Learning from Experience

Incident reporting and sharing

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EPSC Conference

December 2019

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Content

- History of Monsanto's PSM Approach
- KPI's and Learning from Experience
- Analysis of Outcomes and Causes
- Review of three incidents and near misses
  - Near miss on underground piping
  - Cleaning conditions causing runaway and vessel explosion
  - Cleaning conditions causing runaway and vessel explosion
- Summary

A Strong History of Process Safety Management

Monsanto's Texas City, Texas 1947 - An adjacent facility's explosion destroyed our Texas City styrene plant and killed 500+ (145 Monsanto employees, 123 contractors)

Explosion protection Guidelines

Monsanto's Montreal, CA, 1966 – Styrene monomer vapors escape through failed sight glass. Explosion kills 11

Outdoor Process construction standards

Monsanto's Texas City, TX, 1977. 500,000 gallon condensate tank failed burning 7 (5 fatally)

Vessel Inspection Program Developed

Union Carbide's Bhopal, India 1984

High Hazard Material Guidelines & Functional Safety guidelines Developed

Monsanto's Port Plastics, Cincinnati, OH 1988. Operator killed by combustible dust explosion

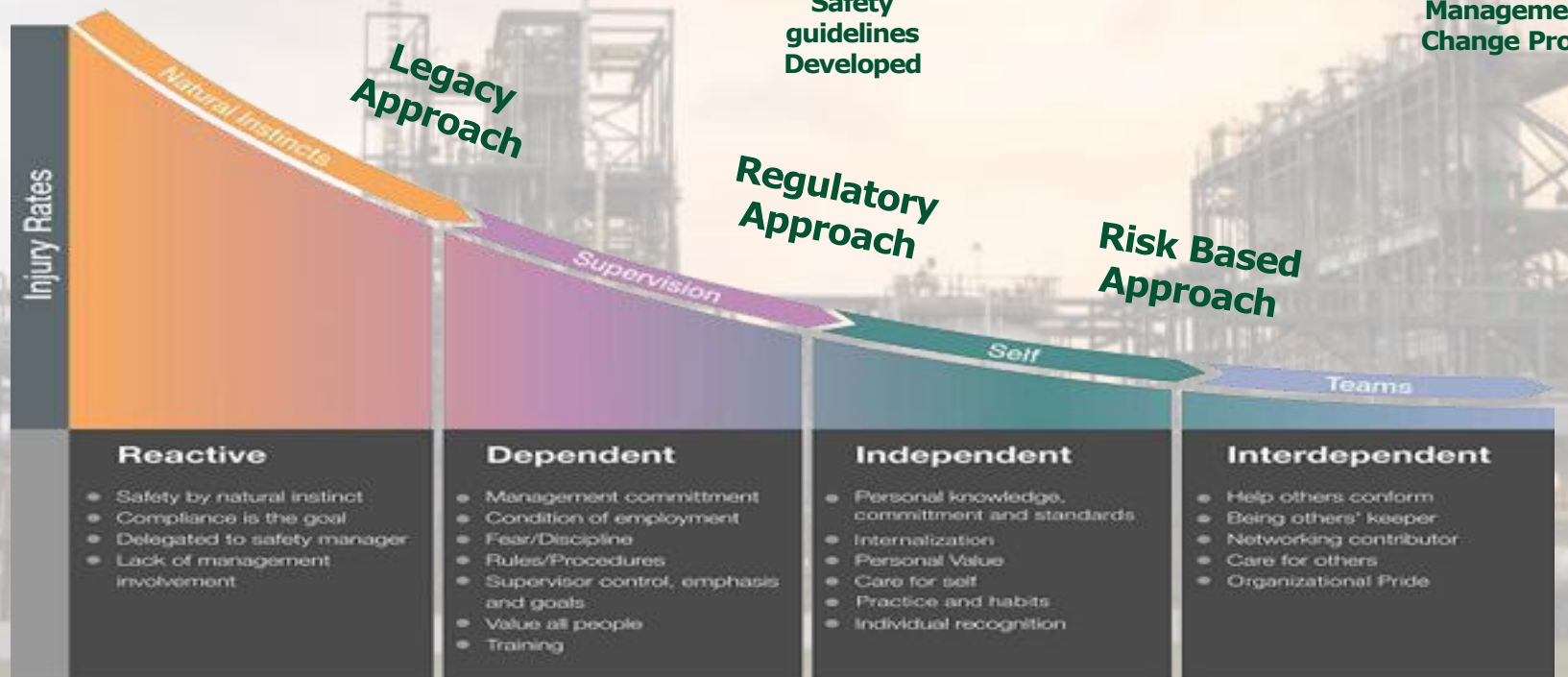
Combustible dust Hazard Assessments

Monsanto's Chocolate Bayou 1992 (Runaway Reaction $150M property loss)

