Risk Analysis Screening Tools (RAST)

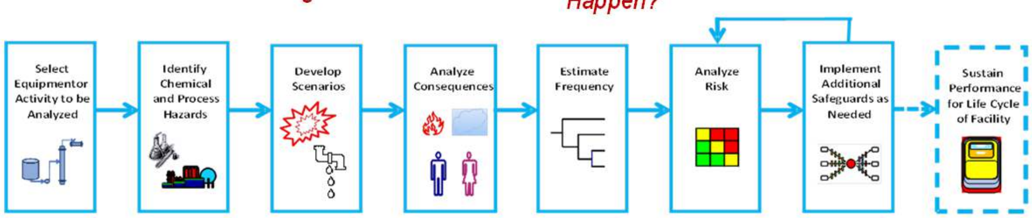
Case Study – BP Texas City

REFINERY EXPLOSION AND FIRE
Texas City, Texas
March 23, 2005

Case Study – BP Texas City

Hazard Identification and Risk Analysis (HIRA) Study

What are the Hazards? *What can go Wrong?* *How Bad could it Be?* *How Often might it Happen?* *Is the Risk Tolerable?*



We begin the study by **Identifying the Equipment or Activity** for which we intend to perform an analysis. RAST uses the operation of a specific equipment item containing a specific chemical or chemical mixture to define the activity. For example, the operation of a storage tank, a reactor, a piping network, etc. Inputs are chemical data, equipment design information, operating conditions, and plant layout.

Risk Analysis Screening Tools (RAST) Overview / Demonstration

Case Study – BP Texas City
Process Description

We have been asked to perform a HIRA study of the ISOM unit of the BP Texas City refinery. The ISOM unit provides higher octane components for unleaded gasoline, consists of four sections: an Ultrafiner14 desulfurizer, a Penex15 reactor, a vapor recovery / liquid recycle unit, and a raffinate splitter. At the BP Texas City refinery, the ISOM unit converted straight-chain normal pentane and hexane into branched-chain isopentane and isohexane for gasoline blending and chemical feedstocks.

We will start with the raffinate splitter section where a hydrocarbon mixture is separated into light and heavy components. About 40 percent of the raffinate feed was recovered as light raffinate (primarily pentane/hexane). The remaining raffinate feed was recovered as heavy raffinate.. The raffinate splitter section could process up to 45,000 barrels per day (approximately 1300 gallons/minute) of raffinate feed.

This is an illustrative example and does not reflect a thorough or complete study.

Risk Analysis Screening Tools (RAST) Overview / Demonstration

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Process Description

The process equipment in the raffinate splitter section consisted of a feed surge drum; a distillation tower; a furnace with two heating sections, one used as a reboiler for heating the bottoms of the tower and the other preheating the feed; air-cooled fin fan condensers and an overhead reflux drum; various pumps; and heat exchangers.

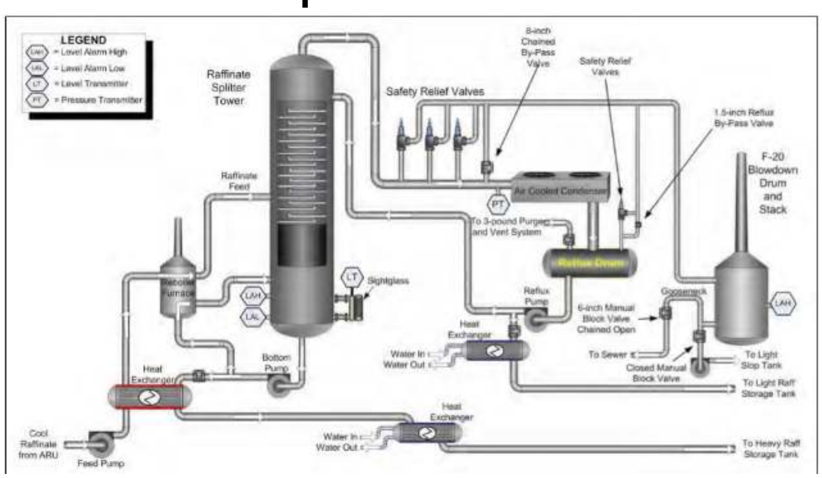

Figure 1: Raffinate Splitter Tower System of the ISOM Unit

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Process Description

Liquid raffinate feed was pumped into the raffinate splitter tower near the tower's midpoint. An automatic flow control valve adjusted the feed rate. The feed was pre-heated by a heat exchanger using heavy raffinate product and again in the preheat section of the reboiler furnace, which used refinery fuel gas. Heavy raffinate was pumped from the bottom of the raffinate splitter tower and circulated through the reboiler furnace, where it was heated and then returned below the bottom tray. Heavy raffinate product was also taken off as a side stream at the discharge of the circulation pump and sent to storage. The flow of this side stream was controlled by a level control.

