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The Wolfson Centre
for Bulk Solids Handling Technology

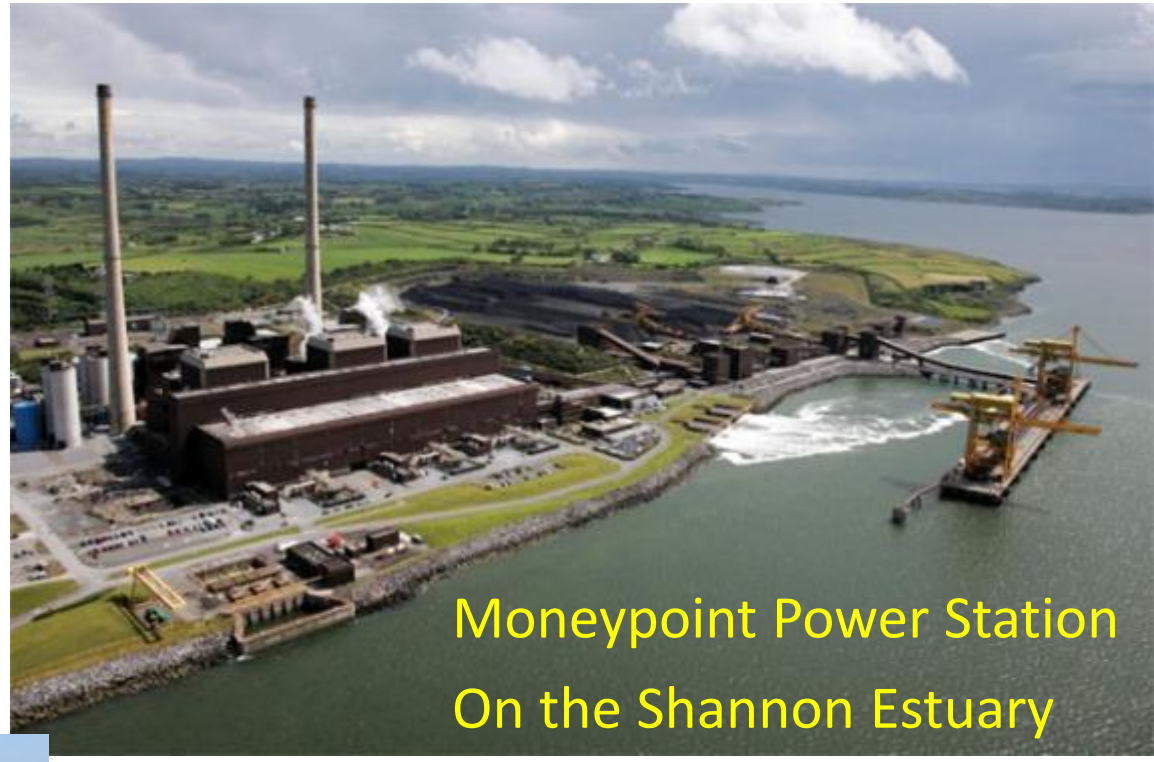
Dust, Mess and Spillage in Dry Bulk Cargo Handling

Prof Mike Bradley

Director



Dust, mess and spillage


Moneypoint Power Station
On the Shannon Estuary


Port of Tyne
Surrounded by the city

- Exposure of personnel to dust
- Annoyance of neighbours
- Lost cargo
- Environmental damage

Grab operations

Grabs





- Two-Rope or Electro-Hydraulic
- Volume – to match crane capacity to bulk solids density
- Different grab size for different commodities!
  - Bulk density change
- Sealing efficiency - dribbling

Reducing dust emission from grabs

- Pyramidal covers over open tops
  - Reduce roll-off of excess bulk solid
  - Reduce wind lift-off of dust

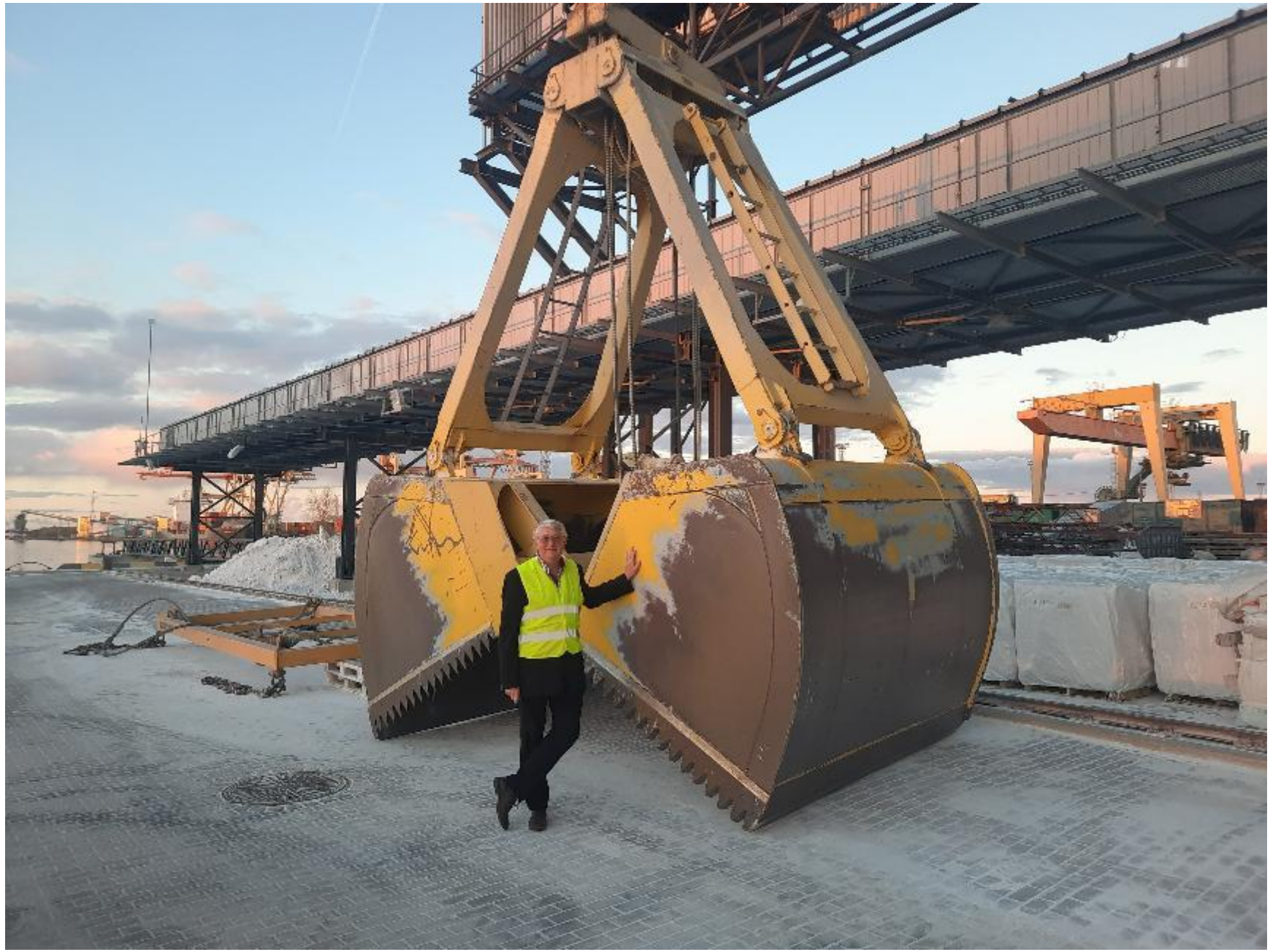






Dribbling during transport









Wind carry-away during discharge





Basic grab discharge hopper inlet



- No shielding against wind
- No depth for grab to be lowered into
- Nothing to prevent dust from rising from below