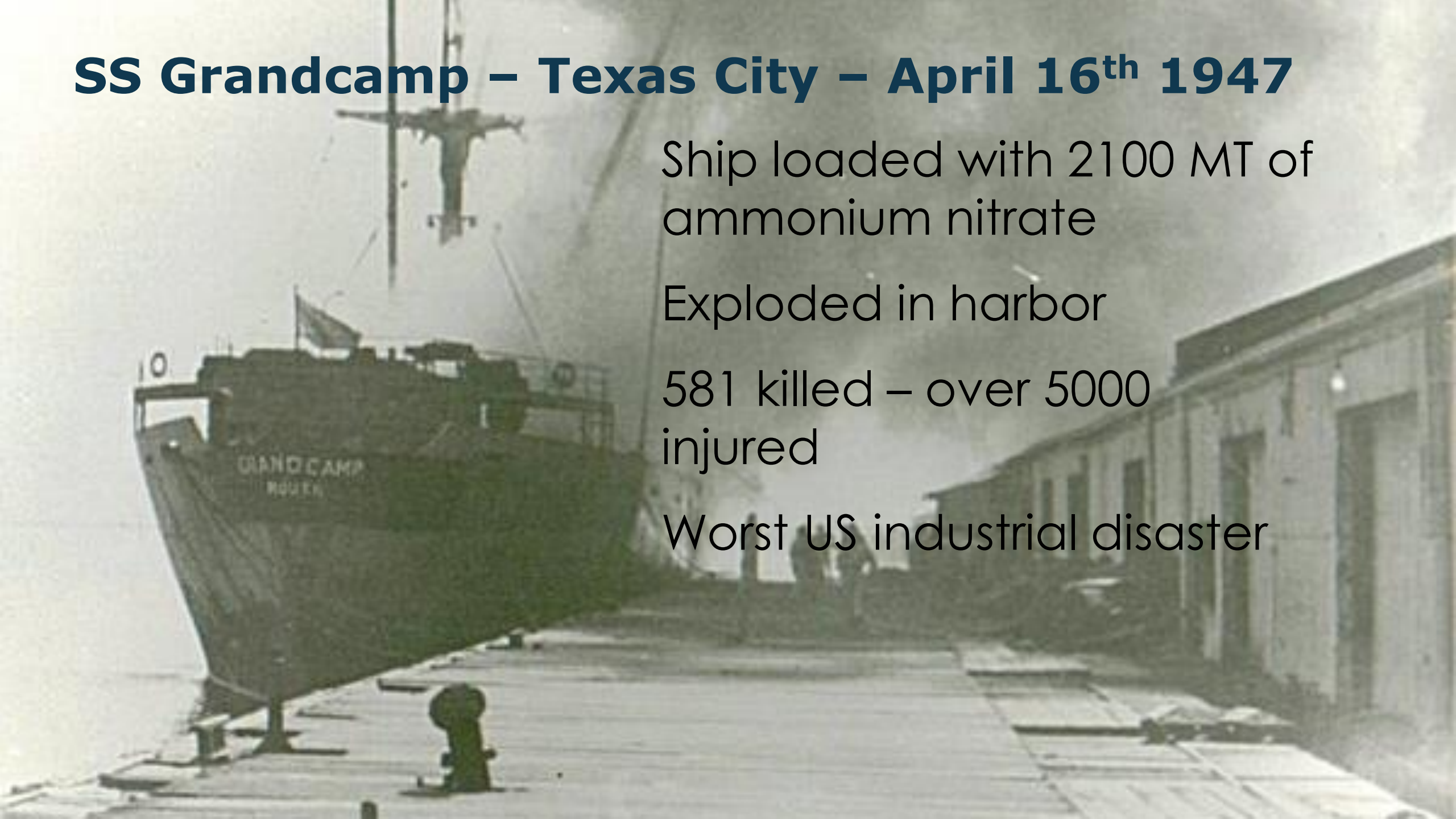
Robust Management of Change Program

BP Texas City 2005 Refinery explosion

Move towards RBPS



SS Grandcamp – Texas City – April 16th 1947



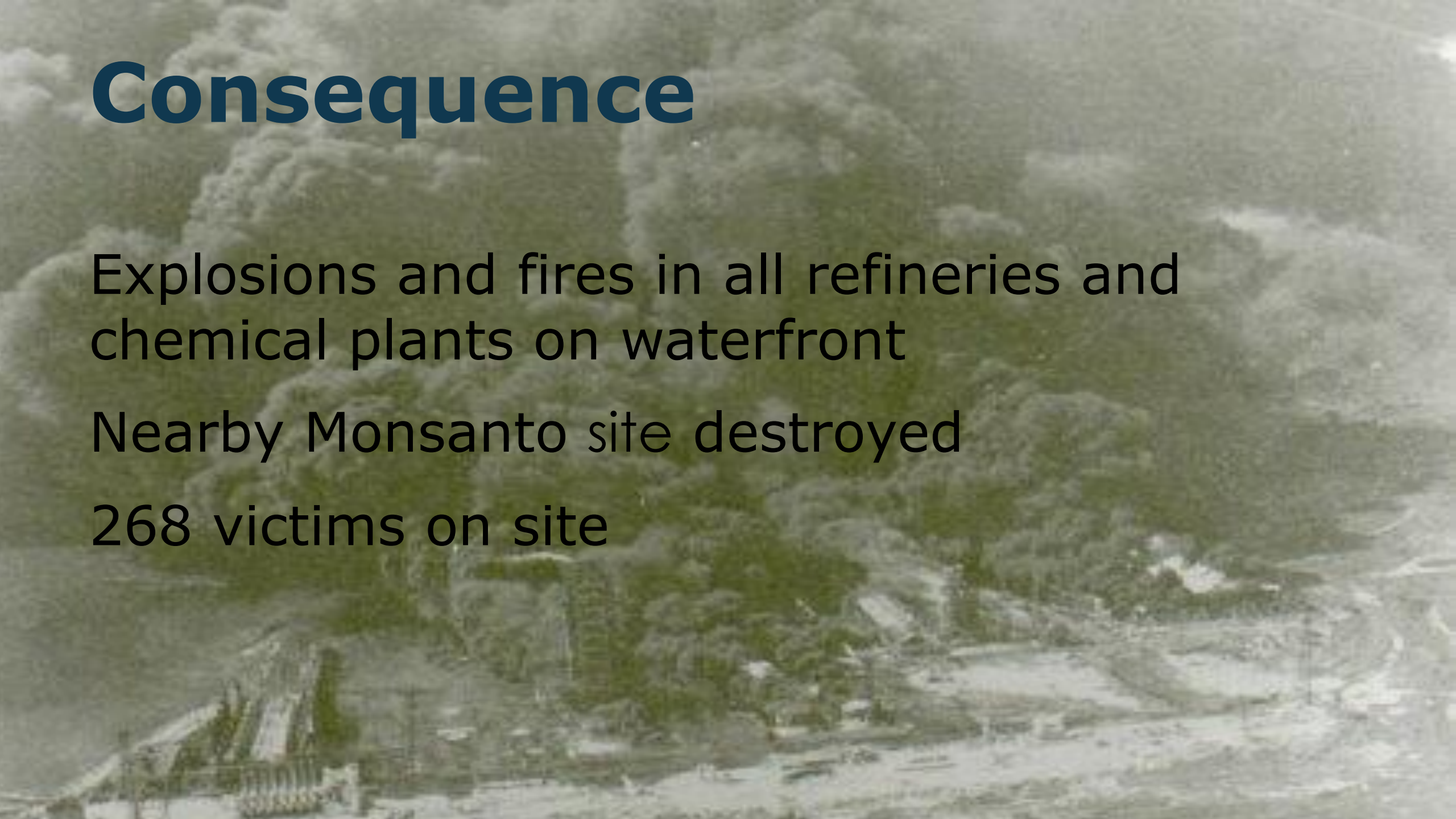
Ship loaded with 2100 MT of ammonium nitrate

