MARSH

SOLUTIONS...DEFINED, DESIGNED, AND DELIVERED.

BUND FIRES
ENTER SUB-TITLE HERE

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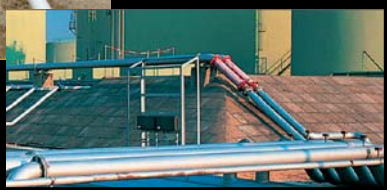
MARSH & McLENNAN COMPANIES

BUND (1)

- Clay dykes and clay floors with pebbles



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BUND (2)

- Concrete bund wall and floor

http://www.jpconcrete.co.uk/concrete-bund-wall/

www.burdensnet.au

BUND (3)

- Metal sheeting
  - Unprotected sheeting will buckle during bund fire
  - Therefore increase wall height, or
  - Protect metal with earth or Bentonite and covered with cement-stabilized sand

http://adanoilandgas.com/page/details/specialization!services!icons!/

BUND (4)

- Small bunds between 1,000 – 1,500 m^2
- Large bunds more than 1,500 m^2
- Intermediate dykes for small spills
- Collection trenches in bunds
- Sloping floor in bund
  - Away from surrounding constructions
  - Taking prevailing wind direction into account

BUND (5)

- Gross and net bund surface – two methods to calculate this value
  1. (Length X width bund X height of bund) – (combined footprint m^2 of all tanks except the largest tank)
  2. (Length X width bund X height of bund) – (combined footprint m^2 of all tanks)
- Net volume bund = net surface X height on bund wall

BUND (6)

- Required prescriptive containment volume (more options)
  - 110% of volume largest tank in bund
  - Volume largest tank + 10% of combined other tanks in same bund
  - Volume largest tank + volume (foam/cooling water) for one hour fire response for bund fire
  - 10% of volume of all tanks in bund
- Volume for performance based approach is based on credible incident scenario

SOME BUND FIRE CAUSES (1)

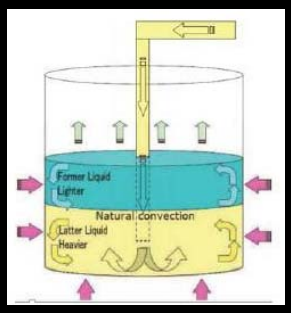
1. Bund fire caused by overflowing storage tank
   - API 2350 level category 3 overfill protection independent high/high level interlock- availability/ reliability ≥ 99% → no credible scenario
2. Loss of containment tank
   - ageing of tank
   - lack of maintenance
   - corrosion under insulation
   - if tanks are fit for purpose "EEMUA 159"
     → no credible scenario

SOME BUND FIRE CAUSES (2)

3. Loss of containment tank caused by low pressure in tank
   - inbreathing capacity meets API 2000 requirements compliance yes/no?
   - if yes → no credible scenario
   - failing steam heating coil Inspection/testing/maintenance Coil fit for purpose yes/no?
   - if yes → no credible scenario

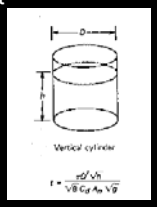
SOME BUND FIRE CAUSES (3)

4. Rollover
   Forces on tank



SOME BUND FIRE CAUSES (3)

5. Leaking gaskets of flanges
   Small leakage allowing time to prevent fire when leak is detected (discussed later)
   - credible scenario
   - small scale scenario at start incident
6. Product line failure
   - calculate maximum flow using Yellow Book *Methods for the calculation of physical effects* 2.3.5.3 or modelling software
   - credible scenario



MODELING EFFECTS OF INCIDENTS

- Modeling is part of the preplanning process to determine not only the effects but also to establish the required staff, equipment, and fire fighting material, including water and fire fighting foam
- Use validated software based on a conservative approach
- 2D software is fine for most situations
- 3D software may be required for more complex situations

BOTLEK TANK TERMINAL

BOTLEK TANK TERMINAL (FUTURE)

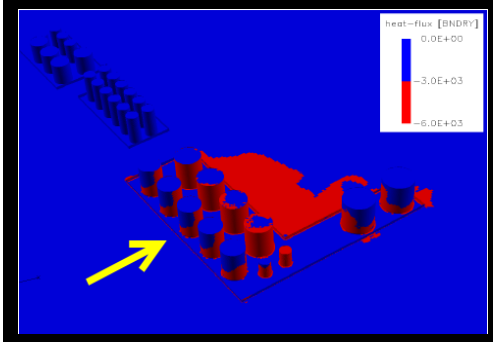
2D MODELING EFFECTS BUND FIRE

Red line
10 kW/m^2

Blue line
3 kW/m^2

AnteaGroup modeling for Botlek Tank Terminal

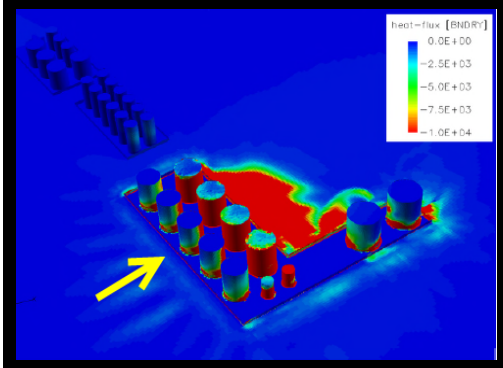
3D MODELING EFFECTS SAME BUND FIRE (1)