Result – evidence of spillage all over hopper tower







Controlling dust at grab discharge

- Containment and shielding against wind
- Grab lowered inside shielded area before opening
  - The deeper, the better the containment (less extraction needed)
- Smallest workable size around grab
- Extraction and filtering of displaced air

Free-standing crane discharge hopper

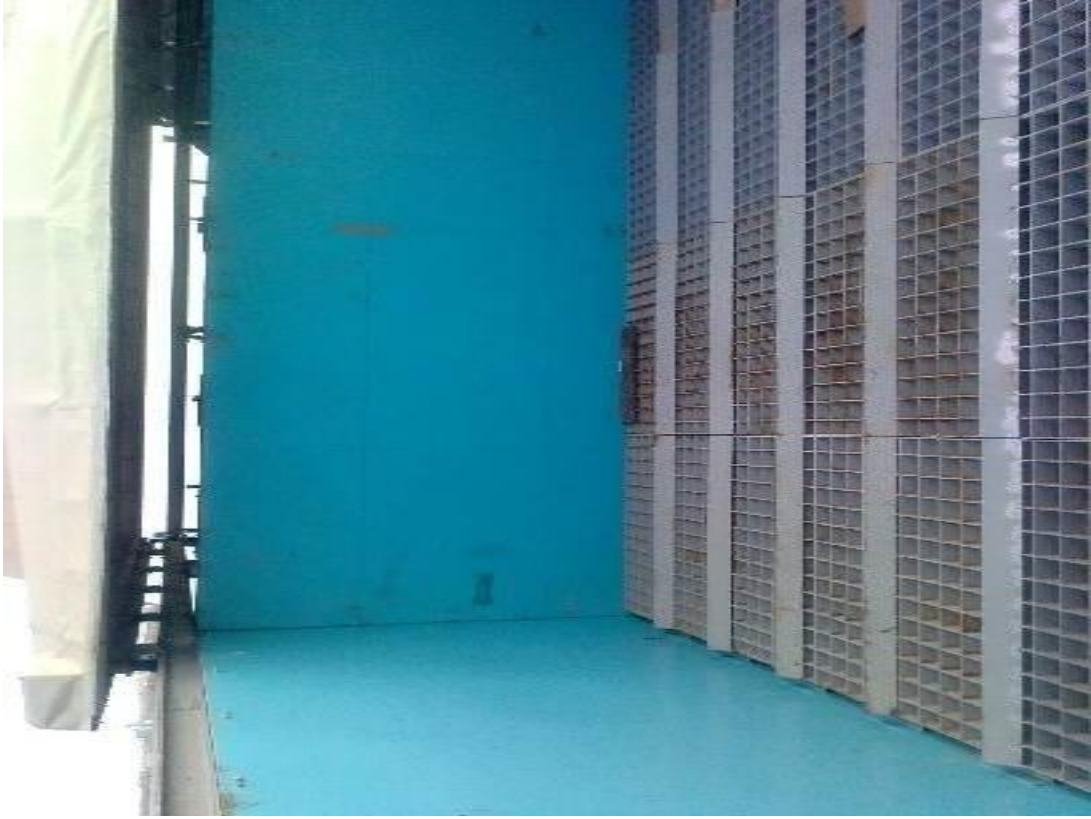
- Grab lowers inside before opening
- Air is projected across from one side, extracted at other
- Dust put back in flow
- Skirts lower to ground
- Roller shutter door prevents wind tunnel effect





Dust control features

- Shielding walls around grab opening position





- Spring loaded slats the open under material pressure then close up

Dust collection system





- Air extracted from inside hopper
- Dust separated and returned into flow

Containerised bulk handling

- Lower well into hold before rotating
- Reduces number of discharge events



Continuous loading

Prevention of Dust Generation at Source



Use of cascade arrangements

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Prevention of Dust Generation at Source



Use of cascade arrangements

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Telescopic loading chute

- “Dust-free” chute outlet remains on cargo surface
- Has on-board extraction and filtering





Director chute on bottom of drop chute

- Design to reduce air entrainment into fall
- Model chute geometry

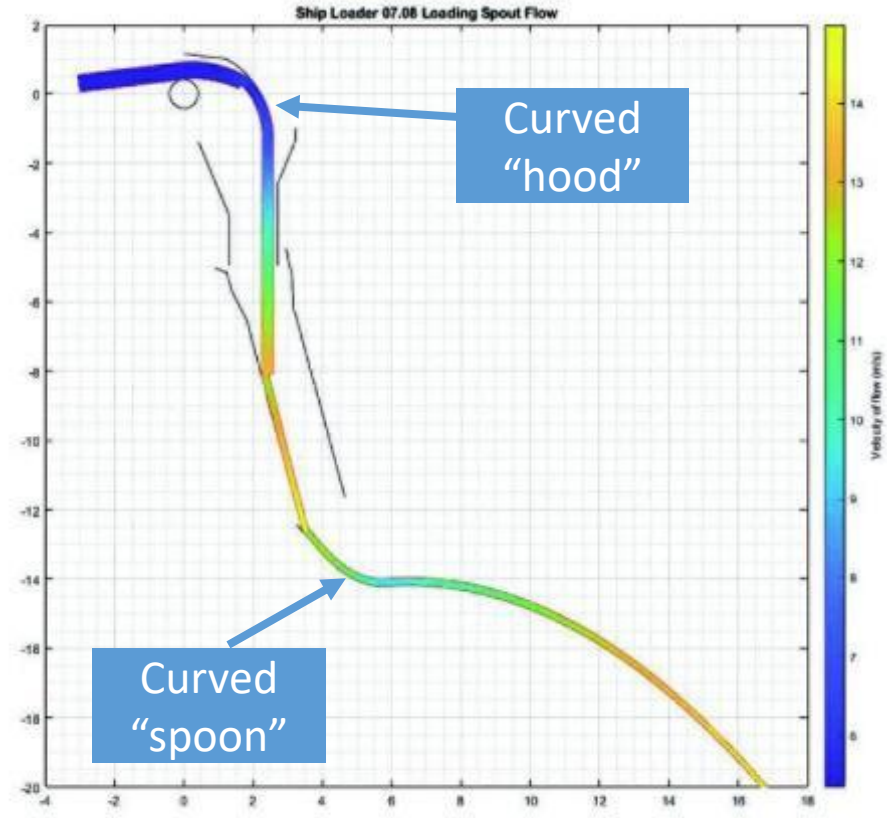


Analyse solids and air flow:

Use “hood and spoon” design principles

Minimum air entrainment = minimum dust emission





- ***Sloped chute keeps and air solids separated!***
  - Less air entrainment than vertical chute
- Gentle curves keep material in a concentrated stream
  - Top and bottom
- Modelling by University of Newcastle


What to do with the extracted dust?