Exploded in harbor

581 killed – over 5000 injured

Worst US industrial disaster

Consequence



Explosions and fires in all refineries and chemical plants on waterfront

Nearby Monsanto site destroyed

268 victims on site

Lessons learned

Fire protection

Layout & spacing

Importance of mitigation

MONSANTO

CROP PROTECTION GLOBAL PSM DASHBOARD

ESH

MANAGE RISKS

Past due safety actions

Target=10% Avg=4,0%

RO	0%	PS	0%
FC	27,0%	MA	0%
BA	0%	MC	0%
CH	0%	MU	2,0%
JU	3,6%	SE	0%
LI	15,5%	TO	0,0%

Open Safety Actions

RO	0	PS	3
FC	18	MA	190
BA	16	MC	0
CH	0	MU	88
JU	222	SE	0
LI	250	TO	41

MOCs not reviewed

Target=5 Sum=0

RO	0	PS	0
FC	0	MA	0
BA	0	MC	0
CH	0	MU	0
JU	0	SE	0
LI	0	TO	0

Past due MI Inspec

Target=5 Sum=39

RO	0	PS	0
FC	27	MA	0
BA	0	MC	0
CH	0	MU	0
JU	6	SE	0
LI	3	TO	3

Overdue MI actions

Target=5 Sum=130

RO	0	PS	0
FC	15	MA	0
BA	115	MC	0
CH	0	MU	0
JU	0	SE	0
LI	0	TO	0

Average alarm rate

Target=10 Avg=1,2

RO	0	PS	3
FC	1,6	MA	2
BA	0,8	MC	0
CH	0	MU	6,4
JU	0	SE	0,32
LI	0	TO	0

Op. procedures not up-to-date or recertified

Target=5 Sum=0

RO	0	PS	0
FC	0	MA	0
BA	0	MC	0
CH	0	MU	0
JU	0	SE	0
LI	0	TO	0

People overdue in process safety training

Target=4 Sum=12

RO	0	PS	0
FC	0	MA	2
BA	0	MC	0
CH	0	MU	1
JU	6	SE	0
LI	0	TO	3

Safety device impairments

Target=10 Sum=26

RO	0	PS	0
FC	15	MA	9
BA	1	MC	0
CH	0	MU	0
JU	0	SE	2
LI	0	TO	0

LEARN FROM EXPERIENCE

Tier 1

Target=0 Sum=1

RO	0	PS	0
FC	0	MA	0
BA	0	MC	0
CH	0	MU	0
JU	0	SE	0
LI	1	TO	0

Tier 2

Target=0 Sum=4

RO	0	PS	0
FC	0	MA	0
BA	0	MC	0
CH	0	MU	1
JU	1	SE	0
LI	2	TO	0

Reportable releases

Target=0 Sum=7

RO	0	PS	0
FC	0	MA	0
BA	0	MC	0
CH	0	MU	0
JU	6	SE	0
LI	1	TO	0

UNDERSTAND HAZARD & RISKS

Repeat PHA Rec

Target=0 Sum=10

RO	0	PS	0
FC	2	MA	8
BA	0	MC	0
CH	0	MU	0
JU	0	SE	0
LI	0	TO	0

Number hours of service limit exception

Target=5 Sum=5

RO	0	PS	0
FC	0	MA	0
BA	0	MC	0
CH	0	MU	0
JU	5	SE	0
LI	0	TO	0

COMMIT TO PROCESS SAFETY

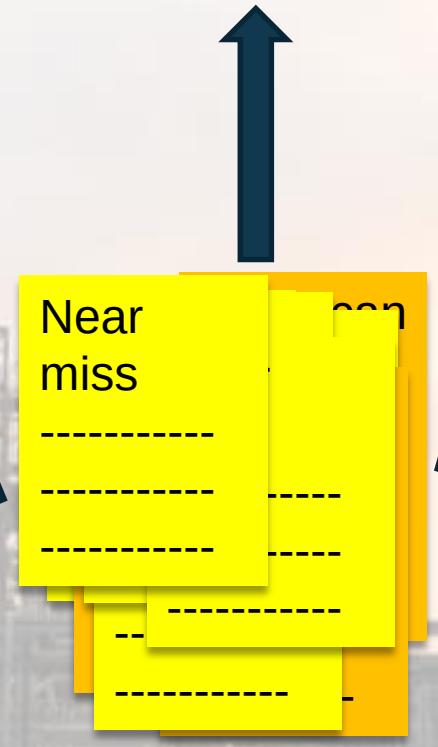
Near Miss

Target>0 Sum=440

RO	1	PS	0
FC	76	MA	46
BA	76	MC	0
CH	4	MU	18
JU	85	SE	0
LI	15	TO	119

Learning from incidents & near misses

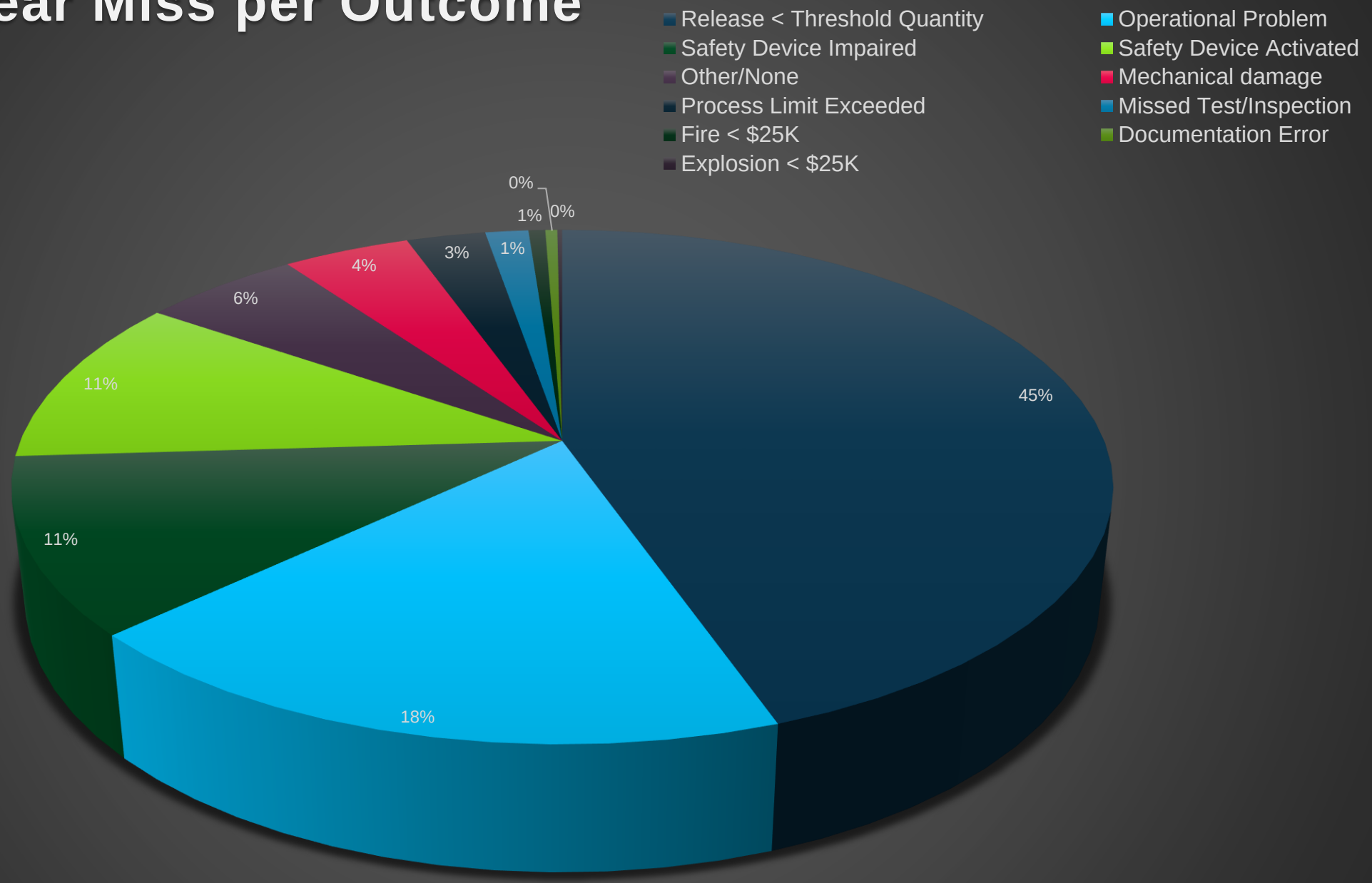
Implement actions locally to prevent re-occurrence of same event



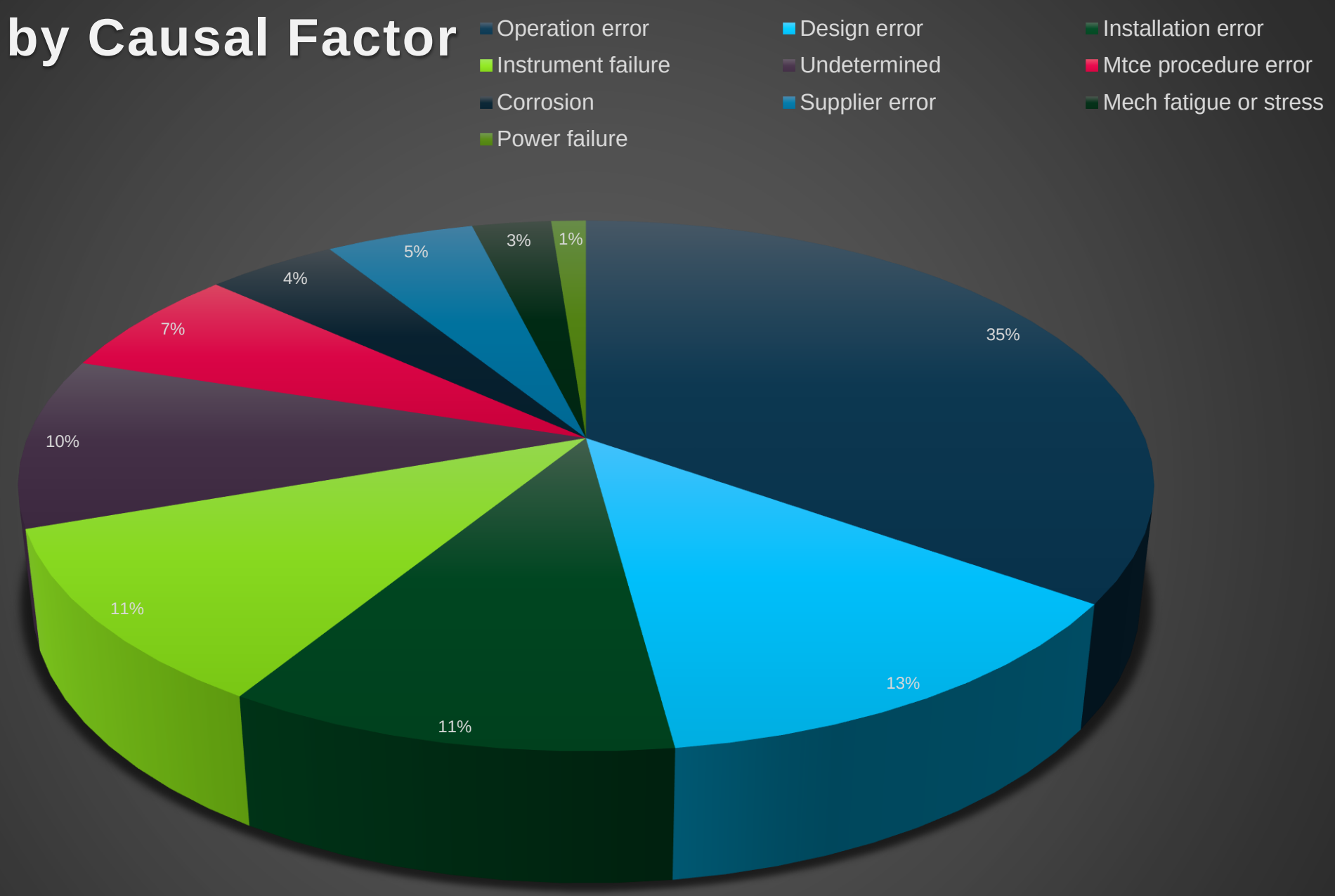
Statistical analysis to evaluate PSM programs