Light raffinate vapors flows overhead, is condensed by air-cooled fin fan condensers, and then deposited into a reflux drum. Liquid from the reflux drum, was then pumped back into the raffinate splitter tower above the top tray.

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We will start by entering information for the raffinate column and reboiler. These items were selected as higher hazard equipment. At some point, we may decide to include other equipment in the study.

One the Main Menu, enter the equipment identification as the **Raffinate Splitter**, equipment type as **Distillation** and location as **Outdoors**.

Chemical Data – RAST requires a chemical or chemical mixture that is representative of the hazards. RAST does not perform time-dependent or location-dependent composition changes (such as within a reactor or distillation column). Where hazards may be significantly different between reactor feed and products, or distillation overheads versus bottoms; evaluation of the equipment may be repeated using different composition (such as Reactor A with feed composition and Reactor B with products composition).

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Risk Analysis Screening Tools (RAST)

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Begin by entering information on the Main Menu worksheet. Start with the Raffinate Splitter.

Enter Equipment Identification, Equipment Type and Location

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Raffinate Composition

Table G- 1. Raffinate splitter column simplified composition model (Fisher, 2006)

Compound	Weight Fraction
n-pentane	0.0383
2-methyl butane	0.0263
n-hexane	0.1519
2-methyl pentane	0.2950
n-heptane	0.3072
n-octane	0.1300
n-nonane	0.0409
Heavies as n-decane	0.0104
Total	1.0000

For entry into RAST, the mixture is simplified to:

- 0.06 n-pentane (including isopentane)
- 0.15 n-hexane
- 0.30 isohexane (2-methl pentane)
- 0.31 n-heptane
- 0.18 n-octane

Typical Raffinate composition *per Refinery Explosion and Fire*, CSB Report No. 2005-04-I-TX page 259

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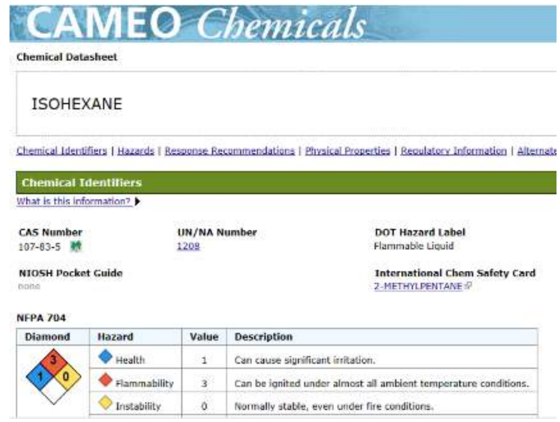
2-methl pentane or isohexane is one major component of the feed but not listed in the RAST chemical data table, so we will enter this as a new chemical. Many companies have access to large chemical property databases that contain the information we will need. In other cases, vendor Safety Data Sheets, Cameo Chemicals (US National Oceanic and Atmospheric Administration), or literature references may be used. It is good to look for agreement among multiple sources.



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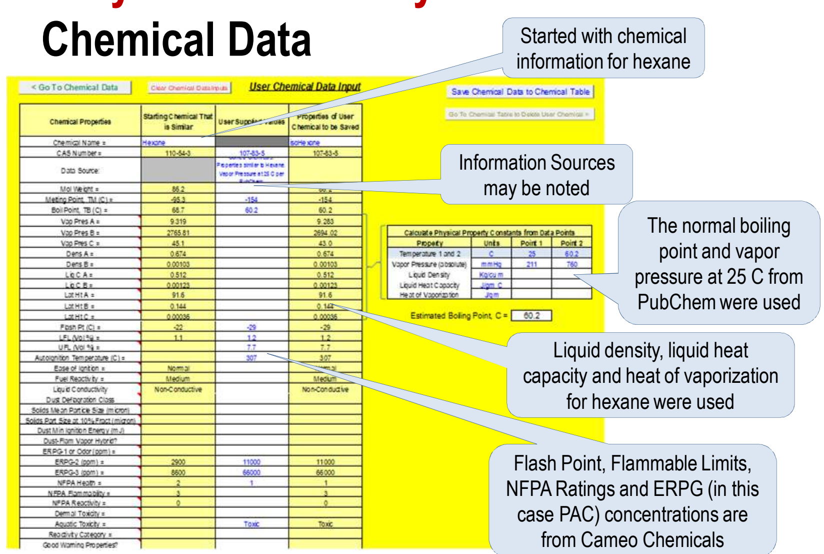
Chemical Data

Select "Add New Chemical" from the Chemical Data worksheet to access the "New Chemical" worksheet.