What to do with extracted dust?

- Put back into flow?
  - Only a small proportion of the total dust is collected at each extraction point
- Convey separately?

Shore side operations

Some common problems and solutions

Operational buildings

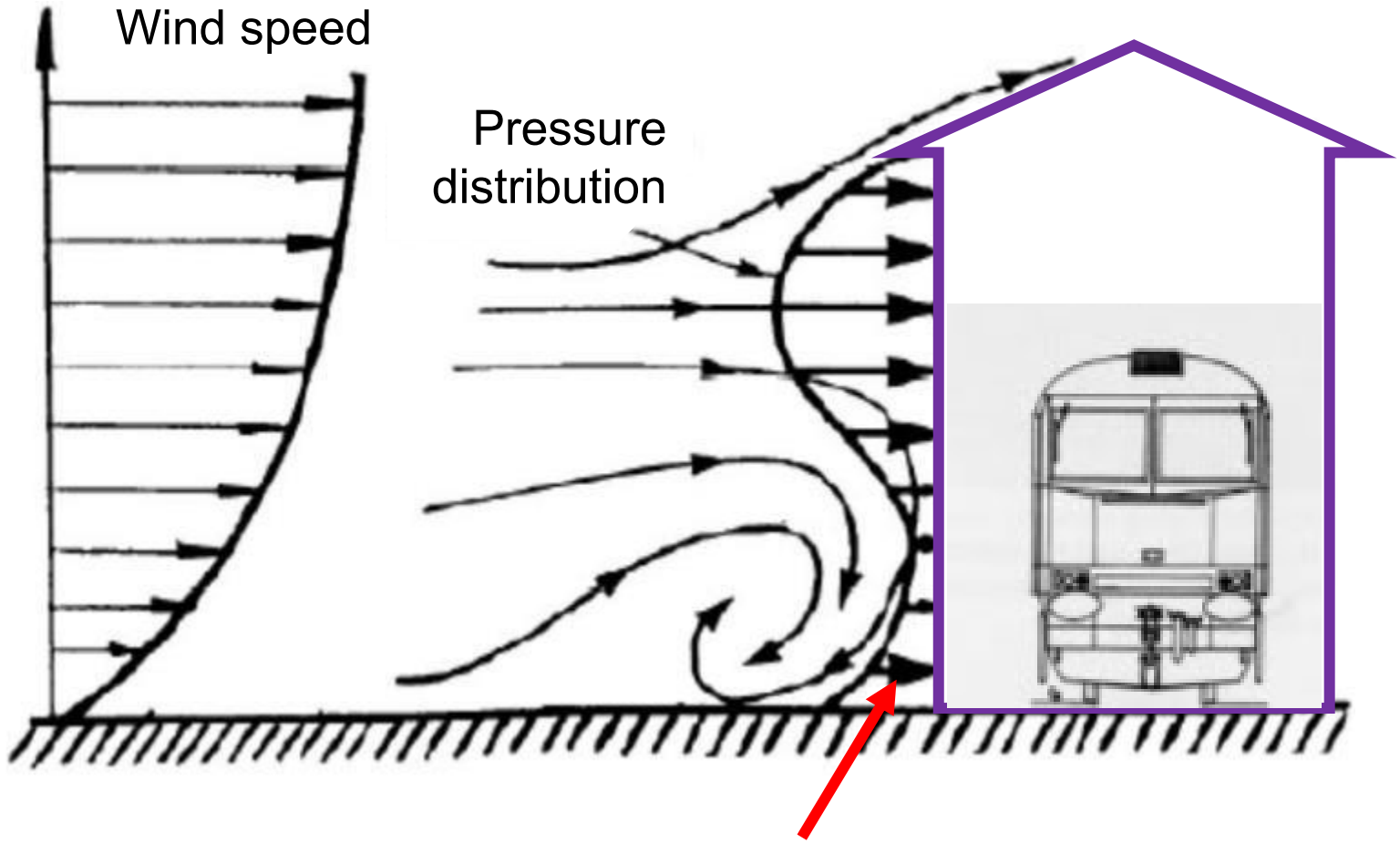
- Rail loading and unloading
- Transfer towers
- Etc