Implement actions globally to prevent re-occurrence of similar events

PSM Near Miss per Outcome



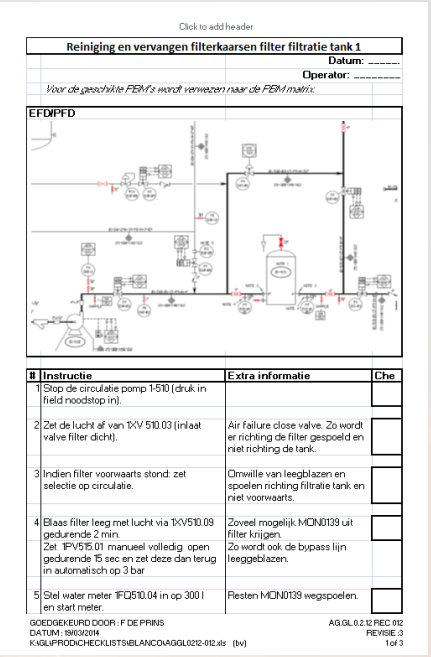
PSM NM by Causal Factor



Human Reliability Programs

Control Room Layout

Alarm Management



Click to add header

Reiniging en vervangen filterkaarsen filter filtratie tank 1

Datum: _____

Operator: _____

Voor de geschikte PBM's wordt verwezen naar de PBM matrix.

EFD/PFD

#	Instructie	Extra informatie	Che
1	Stop de circulatie pomp 1-510 (druk in field noodstop in).		
2	Zet de lucht af van 1XV 510.03 (inlaat valve filter dicht).	Air failure close valve. Zo wordt er richting de filter gespoeld en niet richting de tank.	
3	Indien filter voorwaarts stond: zet selectie op circulatie.	Omwille van leegblazen en spoelen richting filtratie tank en niet voorwaarts.	
4	Blaas filter leeg met lucht via 1XV510.09 gedurende 2 min.	Zoveel mogelijk MON0139 uit filter krijgen.	
	Zet 1PV515.01 manueel volledig open gedurende 15 sec en zet deze dan terug in automatisch op 3 bar	Zo wordt ook de bypass lijn leeggeblazen.	
5	Stel water meter 1FQ510.04 in op 300 l en start meter.	Resten MON0139 wegspoelen.	

GOEDGEKEURD DOOR : F DE PRINS — AG.GL.0.2.12 REC 012

DATUM : 19/03/2014 — REVISIE :3

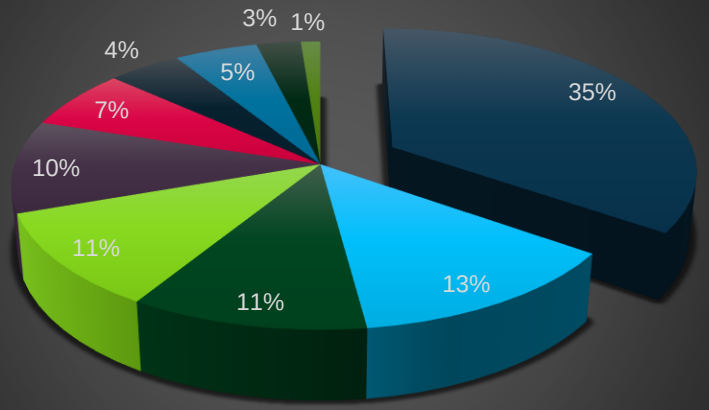
K:\GL\PRODI\CHECKLISTS\BLANCO\AGGL0212-012.xls (bv) — 1 of 3

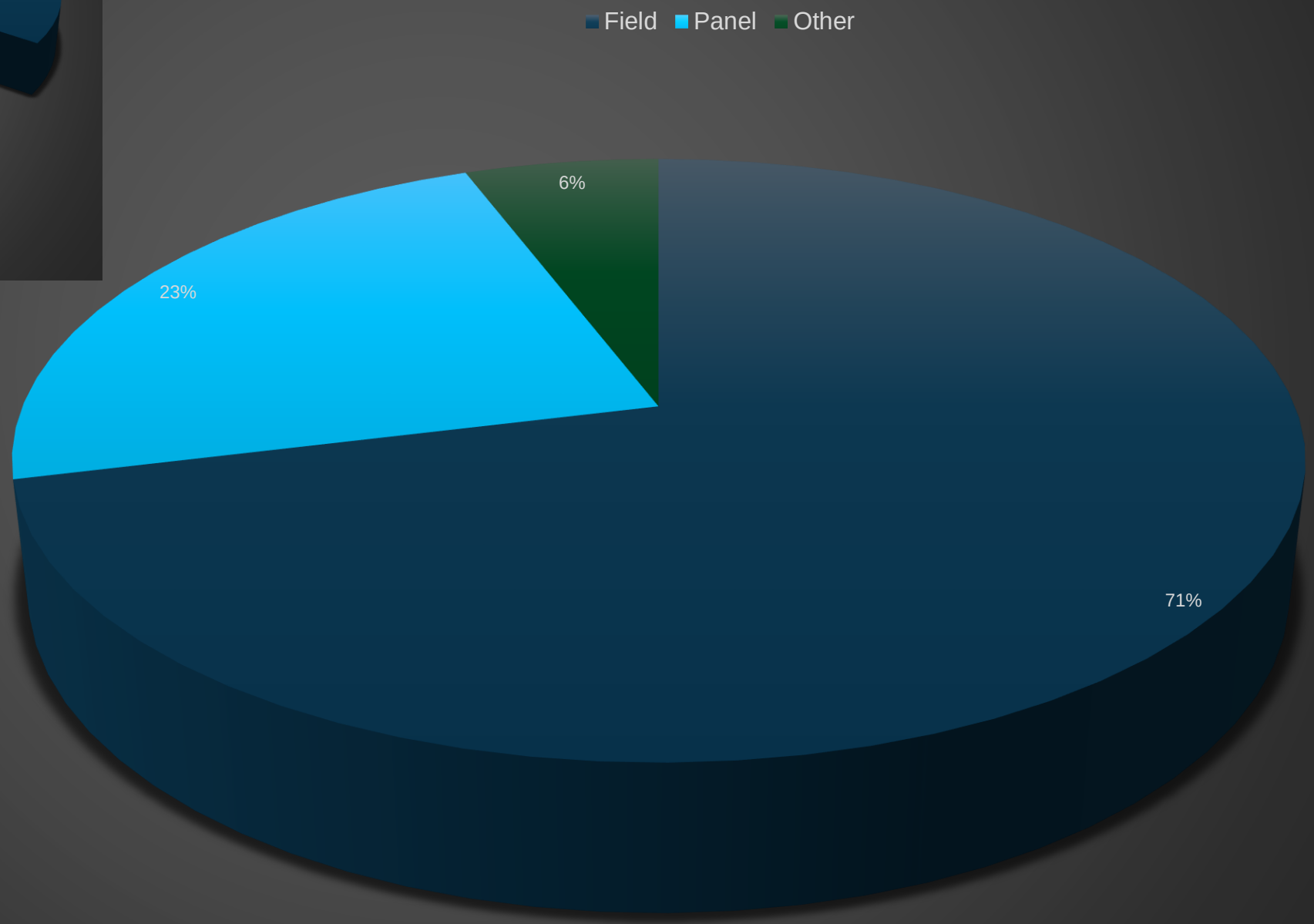
Operation Instructions

Operator Training Stations

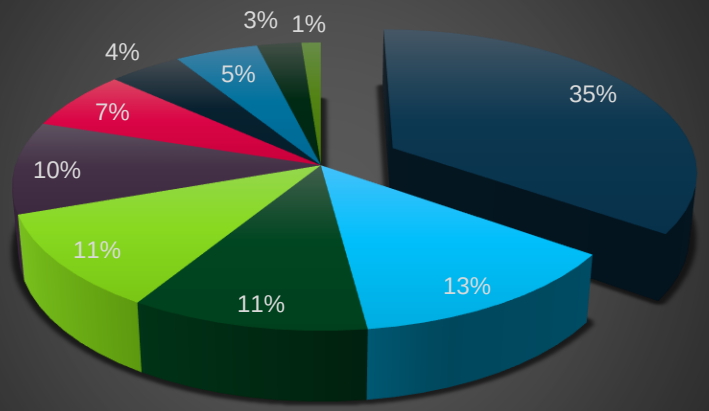
Fatigue management

Operational Error - Where?

