MECHON

Enhanced Environments

Shaping Your Environment

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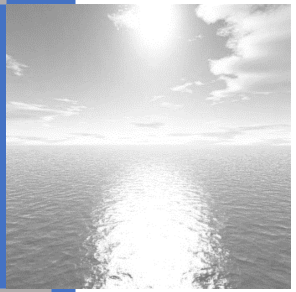


From Source to Atmosphere

Environmental Impact of LEV Emissions

Introduction – The Complete Journey of Contaminants

The two Sides of LEV:

LEV systems capture airborne contaminants **at source** to protect workers — captured pollutants are then exhausted **to the atmosphere**

Why This Matters:

- Capturing pollutants is only half the story
- Once released, emissions affect wider community health and environment
- Workplace exposure limited to ~8 hrs/day for workers
- Environmental exposure affects entire communities 24/7, including the vulnerable

Todays Focus:

Understanding how to design, assess, and monitor LEV systems that protect **both** workers inside and communities outside.

Theme: Collaboration — Occupational hygienists, engineers, environmental regulators, and communities working together to control emissions at every stage.

Why Emissions Matter

12,000 annual deaths from work-related lung diseases in the UK

>30,000 deaths per year linked to ambient air pollution in the UK

Three Key Concerns:

- **Health Impacts:** Pollutants cause respiratory/cardiovascular diseases, cancers.
- **Community Concerns:** Odours, dust, visible plumes trigger complaints.
- **Legal Obligations:** Environmental Protection Act 1990, EPR. Non-compliance = fines, permit breaches, shutdowns

Common Pollutants & Emission Concerns

Vapours (VOCs)
Paint fumes, solvents. Cause odour complaints, contribute to smog formation, health symptoms (headaches, nausea)

Dusts & Particulates (PM_{10}, $PM_{2.5}$)
Woodworking, grinding. Visible nuisance, respiratory/cardiovascular disease. Stringent limits: 40 $\mu g/m^3$ annual mean

Combustion Fumes (NO_2, CO, SO_2)
Engines, welding. Linked to asthma, heart/lung disease. NO_2 limit: 40 $\mu g/m^3$ annual, 200 $\mu g/m^3$ hourly

Mist & Fumes
Acid mists, metal fumes. Can harm vegetation, water bodies. Critical levels low for sensitive ecosystems

Regulatory Context (UK)

Environmental Permitting Regulations (EPR)

Environment Agency

Regulates larger "Part A1" installations. Requires Environmental Risk Assessment, dispersion modelling, BAT (Best Available Techniques)

Local Authorities

Regulate smaller "Part B" processes (air emissions only). Paint shops, foundries, woodworking. Set filter requirements, stack heights

D1 and M1 Guidance

D1 Guidance (Historic)

Purpose: Calculate safe stack height

Status: Old guidance - principle remains valid

Use: Conservative approach, often resulted in taller stacks than strictly needed.

M1 Guidance (Current)

Purpose: Guidance on sampling requirements for monitoring emissions

Key Requirements:

- Sampling location in stable flow
- Adequate port size and safe access
- Accredited sample methods
- Certification for equipment and personnel

H1 and H2 Screening

Initial H1 Screening (Stage 1):

Purpose: Determine emissions significance considers background pollution levels

Process Contribution vs Environmental Quality Standards

✓ Impact **insignificant** → Screen out

✗ Impact **significant**

Secondary Screening (Stage 2)

Purpose: Considers background pollution levels

Predicted Environmental Concentration

✓ Impact **insignificant** → Screen out

✗ Impact **significant**

Modelling might be required

When Dispersion Modelling is Needed

Triggers for Detailed Modelling:

- Exceeding Screening Criteria
- Permit Requirements
- Planning Applications
- Complex Scenarios
- Design Optimization

What Modelling Determines:

- Ground-level concentrations at receptors
- Spatial extent of pollution plume
- Worst-case exposure scenario
- Cumulative effects from multiple sources
- Compliance margins
- Design optimization parameters