Corrosion holes in cladding at ground level

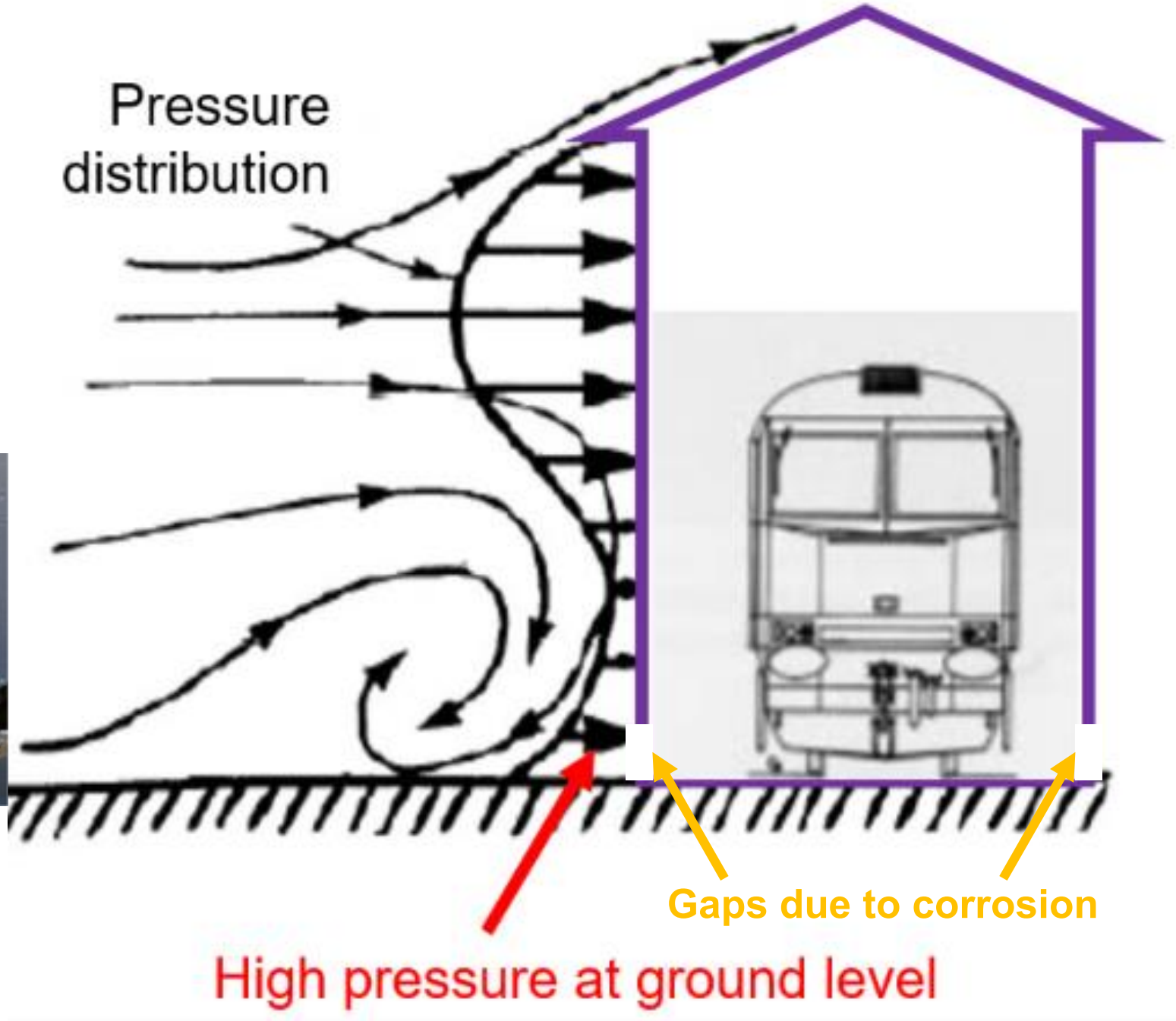


Wind pressure on buildings



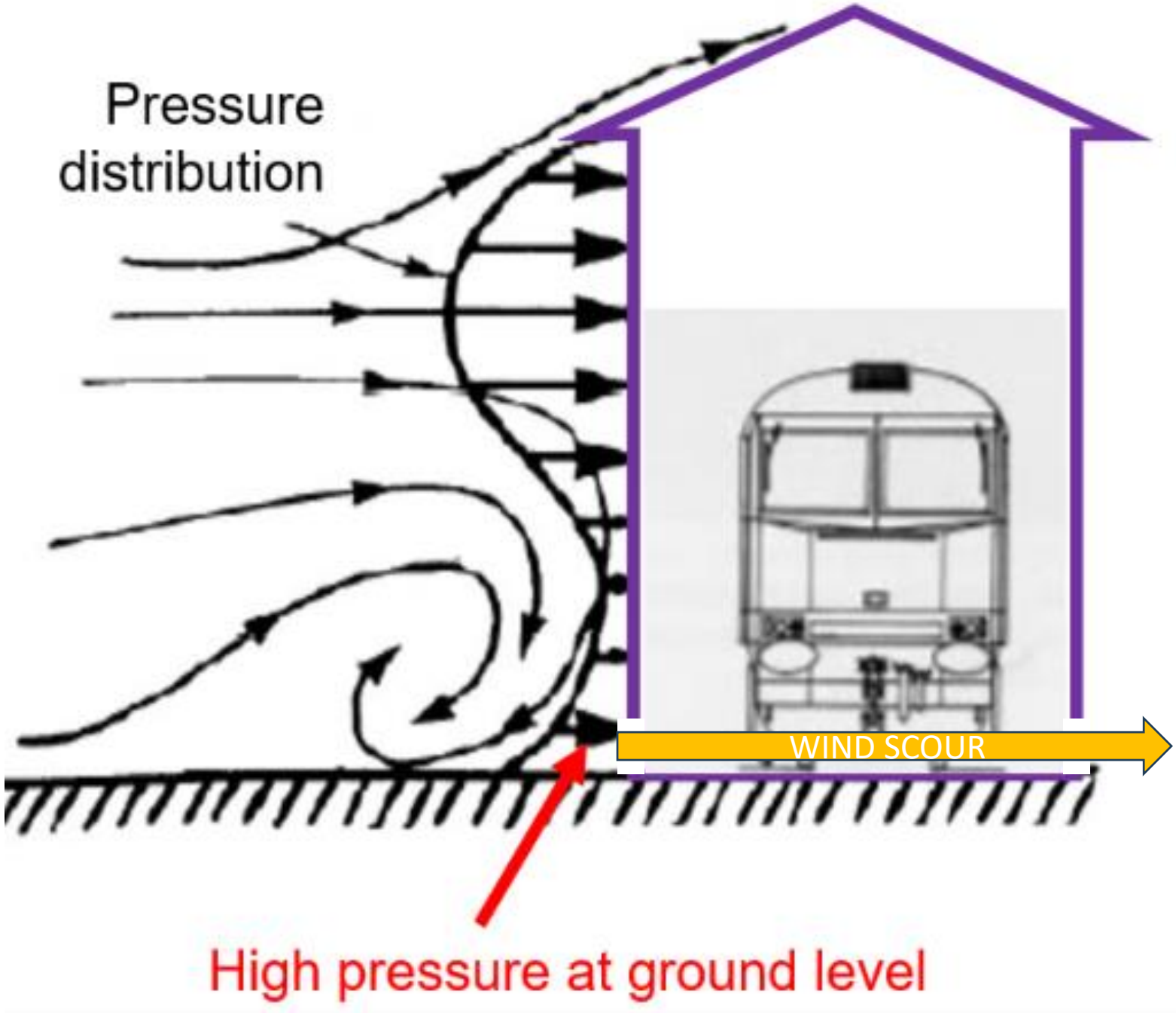
Effect of rotted-off cladding at ground level





