Click on incident name in "Event" column
to go directly to 1-Page incident summary.

Click on link to go directly
to investigation report.

Major Process Safety Incident vs Root Cause Map

(Quick Reference Guide)

Trevor Kletz famously observed that ***"Organisations have no memory. Only people have memory and they move on"*** . He also observed that ***"Accidents are not due to lack of knowledge, but failure to use the knowledge we have"*** .

This Refining Process Safety Incident database was inspired by these observations. Its purpose is simply to raise awareness of major incidents in the oil refining sector, to promote the importance of root cause analysis and to catalyse sharing of lessons learned and good practices. The infographic below provides an overview of the main root causes of each incident and enables the user to quickly identify which incidents share common root causes across multiple refining technologies. The document contains hyperlinks so the user can simply click on the incident name in the "Event" column to directly access a 1-Page incident summary or can click on the corresponding link in the "Investigation Reports" column to directly access the investigation report (where available in the public domain). The 1-Page incident summaries provide a brief description of the incident and highlight key points (including basic causes, critical factors, root causes and lessons learned) in addition to signposting users to the detailed investigation report and selected other pertinent reference materials.

The following definitions were used in development of these 1-Pagers:
- Near Miss is an undesirable event which, under different circumstances, could have resulted in a process safety incident.
- Immediate Cause (or Basic Cause) is a sub-standard act or condition that led directly to the incident.
- Critical Factor is an undesirable act or condition which, if eliminated, would have prevented occurrence or reduced the severity of the incident.
- Root Cause (or System Cause) is an organisational failing that created circumstances or conditions enabling the incident to take place.

The significance of the red cross (**X**) in the infographic below is to highlight which of the multiple root causes I believe to be the dominant one for each incident. So, for example, if you are organising a safety stand-down to show the importance of procedures, the user can quickly and easily identify some examples where inadequate procedures were a dominant root cause.