Tools: Gaussian plume models (ADMS, AERMOD) with hourly weather data, terrain, building effects, etc

Design Implications

Key Design Controls to inform LEV Design:

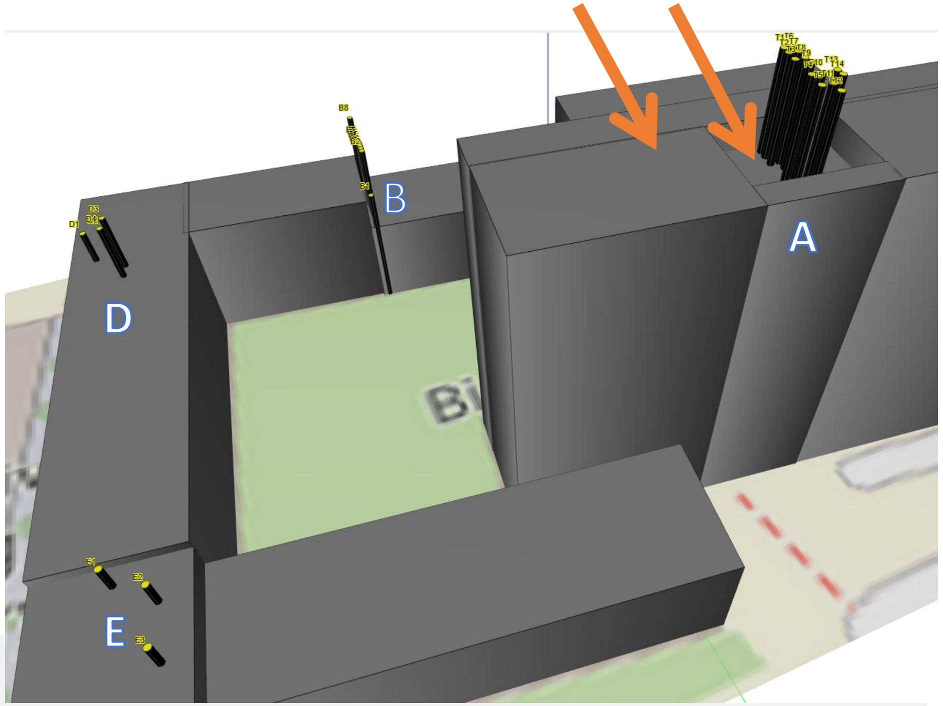
1. Stack Height & Location
2. Exit Flow & Velocity
3. Emission Controls
4. Process siting & Margin of Safety

Interactive Process:

Design → Model → Refine → Model Again → Implement.
Far cheaper to adjust on paper than retrofit later

Case Study: Roof Access Safety

The Challenge:
Laboratory fume cupboards handling chloroform and other chemicals vent to roof stacks. Maintenance personnel need periodic access to the Building A roof.



Question: Can workers safely access the roof?

Assessment Objectives:
Use dispersion modelling to determine if roof-level concentrations exceed 10% of Workplace Exposure Limits (WELs) during normal operations and potential spill scenarios