Effect of rotted-off cladding at ground level

- High wind speed through gap scours dust

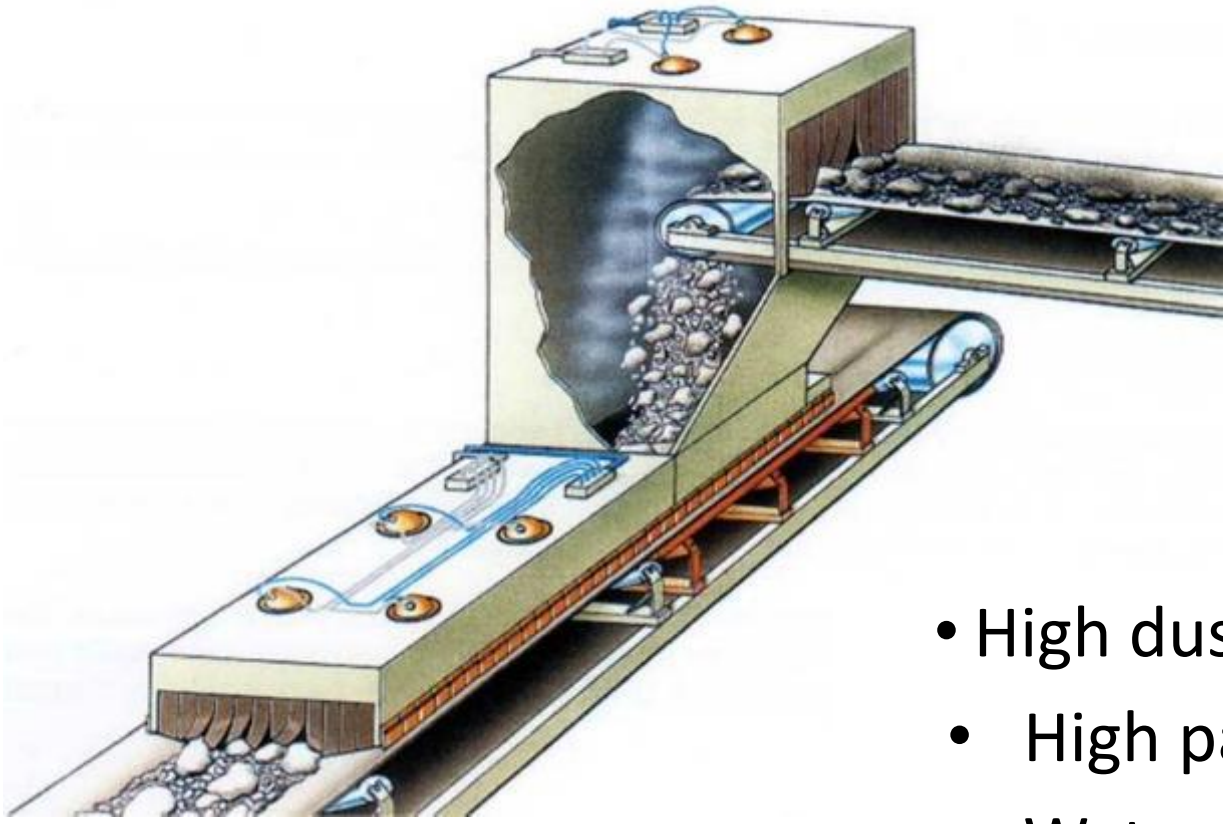



Walls stop clear of ground:
Promotes air flow underneath

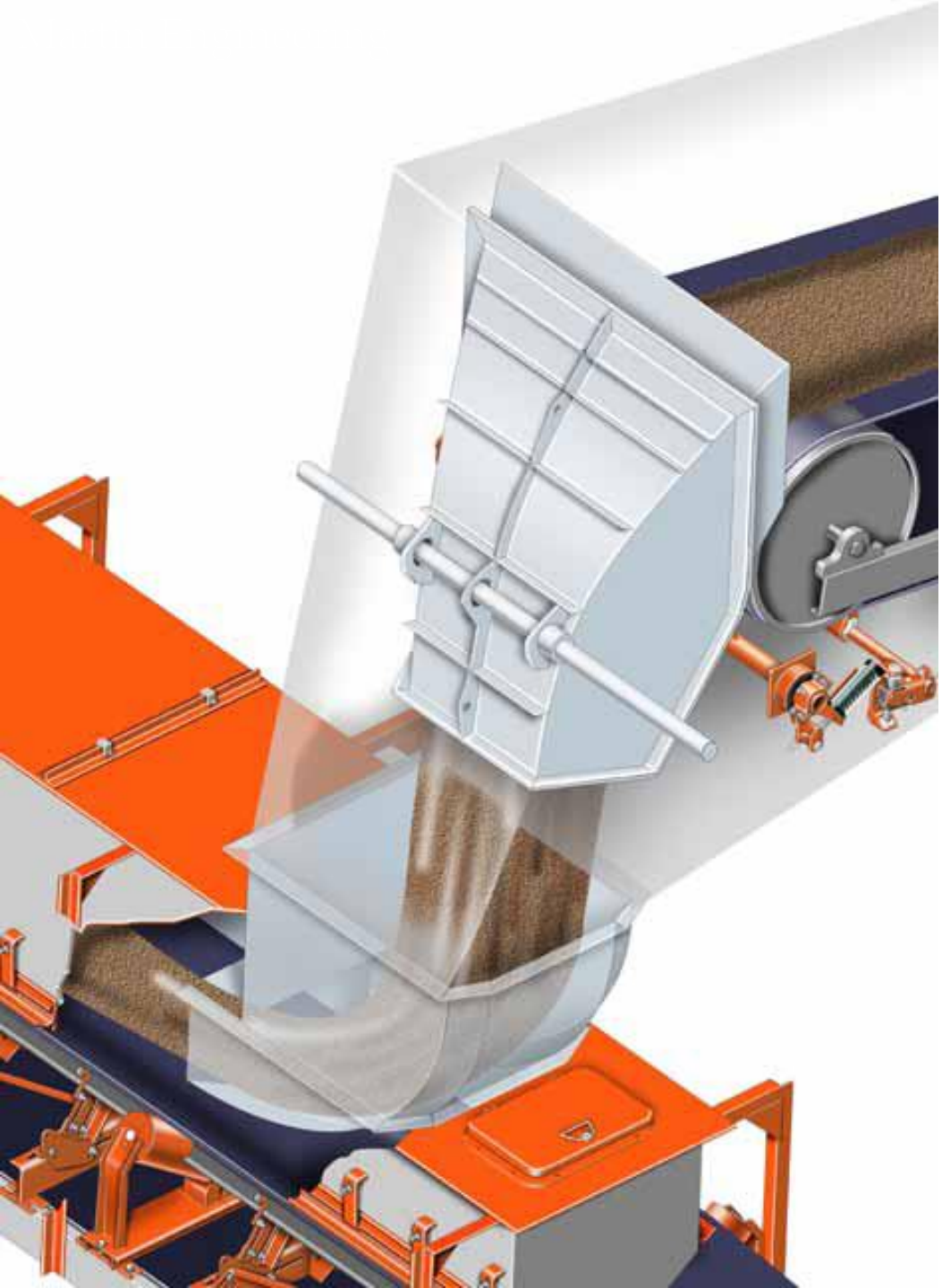
Open doors



Transfer point design – the tradition



- High dust emission
- High particle degradation
- Water spray often used to reduce dust emission
  - Poor effectiveness

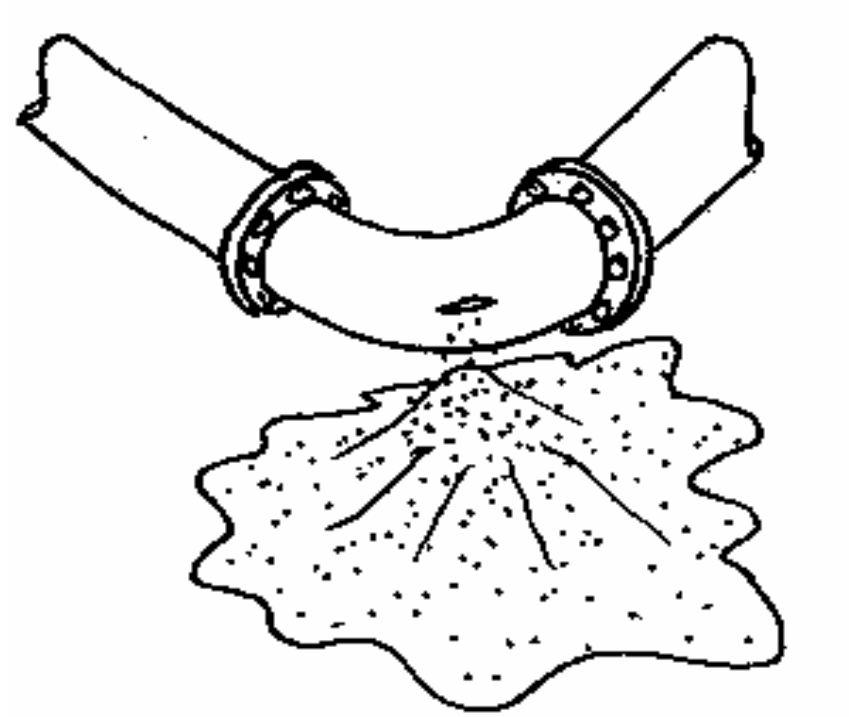


“Hood and Spoon” design

- Gentle transfer to avoid knocking dust out of flow
- Reduces particle degradation
- Design curve to suit particle trajectory
- Adjustment needed on site
- Can eliminate need for wet sprays

