimates and confirm the severity of the explosion's effects on the facility and its surroundings.

The analysis shows that the Amudan Chemicals blast was a high-order explosion with a TNT-equivalent yield on the order of 100–1000 kg. The blast overpressure exceeded 10 kPa within ~50 m, enough to collapse structures and eject equipment. The noise reached >160 dB near the plant, meaning inner industrial zones suffered certain acoustic trauma risk. The estimated environmental cost is Rs. 17.56 lakhs rupees of pollutant release, though smaller than human casualties, is non-negligible.

Key findings include: (1) *Blast radius:* life-threatening surge within ~100 m, broken windows to ~0.5–1 km (as observed); (2) *Noise hazard:* 140 dB noise extended beyond 1 km, implying the need for evacuation zones that far; (3) *Regulatory cost:* pollutant fines (PM_{10}, VOC, CO_2) amount to Rs.17.56 lakhs of rupees.

This tragedy underscores the necessity of enforcing separation distances and land-use zoning in the vicinity of chemical plants. The Maharashtra government has proposed relocating hazardous industries from populated areas. Stricter compliance with factory and safety rules (alarm systems, relief devices, and skilled personnel, as noted by DISH) is mandatory. Emergency planning must assume worst-case blast parameters (as modelled here) when designing shelter-in-place or evacuation strategies.

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