Case Study: Roof Access Safety

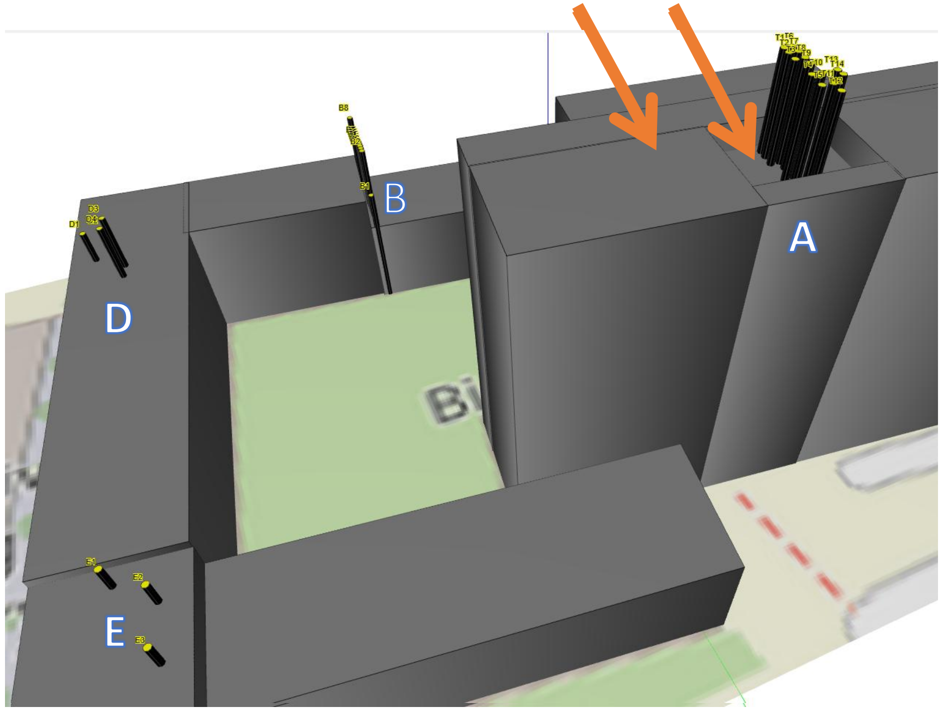
Model Configuration:

Input Parameters

Receptors: 1.5m above roof surface (breathing height)

Buildings: 12 structures modelled for downwash effects

Stacks: 29 individual sources, 10 m/s minimum velocity



Exposure Targets (10% of WELs):

Short-term: 2.97 mg/m³ (15-minute average)

Long-term: 0.99 mg/m³ (8-hour TWA)

Case Study: Source Location Matters

Stack Contribution Analysis:
Initial modelling identified which emission sources pose the greatest risk to roof concentrations