Dust control options

Containment of Dust



Maintenance of equipment / care of operation

Containment of Dust



Ensure that access panels are replaced after maintenance

Containment of Dust

Design of intake hoppers, transfer points

- Minimise open areas

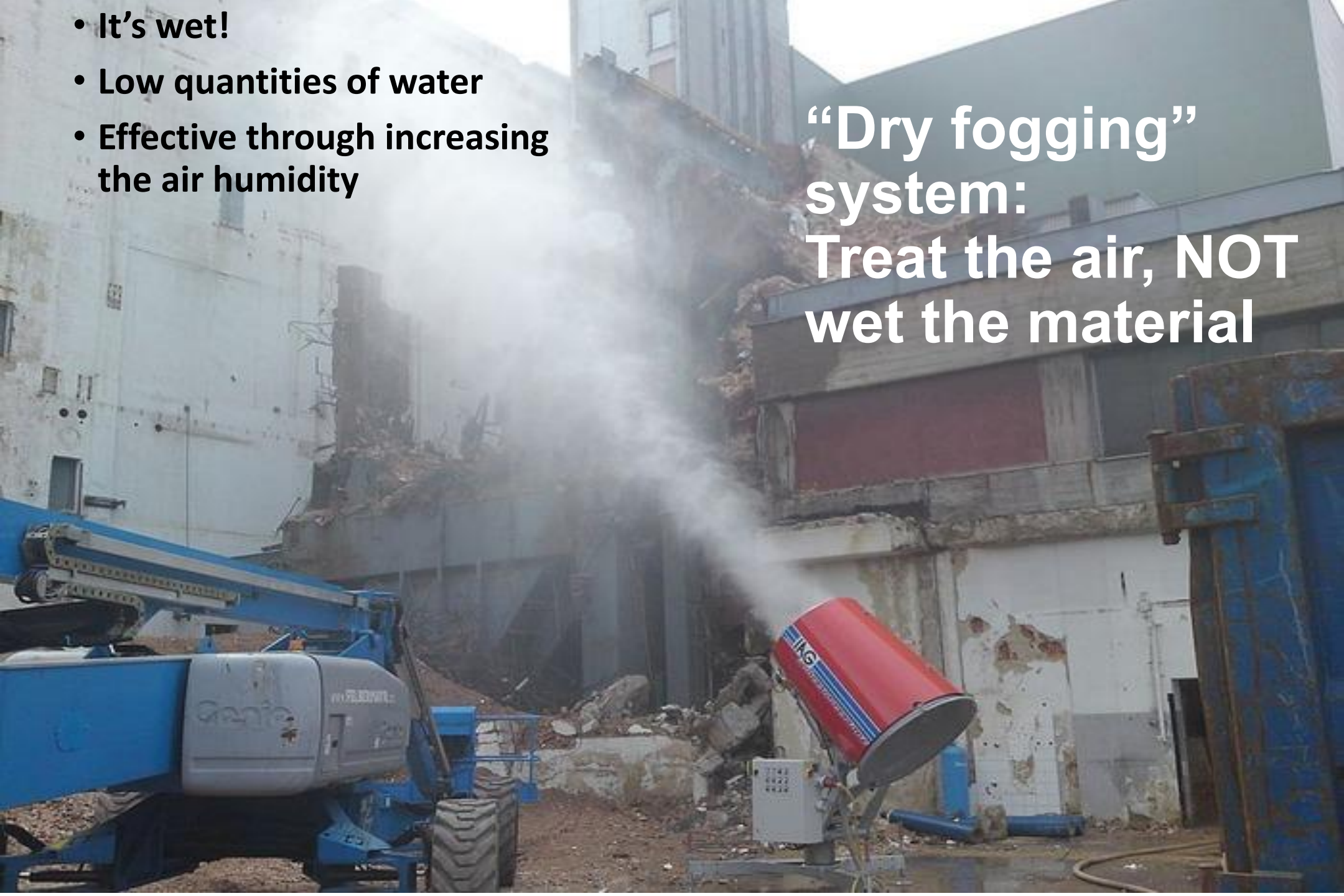
Environmental factors

- Minimise air currents
- Ensure transfer towers etc are sealed
- Fit vehicle access openings with high-speed roller doors
- Cover hot surfaces to reduce air convection

Suppression of Dust

Water based (beware of changing material properties)
- Sprays
- Wetting of surface

Foam based (beware of chemical contamination)
- More expensive
- Reduced water addition



- It’s wet!
- Low quantities of water
- Effective through increasing the air humidity

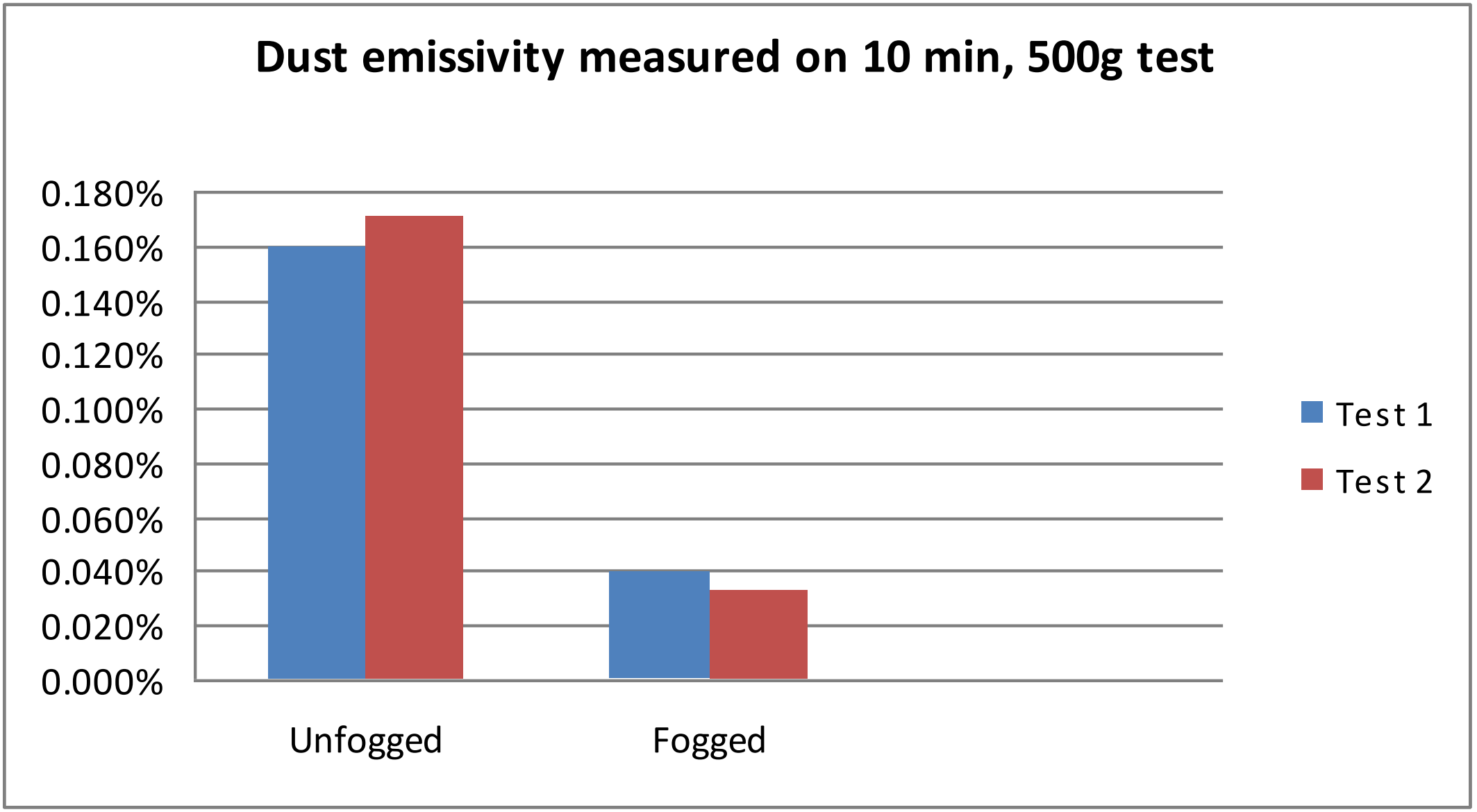
“Dry fogging” system: Treat the air, NOT wet the material