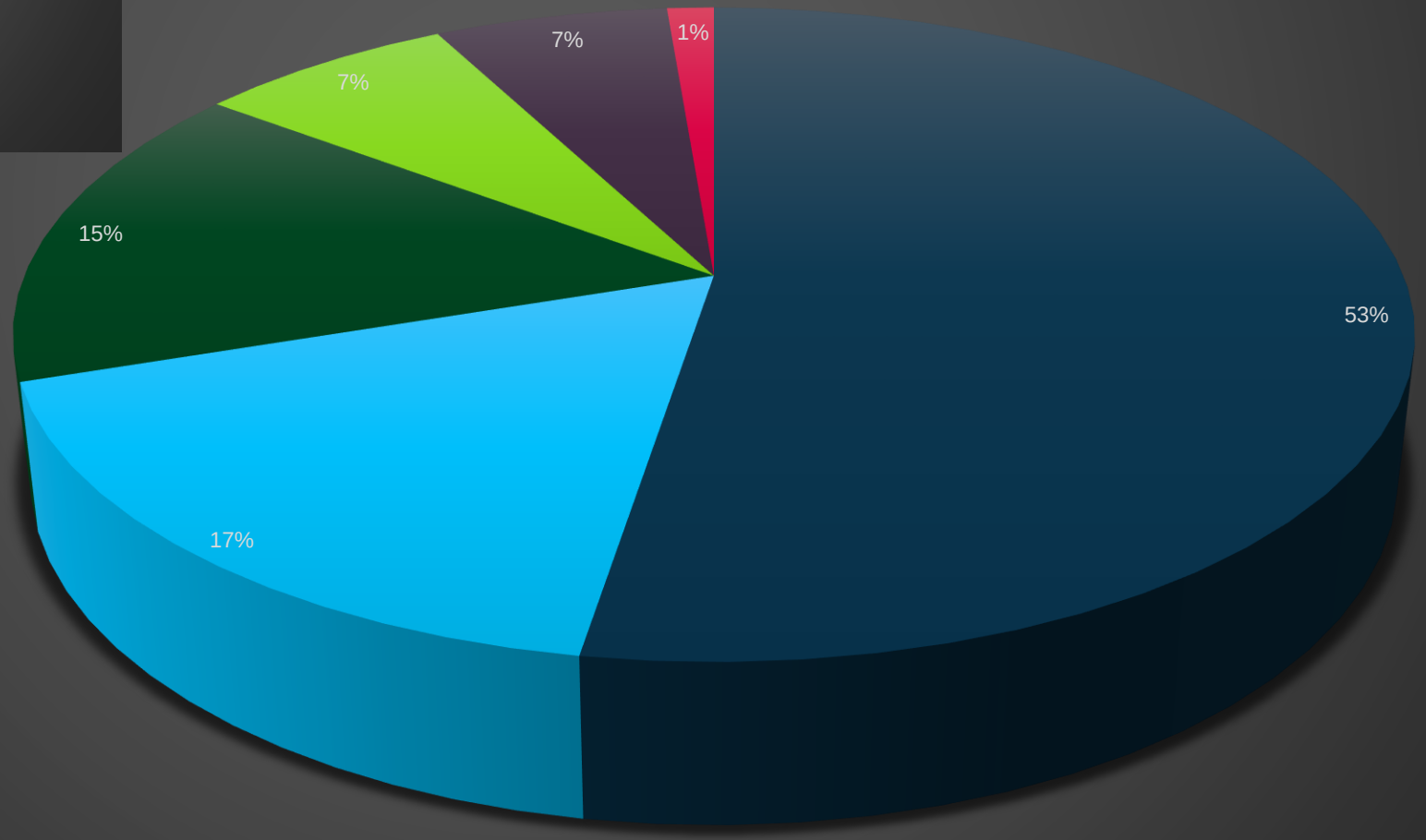




PSNM Operational Error - Causes



- Apply Proc /Instruct
- Permit
- Proc/Instruct NOK
- Other
- Alarm handling
- Communication



Learning From Experience – examples

Near miss underground piping (2016)

Runaway due to cleaning conditions – vessel rupture (1992)

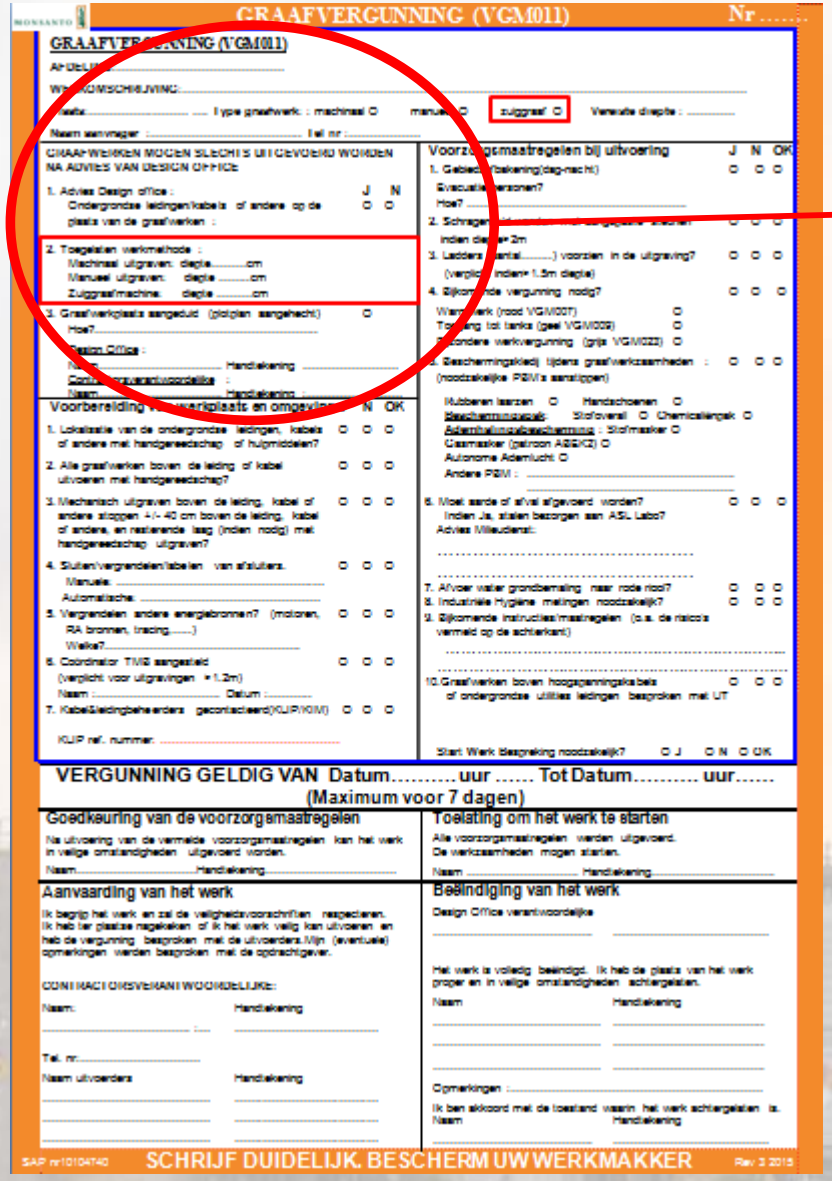
Runaway due to startup difficulties – vessel rupture (2008)

Ghislenghien 2004

24 dead
132 injured
Underground gaspipe damaged during excavation works
Leak ignited during repair

Other gas pipeline incidents

Excavation permit



GRAAFVERGUNNING (VGM011) Nr .....

GRAAFVERGUNNING (VGM011)

AFDELING:

WERKOMSCHRIJVING:

Datum..... Type graafwerk : machinaal ☐ manueel ☐ zuiggraaf ☐ Verwachte diepte : .....

Naam aanvrager : ..... Tel nr : .....