Since the information available from common sources is very limited, we will start with data from hexane and update with what little we know.

RAST uses relatively simple correlations for chemical properties that require only one or two data points.



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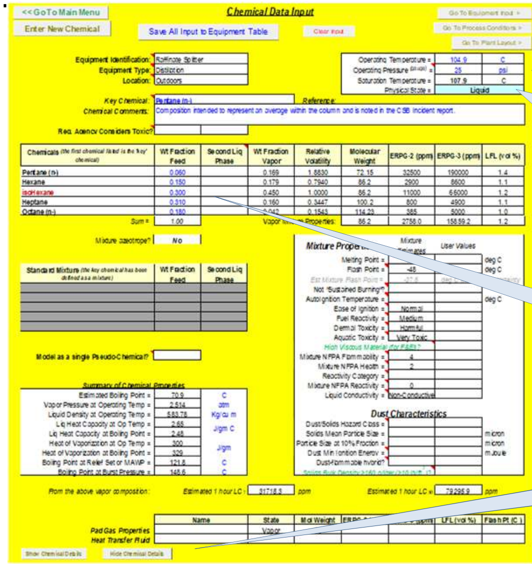
Chemical Data

A composition (weight fraction):

- 0.06 n-pentane
- 0.15 n-hexane
- 0.3 isohexane
- 0.31 n-heptane
- 0.18 n-octane

was used as representative.

The operating pressure was entered as 25 psig and the operating temperature was selected as the saturation temperature such that the physical state is "liquid" (essentially a boiling liquid).



The operating pressure entered as an "average" within the column

Saturation temperature entered as Operating Temperature with physical state as "liquid"

RAST allows up to 5 components.

Chemical details may be shown or hidden

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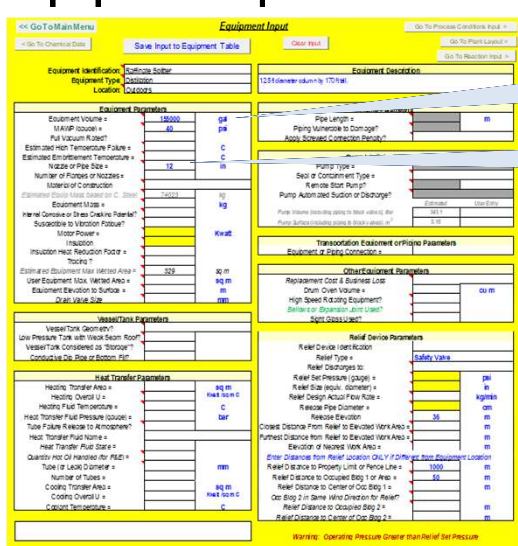
Equipment Input

The raffinate splitter is a 12.5 ft diameter column 170 ft tall. It has a total volume of roughly 155,000 gallons and a maximum allowable working pressure near 40 psig.

The column relief system discharges to a blowdown tank with elevated stack located 120 m northeast of the unit.

Only minimal data will be entered at this time.



The equipment volume and maximum allowable working pressure

A largest "working" nozzle of 12 inches is also entered

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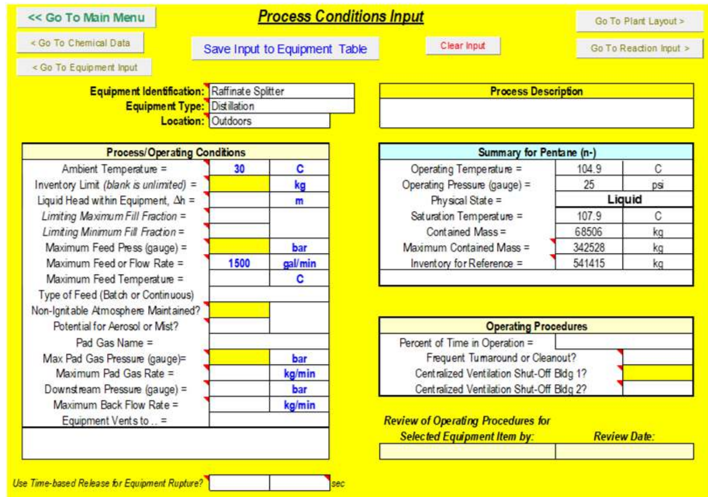
Process Conditions

The maximum flowrate to the column is approximately 1500 gal/min. under normal operations.