“Dry fogging”



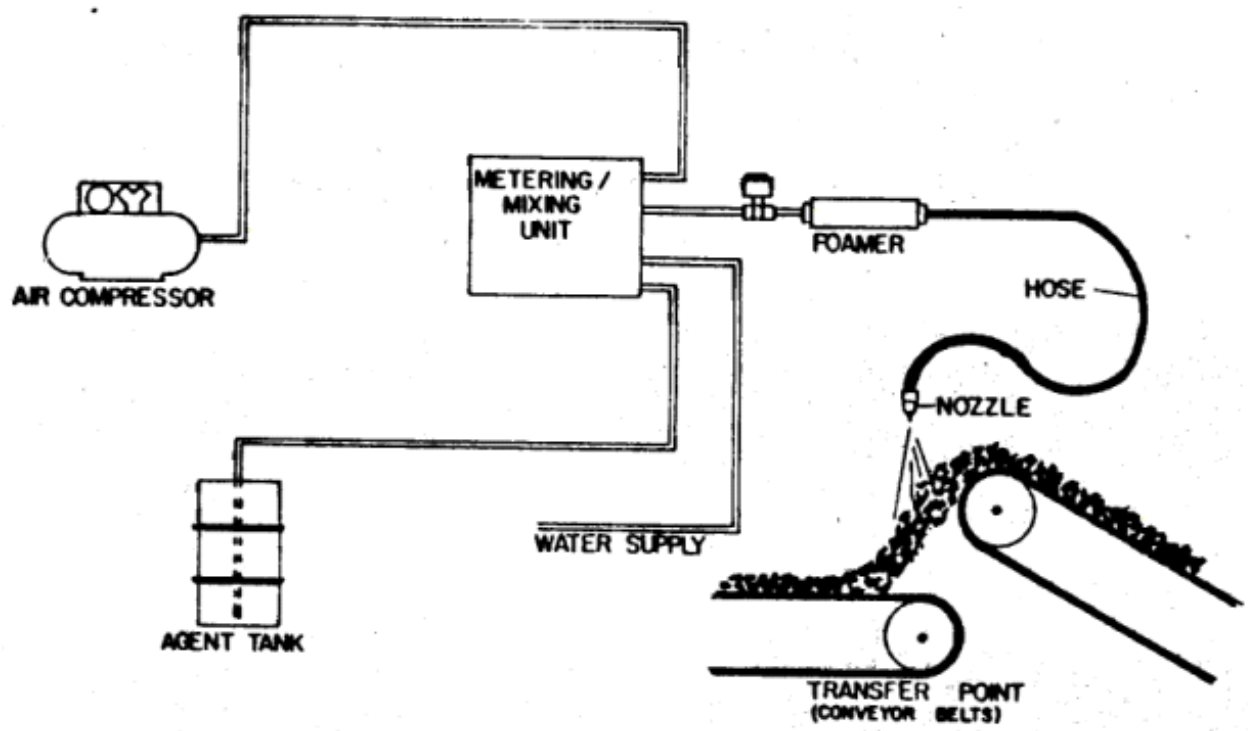
Sealpump
engineering


Dust emissivity measured on 10 min, 500g test
0.180%
0.160%
0.140%
0.120%
0.100%
0.080%
0.060%
0.040%
0.020%
0.000%
Unfogged
Fogged
Test 1
Test 2

“Dry fogging”

- Water particles very small
  - Similar to dust particles
- Effective?
  - In one test at 260% RH, dust dropped 70% - 80%
  - More data needed
- Hazards
  - Condensation on surfaces where no biomass present
  - Ice formation
  - Wetting and self heating?

Suppression of Dust by Foam



Micro-foam installation on a belt conveyor

Suppression of Dust



Dust control installation on a walled belt conveyor

the UNIVERSITY of GREENWICH

Foam dust suppression

- Treats the material not the air
- Foam makes the effect of the water go further – reducing water addition level
- Well established in minerals esp. crushing
- Unproven for biomass
- Chemical addition

Stockpiles

Wind fencing

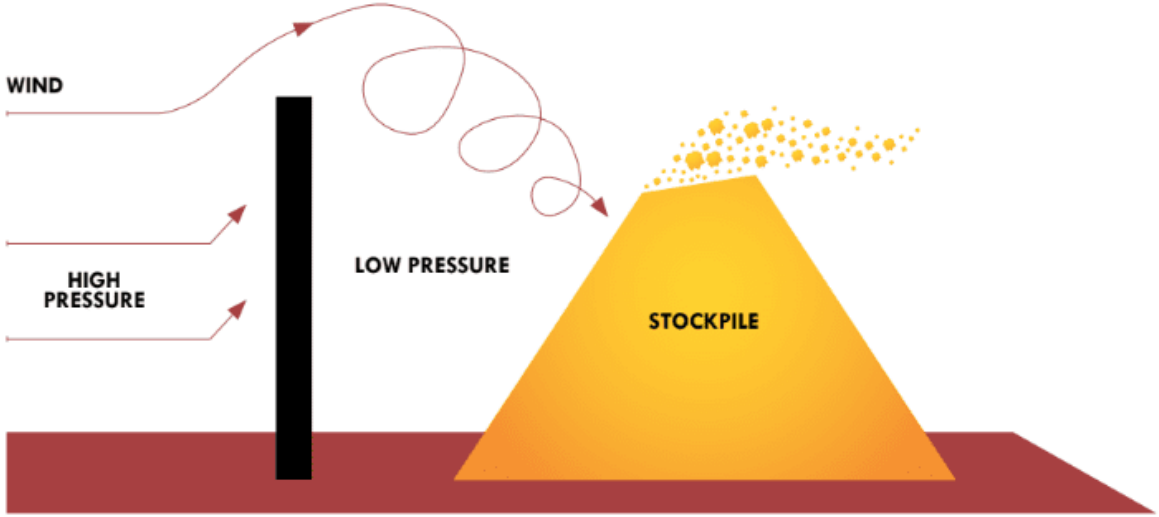


FIGURE 13A
EFFECT OF WIND ON STOCKPILE WITH SOLID WALL

- Some suppliers claim open fencing is better than a solid wall
- Interesting theory – does it work