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Process Type	Date	Event	Country	Type	Fatalities	Injuries	Abnormal Operations	Escalation Potential	Earthquake	Tsunami	Flood	Cyclone/Hurricane	Extreme Cold/Ice	Hazard Identification	Process Design	Equipment/Piping Design	Matterials of Construction	Instrumentation	Safety Instrumented Systems	Protective Systems	Plant Layout	Occupied Buildings	Process Monitoring	Process Control	Cyber Security Breach	Alarm Management	Creeping Change	Hazard Awareness	Operations Risk Assessment	Preventative Maintenance	Inspection/Testing	Material Degradation	Work Planning	Maintenance Risk Assessment	Energy Isolation	Control of Work	Housekeeping	Human Factors	Role Clarity	Personal Protective Equipment	Communication	Procedures	Training	Supervision/Leadership	Contractor Selection	Production over Safety	Normalisation of Deviance	Quality Assurance/Control	Management of Change	Failure to Learn	Emergency Preparedness	Process Safety Management	Design Standards	Land Use Planning	Regulatory Compliance Audits	Investigation Reports
							Context		"Natech" Triggers: Natural Hazards					Root Causes: Design Factors									Operations Factors							Maintenance Factors								Personal			Competency					Culture							Regulator			Links
Alkylation (H2SO4)	17-Jul-01	Delaware City	USA	Explosion	1	8		X						X	X	X				X								X	X	X	X	X		X		X		X			X			X					**X**	X		X				Click
Alkylation (H2SO4)	12-Feb-14	Martinez	USA	Acid Release	0	2		X								**X**													X		X							X		X		X	X	X		X	X			X	X		X		X	Click
Alkylation (H2SO4)	22-Nov-16	Baton Rouge	USA	Fire	0	4								X		**X**												X						X		X		X			X	X	X				X			X		X	X			Click
Alkylation (HF)	08-Apr-04	Ciniza	USA	Explosion	0	6		X								X					X								X	X		X		X	**X**	X		X			X						X		X	X						Click
Alkylation (HF)	19-Jul-09	Corpus Christi	USA	Fire	0	2		X							X	**X**																											X							X	X	X			X	Click
Alkylation (HF)	21-Jun-19	Girard Point	USA	Explosion	0	6		X									X		X	X								X			**X**	X																					X			Click
Amine Regeneration	02-Jun-11	Pembroke	UK	Explosion	4	1	X	X						X									X				X	X	X				X	X		X		X	X		X	X	X	X			X		**X**			X				Click
Amine Regeneration	10-Oct-24	Deer Park	USA	H_2S Release	2	13		X													X							X	X				X	X	X	**X**		X	X	X	X	X		X						X		X	X			Click
Atmospheric Crude Distillation	23-Feb-99	Avon	USA	Fire	4	1	X							X													X		X	X	X	X	X		X	**X**						X	X	X		X			X			X				Click
Atmospheric Crude Distillation	17-Aug-99	Izmit	Turkey	Fire	0	0		X	X						X	X	X			X	X								X			X						X			X		X								**X**	X			X	Click
Atmospheric Crude Distillation	06-Aug-12	Richmond	USA	Fire	0	26								X			**X**												X		X	X												X		X					X	X	X	X		Click
Catalytic Reforming (CCR)	19-Nov-13	Antwerp	Belgium	Explosion	2	0										**X**							X	X			X							X								X														Click
Catalytic Reforming (S-R)	21-Aug-17	Rotterdam	Netherlands	Fire	0	0	X												**X**				X			X			X							X		X			X	X										X				Click
Coking (DCU)	25-Nov-98	Puget Sound	USA	Fire	6	0	X							X				X			X		X					X	X							X		X				X	X	X		X			**X**	X		X				Click
Diesel Hydrotreating (HDO)	19-Nov-23	Martinez	USA	Fire	0	1	X	X						**X**	X			X	X				X			X		X	X									X				X	X							X		X	X			Click
Fluid Catalytic Cracking	23-Jul-84	Romeoville	USA	Explosion	17	22								X			X											X			X	**X**										X											X			Click
Fluid Catalytic Cracking	09-Nov-92	La Mède	France	Explosion	6	38		X						X							**X**	X	X								X	X		X																		X	X		X	Click
Fluid Catalytic Cracking	24-Jul-94	Milford Haven	UK	Explosion	0	26	X	X								X		X					X			X			X	X	**X**	X				X		X			X		X						X		X	X				Click
Fluid Catalytic Cracking	10-Jun-00	Grangemouth	UK	Fire	0	0	X	X						X		X			X				X	X		X	X	X			X										X						X		**X**			X				Click
Fluid Catalytic Cracking	18-Feb-15	Torrance	USA	Explosion	0	4	X	X						X				X	X		X		**X**					X		X	X	X		X	X	X						X		X					X	X		X				Click
Fluid Catalytic Cracking	26-Apr-18	Superior	USA	Explosion	0	36	X	X						X			X	X			X		**X**	X				X	X			X										X	X				X			X	X	X	X			Click
Hydrocracking	22-Mar-87	Grangemouth	UK	Explosion	1	0	X	X						X		X		X	**X**	X								X								X					X	X	X			X			X	X		X				Click
Hydrocracking	21-Jan-97	Avon	USA	Runaway	1	46	X	X						X				**X**	X				X			X			X		X							X			X	X	X	X		X	X		X	X		X				Click
Hydrocracking	28-Jul-05	Texas City	USA	Fire	0	1		X								X	X											X			X	X	X	X		X		X			X	X						**X**				X				Click
Hydrocracking	05-Nov-05	Delaware City	USA	Asphyxiation	2	0																						X						X		**X**		X				X	X													Click
Naphtha Hydrotreating	02-Apr-10	Anacortes	USA	Explosion	7	0	X							X		X	**X**	X					X				X		X			X										X					X					X	X		X	Click
Naphtha Splitter	23-Mar-05	Texas City	USA	Explosion	15	180	X							X	X			X				X	X				X		X	X		X				X		X	X		X	**X**	X			X	X		X	X		X			X	Click
Oil Storage	04-Jan-66	Feyzin	France	BLEVE	18	84									X	X				X								X														**X**	X								X		X			Click
Oil Storage	25-Oct-88	Pulau Merlimau	Singapore	Fire	0	25		X			X				X	X		X		X			X							X	**X**	X						X				X				X			X	X	X	X	X			Click
Oil Storage	11-Mar-11	Chiba	Japan	BLEVE	0	6		X	X							**X**				X	X						X		X		X		X										X								X	X		X		Click
Propane Deasphalting	16-Feb-07	McKee	USA	Fire	0	4		X					X	X	X				X	X	X										X			X															**X**				X			Click
Saturated Gas Plant	16-Apr-01	Humber	UK	Explosion	0	5		X						X		X														X	X	X									X								**X**			X				Click

Observations:

1) These 32 incidents alone have resulted in 86 fatalities and 547 injuries.

2) The most common root causes of these incidents are: a) inadequate process safety management (24/32), b) inadequate operating/maintenance procedures (20/32) and c) inadequate hazard identification (18/32).

3) Other causal factors include: a) escalation potential (21/32), b) abnormal operation (13/32) and c) Natech triggers (4/32).