Ambient temperature of 30 C has been assumed.



<< Go To Main Menu
< Go To Chemical Data
< Go To Equipment Input
Process Conditions Input
Save Input to Equipment Table
Clear Input
Go To Plant Layout >
Go To Reaction Input >

Equipment Identification: Raffinate Splitter
Equipment Type: Distillation
Location: Outdoors

Process/Operating Conditions		
Ambient Temperature =	30	C
Inventory Limit *(blank is unlimited)* =		kg
Liquid Head within Equipment, Δh =		m
Limiting Maximum Fill Fraction =		
Limiting Minimum Fill Fraction =		
Maximum Feed Press (gauge) =		bar
Maximum Feed or Flow Rate =	1500	gal/min
Maximum Feed Temperature =		C
Type of Feed (Batch or Continuous)		
Non-Ignitable Atmosphere Maintained?		
Potential for Aerosol or Mist?		
Pad Gas Name =		
Max Pad Gas Pressure (gauge)=		bar
Maximum Pad Gas Rate =		kg/min
Downstream Pressure (gauge) =		bar
Maximum Back Flow Rate =		kg/min
Equipment Vents to ... =		

Use Time-based Release for Equipment Rupture? sec

Process Description

Summary for Pentane (n-)		
Operating Temperature =	104.9	C
Operating Pressure (gauge) =	25	psi
Physical State =	Liquid	
Saturation Temperature =	107.9	C
Contained Mass =	68506	kg
Maximum Contained Mass =	342528	kg
Inventory for Reference =	541415	kg

Operating Procedures	
Percent of Time in Operation =	
Frequent Turnaround or Cleanout?	
Centralized Ventilation Shut-Off Bldg 1?	
Centralized Ventilation Shut-Off Bldg 2?	

Review of Operating Procedures for Selected Equipment Item by: *Review Date:*

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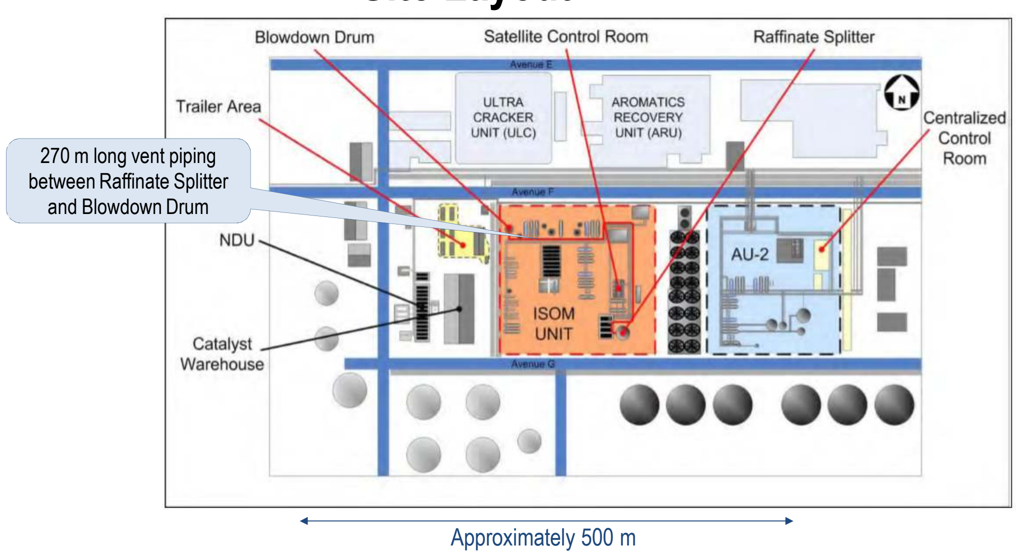
Site Layout



Site Layout

Congestion or Obstacle Density Categories

RAST is limited to consideration of the entire cloud volume as a single Potential Explosion Site (PES) at an overall or average category of process equipment congestion. RAST does not account for small localized areas of higher congestion where blast overpressure will be higher.

<u>Low</u> – Only 1-2 layers of obstacles. One can easily walk through the area relatively unimpeded.

<u>Medium</u> – 2-4 layers of obstacles. One can walk through an area, but it is cumbersome to do so. Medium Congestion is assumed in RAST if a category is not entered by the user.

<u>High</u> – Many layers of repeated obstacles. One could not possibly walk through the area and little light penetrates the congestion .