High-Risk Sources

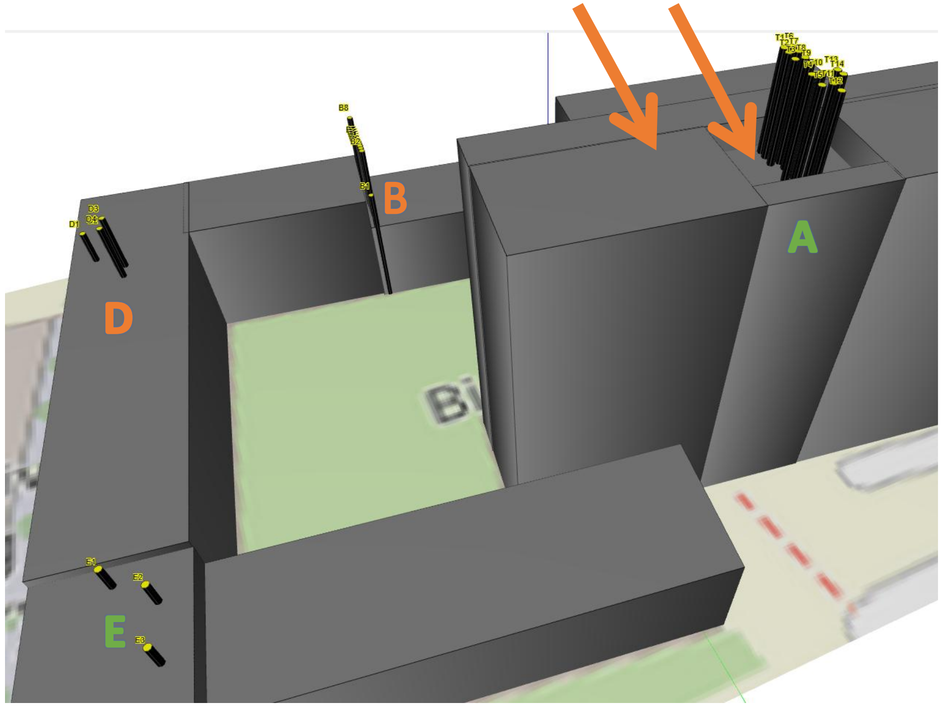
Building B stacks
Building D stacks

Spills can exceed exposure targets

Low-Risk Sources

Building A stacks
Building E stacks

Spills remain below targets

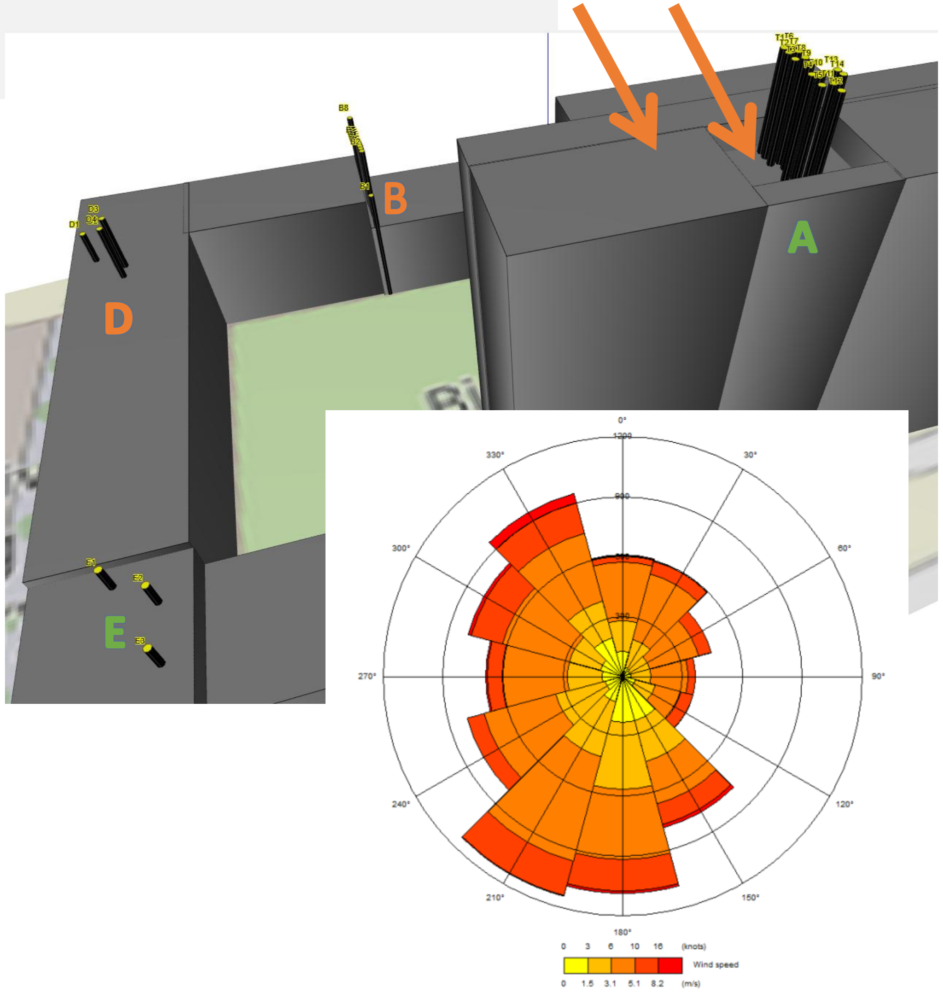


Case Study: Source Location Matters

Stack Contribution Analysis:

Key Difference?