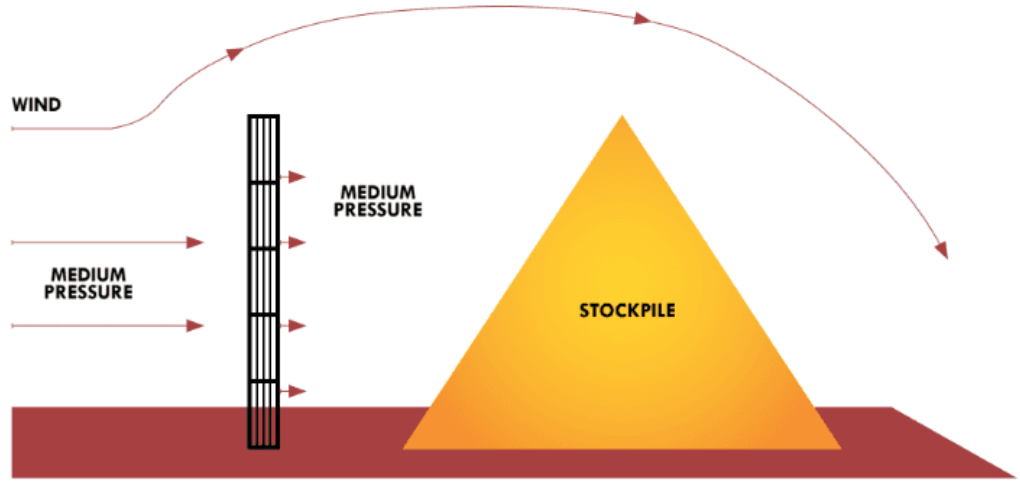


FIGURE 13B
EFFECT OF WIND ON STOCKPILE WITH WIND FENCE

Water spray

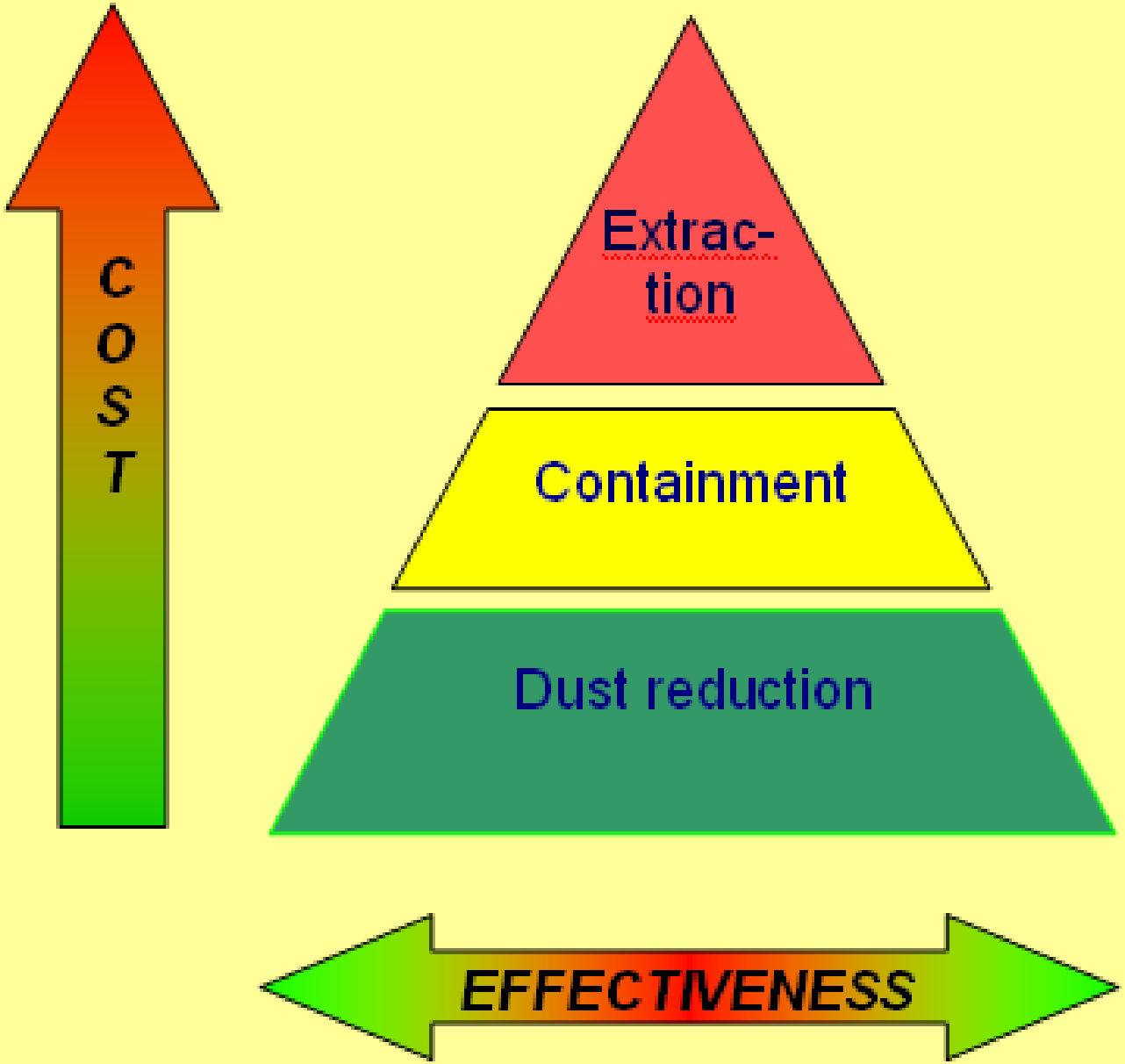


- Dries out fairly quickly
- Can add PVA – at a cost – to produce an impermeable film

Cover the pile

Wind lift-off of dust

- Serious problem in windy or environmentally sensitive areas
- Cover the stockpile
  - Expensive!
- Screening for wind deflection
  - Trees; slow to grow, only partially effective, not suitable for all climates
- Wetting
  - Ineffective in dry/warm climates
  - Needs repeating at appropriate intervals depending on weather
  - Troublesome in cold climates (freezing)
  - Cheap
- Sealing (e.g. PVA solution)
  - Effective even in dry climates
  - Low water use so little freezing
  - Done once, it remains in place
  - Expensive



The hierarchy of dust control methods

Always start from the bottom, do as much as you can to reduce dust first; then contain the problem by excluding draughts and covering dust sources; then if extraction is still needed, the cost of it will be reduced and its effectiveness increased

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Acknowledgements

To owners of some of the photos that are not mine

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Dust, mess and spillage: Practical experience