GRAAFWERKEN MOGEN SLECHTS UITGEVOERD WORDEN NA ADVIES VAN DESIGN OFFICE

	J	N
1. Advies Design office : Ondergrondse leidingen/kabels of andere op de plaats van de graafwerken :	☐	☐
2. Toegelaten werkmethode : Machinaal uitgraven: diepte.....cm Manueel uitgraven: diepte .....cm Zuiggraafmachine: diepte .....cm		
3. Graafwerkplaats aangeduid (plotplan aangehecht) Hoe?.....	☐	

Design Office :

Naam ..... Handtekening .....

Contractverantwoordelijke :

Naam ..... Handtekening .....

Voorbereiding van de werkplaats en omgeving

	J	N	OK
1. Lokalisatie van de ondergrondse leidingen, kabels of andere met handgereedschap of hulpmiddelen?	☐	☐	☐
2. Alle graafwerken boven de leiding of kabel uitvoeren met handgereedschap?	☐	☐	☐
3. Mechanisch uitgraven boven de leiding, kabel of andere stoppen +/- 40 cm boven de leiding, kabel of andere, en resterende laag (indien nodig) met handgereedschap uitgraven?	☐	☐	☐
4. Sluiten/vergrendelen/labelen van afsluiters. Manuele: ..... Automatische:	☐	☐	☐
5. Vergrendelen andere energiebronnen? (motoren, RA bronnen, tracing.....) Welke?.....	☐	☐	☐
6. Coördinator TMB aangeduid (verplicht voor uitgravingen > 1.2m) Naam : ..... Datum	☐	☐	☐
7. Kabel&leidingbeheerders gecontacteerd(KLIP/KIM) KLIP ref. nummer:	☐	☐	☐

Voorzorgsmaatregelen bij uitvoering

	J	N	OK
1. Gebied afsluiten(dag-nacht) Evacuatie personen? Hoe?	☐	☐	☐
2. Schragen indien diepte > 3m	☐	☐	☐
3. Ladders (aantal.....) voorzien in de uitgraving? (verplicht indien > 1.5m diepte)	☐	☐	☐
4. Bijkomende vergunning nodig? Warmwerk (rood VGM007) ☐ Toegang tot tanks (geel VGM009) ☐ Andere werkvergunning (grijs VGM022) ☐	☐	☐	☐
5. Beschermingskledij tijdens graafwerkzaamheden : (noodzakelijke PBM's aanstippen) Rubberen laarzen ☐ Handschoenen ☐ Beschermingspak: Stofoveral ☐ Chemicalienpak ☐ Adembeschermingsmiddelen : Stofmasker ☐ Gasmasker (patroon ABEK2) ☐ Autonome Ademlucht ☐ Andere PBM :	☐	☐	☐
6. Moet aarde of afval afgevoerd worden? Indien Ja, stalen bezorgen aan ASL Labo? Advies Milieudienst:	☐	☐	☐
7. Afvoer water grondbemaling naar rode riool?	☐	☐	☐
8. Industriële Hygiene metingen noodzakelijk?	☐	☐	☐
9. Bijkomende instructies/maatregelen (o.a. de risico's vermeld op de achterkant)			
10. Graafwerken boven hoogspanningskabels of ondergrondse utilities leidingen besproken met UT	☐	☐	☐

Start Werk Besprekking noodzakelijk? ☐ J ☐ N ☐ OK

VERGUNNING GELDIG VAN Datum..... uur ..... Tot Datum..... uur.....
(Maximum voor 7 dagen)

Goedkeuring van de voorzorgsmaatregelen

Na uitvoering van de vermelde voorzorgsmaatregelen kan het werk in veilige omstandigheden uitgevoerd worden.

Naam..... Handtekening.....

Toelating om het werk te starten

Alle voorzorgsmaatregelen werden uitgevoerd. De werkzaamheden mogen starten.

Naam ..... Handtekening.....

Aanvaarding van het werk

Ik begrijp het werk en zal de veiligheidsvoorschriften respecteren. Ik heb ter plaatse nagekeken of ik het werk veilig kan uitvoeren en heb de vergunning besproken met de uitvoerders.Mijn (eventuele) opmerkingen werden besproken met de opdrachtgever.

CONTRACTORSVERANTWOORDELIJKE:

Naam: Handtekening

Tel. nr.:.....

Naam uitvoerders Handtekening

Beëindiging van het werk

Design Office verantwoordelijke

Het werk is volledig beëindigd. Ik heb de plaats van het werk proper en in veilige omstandigheden achtergelaten.

Naam Handtekening

Opmerkingen :.....

Ik ben akkoord met de toestand waarin het werk achtergelaten is.

Naam Handtekening

SAP nr10104740 SCHRIJF DUIDELIJK. BESCHERM UW WERKMAKKER Rev 3 2015

- Advice of design office
- Recommended excavation method
- Communication design office / contractor responsible

Suction dredger or soil vacuum truck

- When piping or cables can be present
- Much higher capacity than manual excavation
- Works for
  - Mud
  - Sand
  - Clay
  - Gravel
  - Stones up to 250 mm
  - …

Fire hydrant relocation

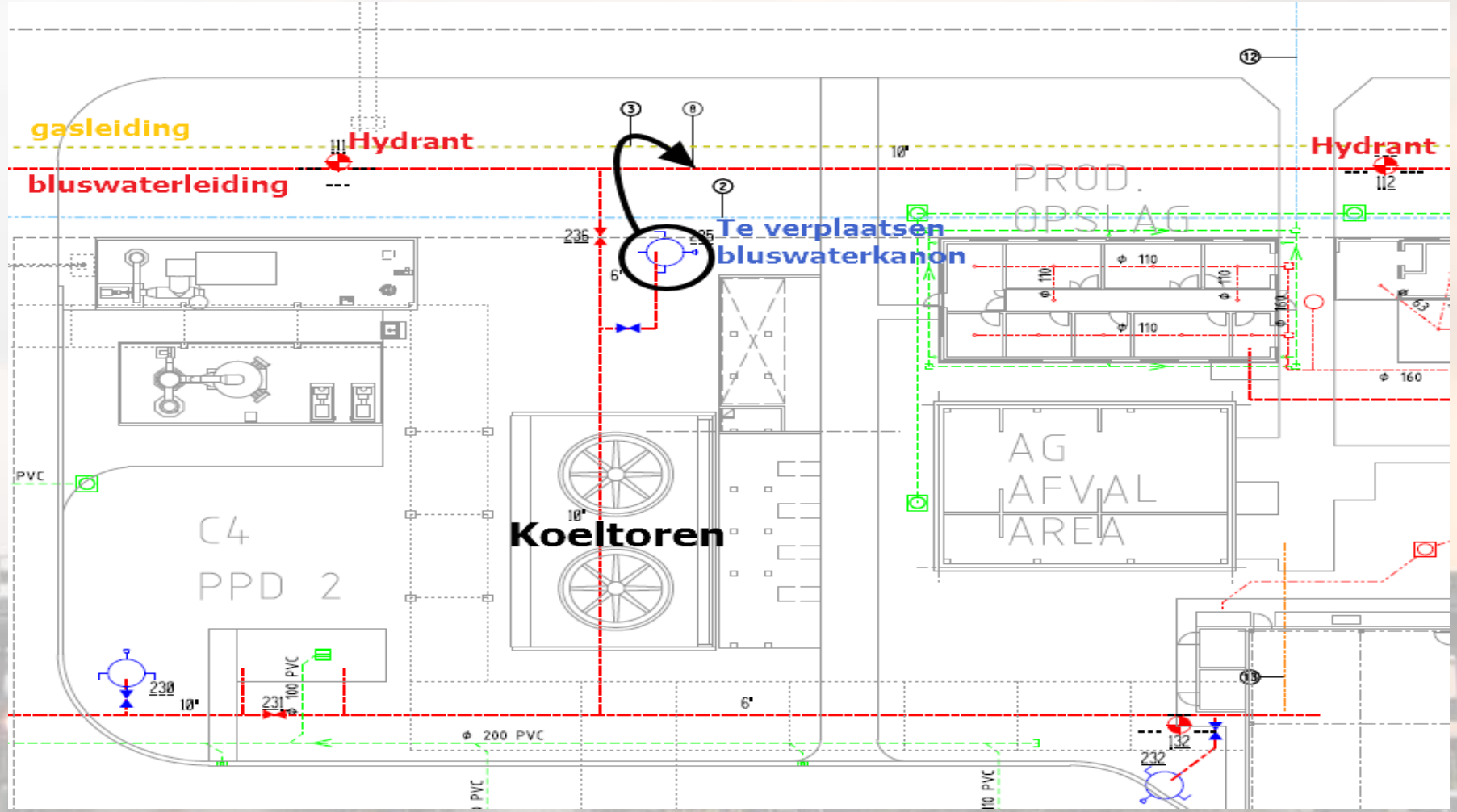
Plan

- A new tie-in was planned on the underground fire water header
- Drawing office prepared an excavation permit with plot-plans
- Excavation works planned with soil vacuum truck because of presence of underground piping

What happened ?