- **Wind Direction & Proximity:** Northwest winds blow Buildings B/D emissions directly toward building A roof
- **Stack Height:** Stacks in building A discharge above the receptor plane

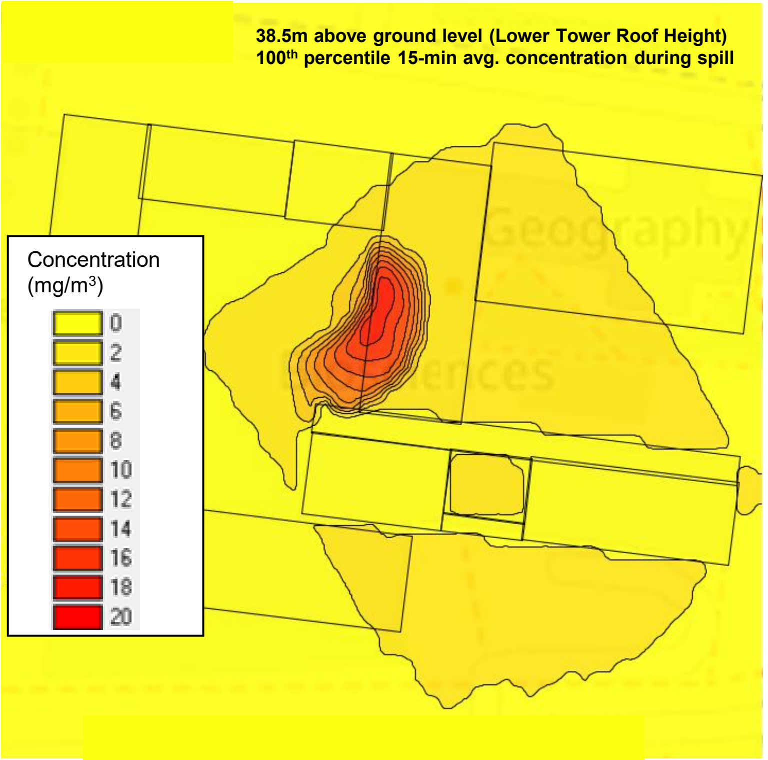


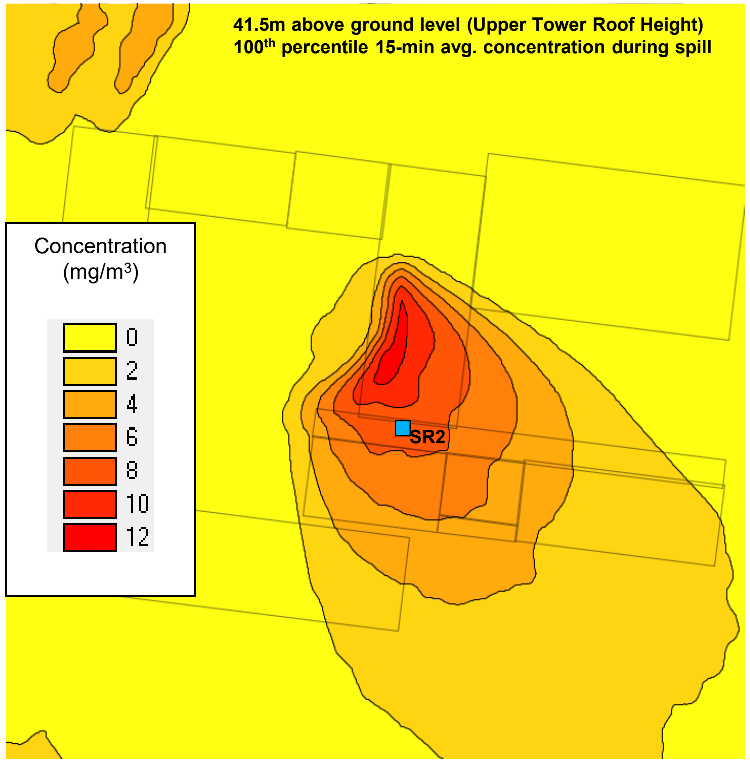
Case Study: Modelling Results Summary

Worst-Case Scenario (Spill at Stack B2):

15-Minute Concentration Predicted: 9.42 mg/m³
Target: 2.97 mg/m³
Exceeds target by **3.2×**