3 kW/m^2

AnteaGroup modeling for Botlek Tank Terminal

3D MODELING EFFECTS SAME BUND FIRE (2)



10 kW/m^2

AnteaGroup modeling for Botlek Tank Terminal

BUND DESIGN AND TERTIARY CONTAINMENT

Design of bund affects development of incident

- Materials bund walls, bund floor
- Height of bund wall
- Sloping floor
- Provisions to direct spill to tertiary containment
- LEL detection in bund → early detection of spill before the fire occurs and before the spill becomes a pool!

MODELING WORST CASE ↔ PFB SCENARIO

WORST CASE		
position	10 kW/m² m	3 kW/m² m
upwind	43	89
downwind	81	128

PFB CREDIBLE SCENARIO		
position	10 kW/m² m	3 kW/m² m
upwind	36	74
downwind	67	106

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SPILL FIRE VERSUS POOL FIRE (1)

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SPILL FIRE VERSUS POOL FIRE (2)

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EXAMPLE LEL DETECTOR

INCREASE RESPONSE LEL DETECTOR

Relative Response of a Flammable/Combustible Sensor

Combustible gas / vapor	Relative response when sensor is calibrated on pentane	Relative response when sensor is calibrated on propane	Relative response when sensor is calibrated on methane
Hydrogen	2.2	1.7	1.1
Methane	2.0	1.5	1.0
Propane	1.3	1.0	0.65
n-Butane	1.2	0.9	0.6
n-Pentane	1.0	0.75	0.5
n-Hexane	0.9	0.7	0.45
n-Octane	0.8	0.6	0.4
Methanol	2.3	1.75	1.15
Ethanol	1.6	1.2	0.8
Isopropyl Alcohol	1.4	1.05	0.7
Acetone	1.4	1.05	0.7
Ammonia	2.6	2.0	1.3
Toluene	0.7	0.5	0.35
Gasoline (Unleaded)	1.2	0.9	0.6

BUND FIRE LASTS LESS THAN 2 HOURS

- Cooling of tanks: 2 l/min/m^2 with fixed system – flanges can start to leak because of affected bolts or
- Cooling tanks: 10 l/min/m^2 with fixed system for controlled burn
- Objects / constructions outside the bund exposed to ≥10 kW/m^2
  - cool with water, application rate 10 l/min/m^2 or
  - use hydroshields / monitors
- Fireproofing supports & bund wall penetrations

FIRE PROOFING SUPPORTS FIRE WATER PIPE

BUND FIRE LASTS >2 HOURS

- Cool tanks in affected bund with water
  - application rate 10 l/min/m^2 with fixed system
- Objects / constructions outside the bund exposed to ≥10 kW/m^2
  - cool with water, application rate 10 l/min/m^2 or
  - use hydroshields / monitors
- Fireproofing supports & bund wall penetrations

OTHER OBJECTS/CONSTRUCTIONS IN BUND

FIRE FIGHTING OPTIONS BUND FIRE (1)

- Small bunds
  1. Fixed system – fully automated by detection
     Fast response – lowest amount of water required
  2. Fixed system – manually activated
     Potentially slower response – lowest amount of water required
  3. Fixed system – fed by fire department
     Later response – lowest amount of water required
  4. Mobile response
     Late response – higher risk of exposure fire fighters – maximum amount of water required

FIRE FIGHTING STRATEGY BUND FIRE (2)

- Large bund > 1000 – 1,500 m^2 - MUTUAL AID?
  1. Fixed system – fully automated by detection
     Fast response – lowest amount of water required
  2. Fixed system – manually activated
     Potentially slower response – lowest amount of water required
  3. Fixed system – fed by fire department
     Later response – lowest amount of water required

FIRE FIGHTING STRATEGY BUND FIRE (3)

- Large bund > 1000 – 1,500 m^2 (continued)
  4. Partially fixed system combined with mobile response
     higher risk of exposure fire fighters – more water required
  5. Mobile relay response
     incident last longer, overall more water required, but flow/hour is lower than with option 6
  6. Mobile response whole bund
     Even later response – higher risk of exposure fire fighters – maximum amount of water required

FIRE FIGHTING STRATEGY BUND FIRE (4)

- Large bund > 1000 – 1,500 m^2 (continued)

7. Drainage to tertiary containment – spill fire
   Fast extinguishment of 'small' fire
   provisions to prevent drainage of burning liquid

QUESTIONS

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