- A trench was excavated to expose the line
- Preparations started for the tie-in on the line (removal of corrosion protection, cleanup ..)
- Monsanto shift supervisor and piping contractor responsible noticed this was not the right line:
  - Different type of corrosion protection
  - Pipe size did not match with prepared tie-in piece (8” instead of 10”)
  - Pipe did not line up with visible fire hydrants

Plot plan


gasleiding
bluswaterleiding
Hydrant
Hydrant
Te verplaatsen
bluswaterkanon
PROD.
OPSLAG
AG
AFVAL
AREA
C4
PPD 2
Koeltoren
PVC
Φ 200 PVC
Φ 110
Φ 160

Situation

Natural gas header

Limit of original excavation

Fire Water header

Causes

Excavation contractor not aware of gas header nearby

- No face to face discussion between contractor and the job owner on drawing office advice
- Natural gas line poorly visible on copy of print-out plan (yellow color)
- During Last Minute Risk Analysis with contractor the unit responsible used the fire water plot plan – this showed location of fire water line but not the gas line and was not 100% as built

Root cause : communication deficiencies

Recommendations

Improve visibility of gas lines on plot plans (color)

Improve ESH procedure 011 (excavations)

- Improved communication drawing office advice to job owner / job executor
- Include method for line identification after excavation
- Make sure up to date master plot plan is present at the excavation works

Communication

- Communicated globally within Monsanto in ‘Learning from experience’ team
- Developed into a ‘PPS lessons learned’ after integration in Bayer

PPS Near Miss
Natural gas vs. Fire Water Header Mix-up

/ WHAT?

- As part of an expansion project, **a fire water monitor needed to be relocated** thus a new tie-in was planned on the underground fire water header
- **Drawing office prepared** an excavation **permit** with plot-plans
- Excavation work planned with **soil vacuum truck** because of presence of underground piping
- A trench was excavated to expose the line
- **Preparations started for the tie-in** on the line (removal of corrosion protection, cleanup, etc.)
- The shift supervisor and piping contractor responsible **noticed this was not the right line** because:
  - Different type of corrosion protection present
  - Pipe size did not match with prepared tie-in piece (8” instead of 10”)
  - Pipe did not line up with visible fire hydrants

// WHY?

- Excavation **contractor unaware of nearby gas header** thus the first pipe encountered was assumed to be the fire water pipe
- **No face to face discussion** between contractor and the ‘job owner’ on advice from drawing office
- Natural **gas line poorly visible** on copy of print-out (yellow color) from drawing office
- During Last Minute Risk Analysis with contractor the unit responsible used the fire water plot plan – **this showed location of fire water line but not the gas line** and was not 100% as built
- A process to **formally identify the line** before start of the work did not exist

ACT SAFE & SUSTAINABLE!

/// LESSON LEARNED

- Do you have the **right people executing excavation permits** at your site?
  - If the **‘job owner’ is not present** during execution, responsibilities for LMRA (Last Minute Risk Assessment) and job follow up must be delegated
- Are your **site plot plans up to date** / as built? Do the **plans easily distinguish materials** (gas vs. water vs. other chemicals)? Are the plot plans required to be present at the excavation job site?
- How **effective** is the **communication** between the drawing office advisor to job owner / job executor
- What methods are used for **positive line identification** after excavation?
- Do you require a **line breaking permit** for underground fire water headers, or are they exempt?