BUT: Exceedance occurs only 1.0% of year (36 hours) during unfavourable meteorology



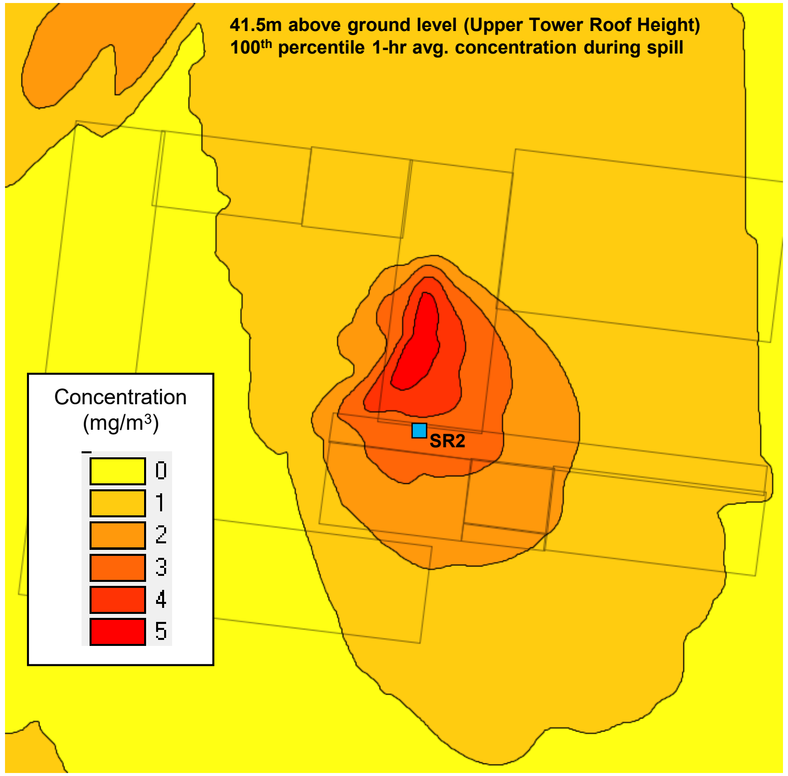


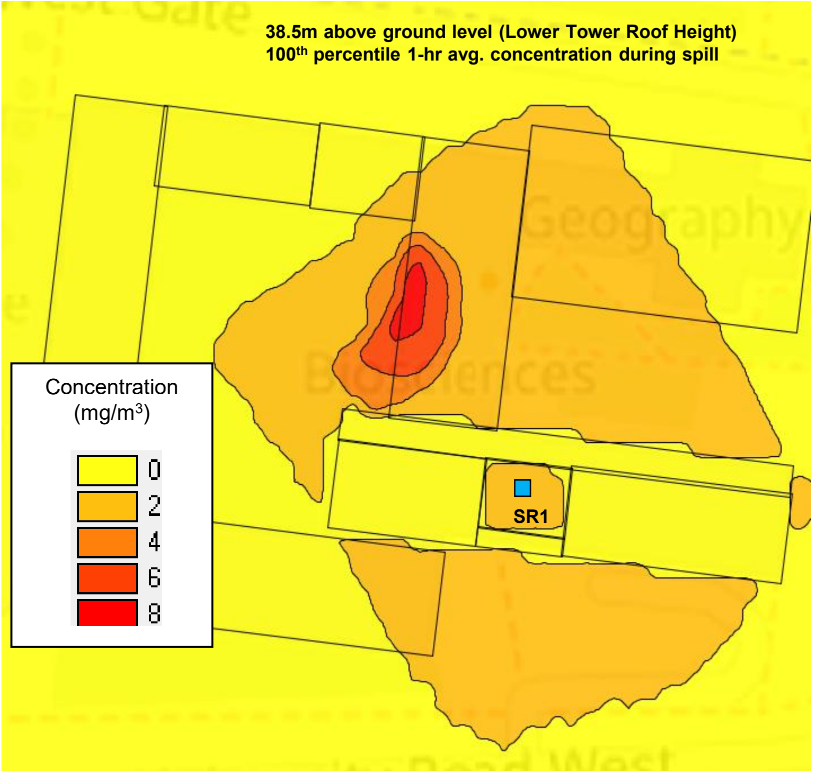
Case Study: Modelling Results Summary

Worst-Case Scenario (Spill at Stack B2):

8-Hour TWA
Predicted: 1.04 mg/m³
Target: 0.99 mg/m³
Exceeds target by **1.05×**

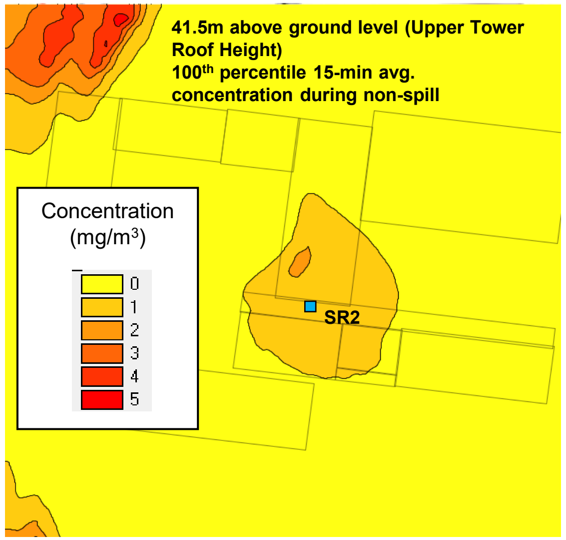
BUT: Exceedance occurs only 0.3% of year (26 hours)

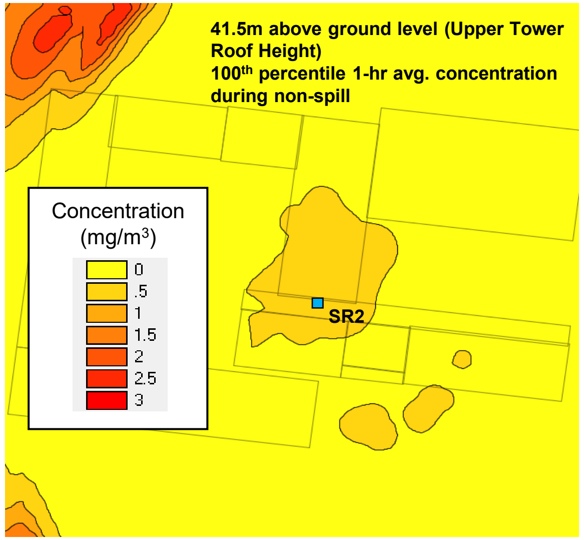


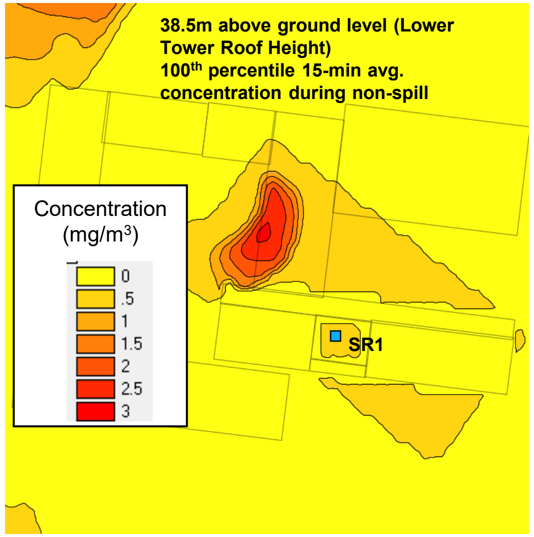


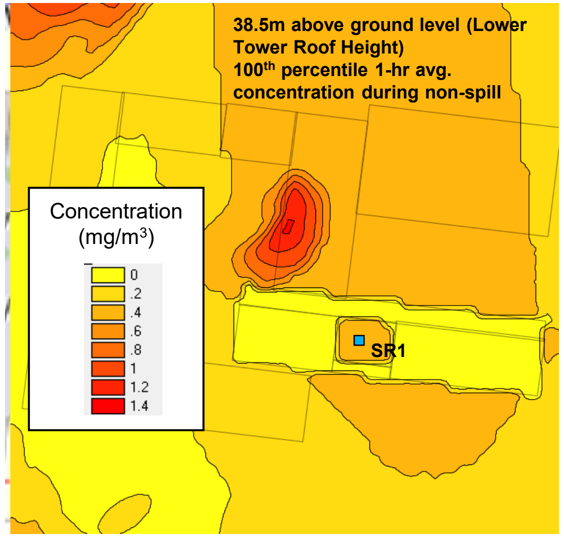
Case Study: Modelling Results Summary

No Spill Scenarios (SR2)









15-Minute Target ✓ Passes
8-Hour TWA Target ✓ Passes

Case Study : Practical Implications for Roof Access

What the Modelling Tells Us:

✓ Safe During Routine Operations

Maintenance personnel can safely access roof A when under no spill conditions. **Predicted conditions 99.7% of the time**.

⚠ Conditional Access During Building B/D Operations

If a spill occurs in Buildings B or D while personnel are on roof A, exposure targets may be exceeded.

✓ Always Safe: Tower and Building E

Even if spills occur in buildings A or E, roof A concentrations remain below exposure targets.

Case Study: Risk Management Strategies

Option 1: Operational Controls - Temporary Shutdown

Action: Stop operations in Buildings B and D during scheduled roof A maintenance

Pros: Eliminates risk, simple to implement

Cons: Disrupts research activities, may not be practical

Option 2: Enhanced Safety Measures - Spill Prevention & Response

- Implement spill containment trays
- Reduce hood face velocity from 1 m/s to 0.5 m/s
- Real-time communication system
- Limit container sizes to 500 ml

Option 3: Weather-Based Access Restrictions

- Monitor weather and restrict access during high-risk periods.