Runaway reaction by cleaning operation

Chocalate Bayou - Texas

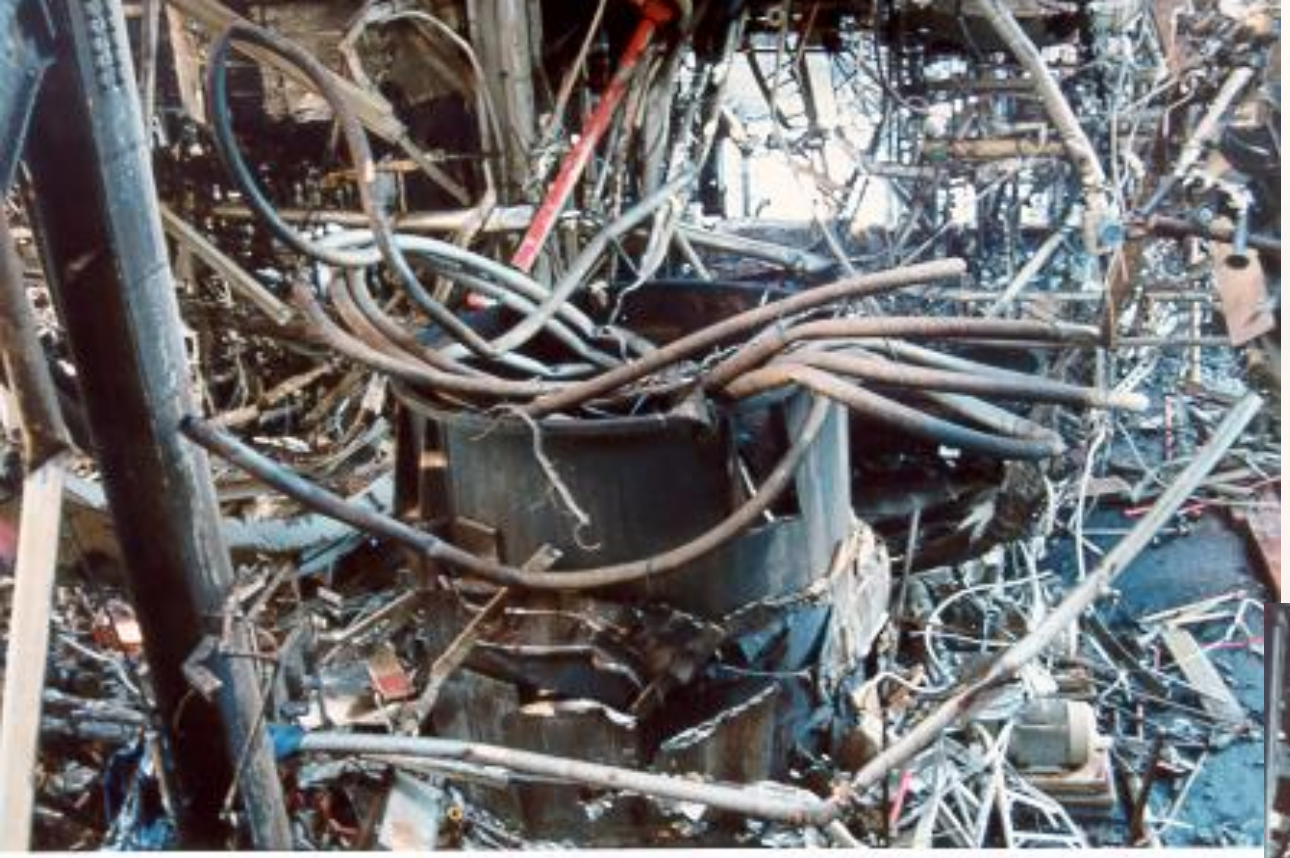
Organic intermediate formed as a slurry

Slurry fed to centrifuge for separation

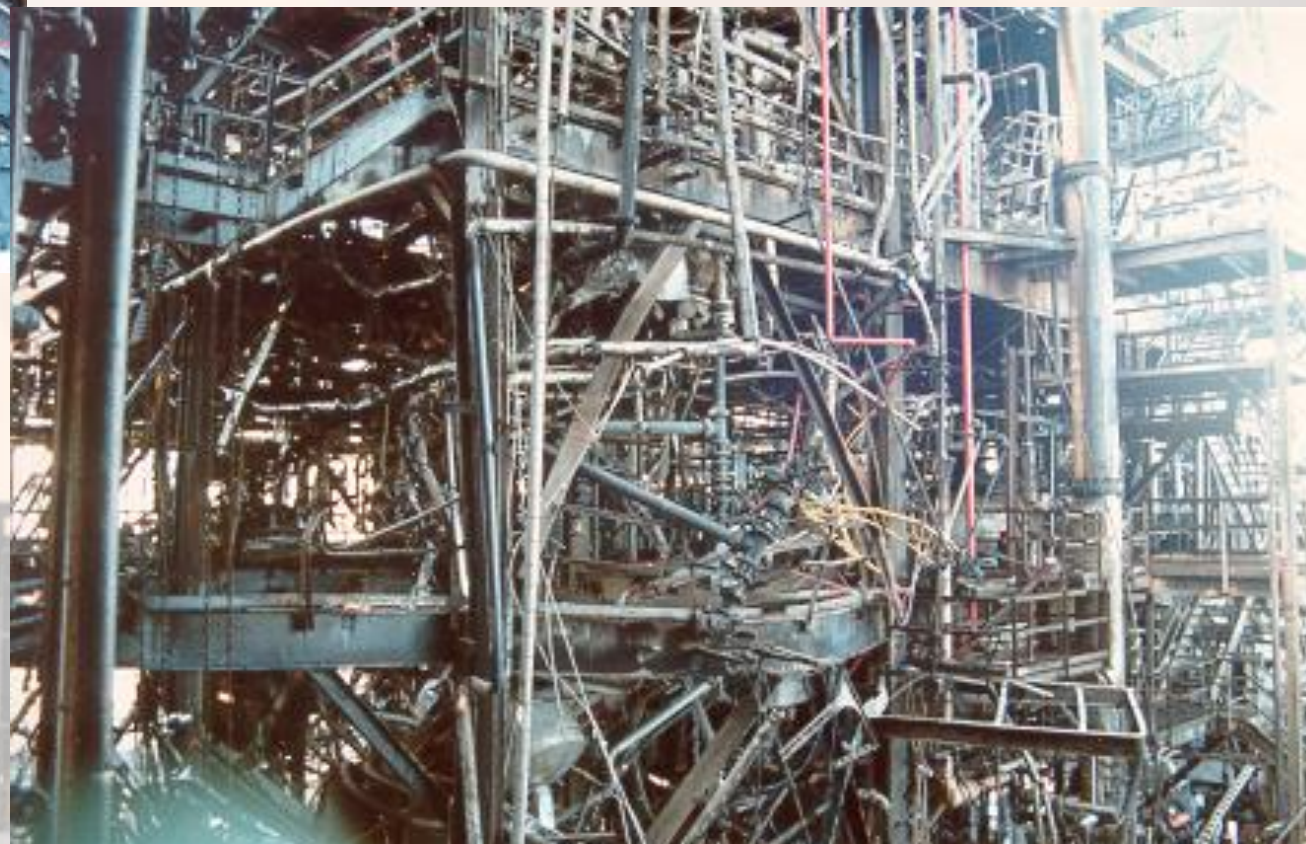
Solid deposits in centrifuge and feed tank

Instruction for periodic cleaning with water

In 1992 – explosion of feed tank



Significant property loss
No injuries



Causes

Organic material thermally unstable

Water wash temperature was increased by site (more efficient wash)

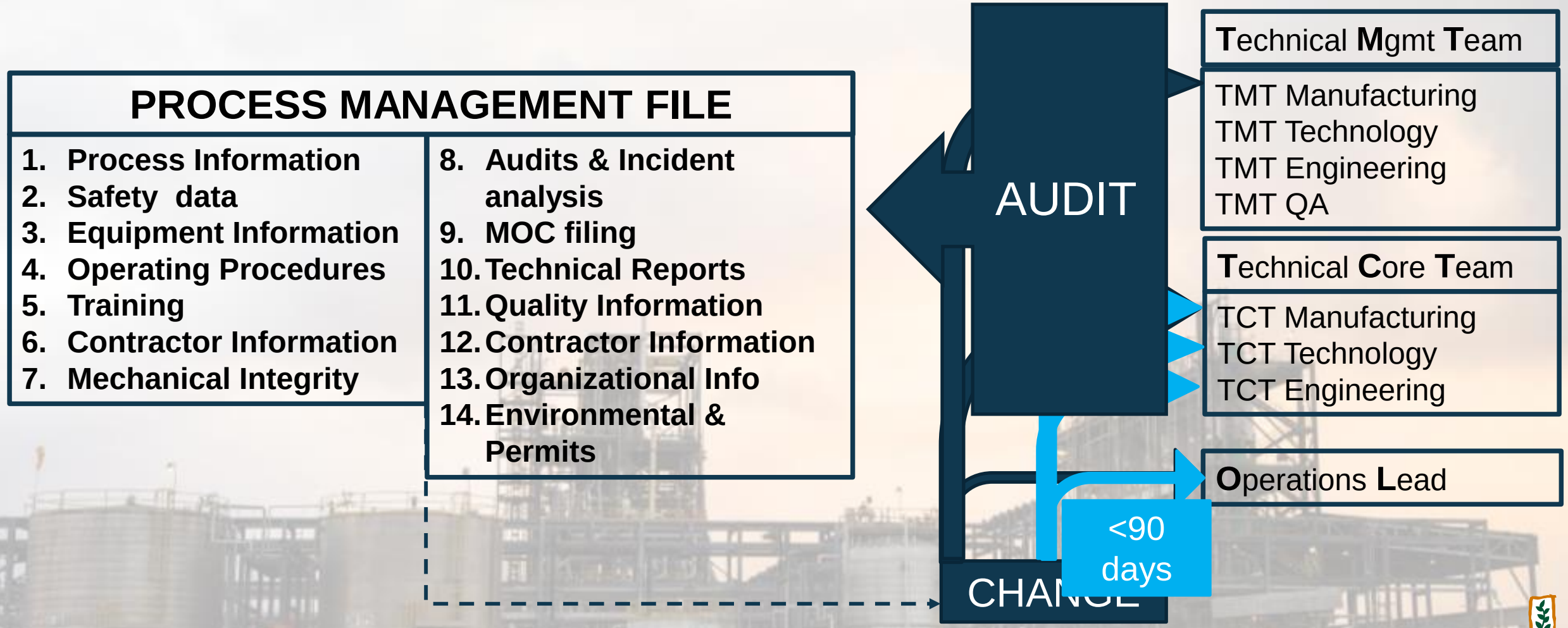
Thermal instability known by corporate technology

Not known by plant operations

Detailed operating instructions and limits for operations

Not for cleaning

PSI & MOC


PROCESS MANAGEMENT FILE
1. Process Information
2. Safety data
3. Equipment Information
4. Operating Procedures
5. Training
6. Contractor Information
7. Mechanical Integrity
8. Audits & Incident analysis
9. MOC filing
10. Technical Reports
11. Quality Information
12. Contractor Information
13. Organizational Info
14. Environmental & Permits
AUDIT
Technical Mgmt Team
TMT Manufacturing
TMT Technology
TMT Engineering
TMT QA
Technical Core Team
TCT Manufacturing
TCT Technology
TCT Engineering
Operations Lead
<90 days
CHANGE

Runaway reaction in startup conditions

Institute – West Virginia

2008 – Start up after large shutdown

// Upgrade of control system

// Replacement of residue treatment vessel

Thermal treatment of residue to fuel

Runaway reaction in startup conditions

What went wrong?

- No solvent ‘heel’ charged to treatment vessel
- Temperature interlock on feed valve bypassed
- Higher concentrations in feed due to process upsets upstream

- Runaway decomposition
- Vessel rupture
- Two fatalities

Belford Roxo – 2007
Tankfarm explosion due to runaway reaction

Lessons learned

Many improvements to PPS management systems

Main focus on

- Upgrade of PHA program
- Training and qualification of PHA practitioners
- General PPS training (TOPPS) for all employees involved in chemical processes
- Very strong focus on thermal hazard data and explosion prevention

Conclusion

- Large incidents with many similarities
- Significant changes to management systems that change the company ‘DNA’
- But changes in different ‘pillars’ of the management system
- There is no right or wrong answer

Key take-aways

Value of mitigation – you can’t prevent everything

Value of a strong near miss reporting culture

Communication during line breaking (incl. underground piping)

Sharing near misses : ‘easier’ than big incidents

Similar incidents can trigger different learnings in different companies

Thank you!

Bye-Bye