Case Study: How Modelling Enables Informed Decisions

Requirements Without Modelling

1. Complete shutdown of all operations during maintenance, or
2. Prohibiting roof access entirely, or
3. Expensive abatement solutions.

With Modelling:

- **Quantified Risk:** Minimal exceedances
- **Targeted Controls:** Buildings B and D
- **Cost Savings**
- **Operational Flexibility**

Key Modelling Benefits:

- Identifies relevant emission sources
- Quantifies frequency and duration
- Multiple scenarios without costly testing
- Provides justification for safety protocols
- Demonstrates safety compliance

Once Implemented: Monitoring & Verification

Why Monitor?

- Regulatory Compliance (ISO 13284-1 for dust, BS EN 14791 for VOCs)
- Performance Verification
- Early Warning

Best Practice: Regular LEV system inspection + emission testing = sustained compliance

Best Practices Summary

Design Phase

- Engage regulators early
- Use H1 screening to scope assessment
- Model multiple scenarios
- Build in safety margins
- Document all assumptions

Operational Phase

- Regular LEV maintenance
- Periodic emission testing
- Monitor complaints log
- Keep records for inspections
- Update risk assessments

Protecting Workers & Communities

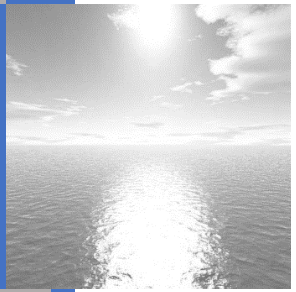
Key Takeaways:

✓ LEV protects workers, **emission control protects communities**

✓ Assessment drives design — iterate early and often

✓ Compliance requires ongoing monitoring and maintenance

✓ Collaboration across disciplines ensures holistic protection



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