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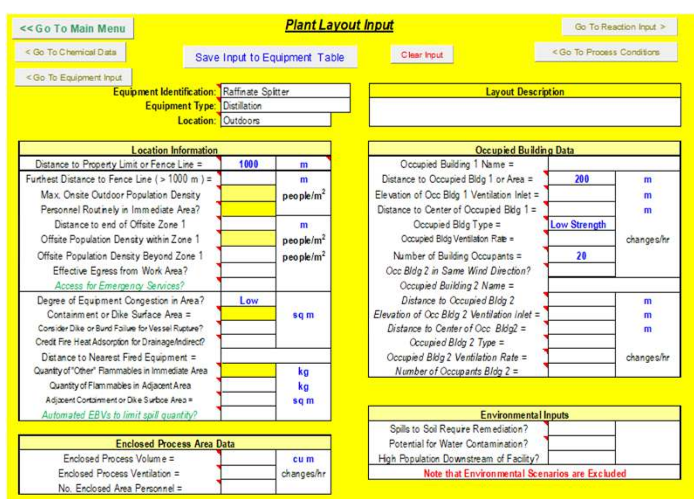
Site Layout

The distance to the property limit for the 1200 acre site is greater than 1000 m. Several wooden trailers are located approximately 200 m from the raffinate splitter housing 20 people. The trailers are "low strength" construction. In addition, the process area appears to be relatively "*low"* equipment congestion.

The blowdown tank which receives the discharge from the raffinate splitter relief devices is located 50 m from the wooden trailers and vents at an elevation of 36 m. *This location information is entered on the Equipment Input worksheet.*



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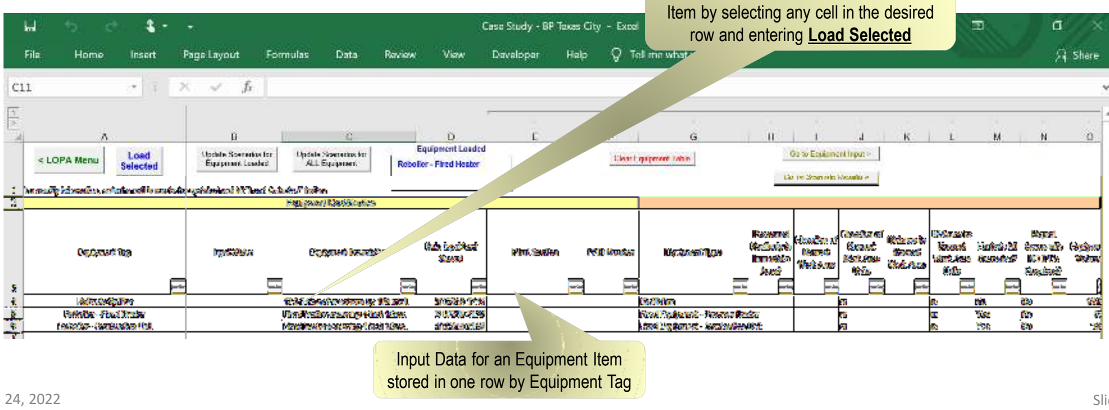
Select <u>Save Inputs to Equipment Table</u> (blue macro button). All Input Information will be stored in the Equipment Table in a single row identified by a unique Equipment Identification or Tag.

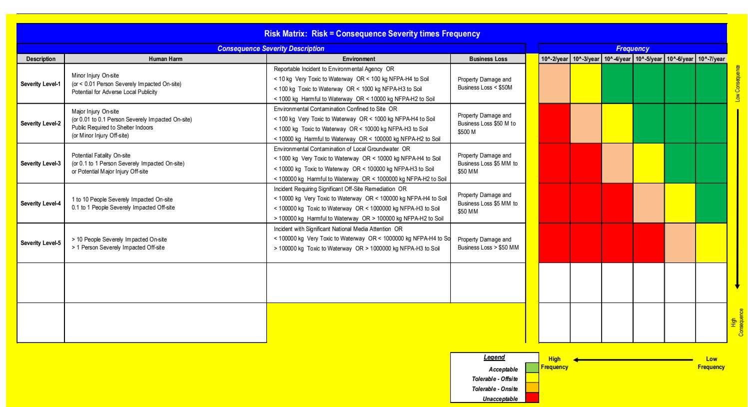


Risk Analysis Screening Tools (RAST)

Risk Matrix

To understand the Consequence Severity and Tolerable Frequency, the values for key Study Parameters and a Risk Matrix may be viewed on the Workbook Notes worksheet. These values may be updated on hidden worksheets and should reflect the company's specific risk criteria.

For this case study, the Risk Matrix (right) has been used. The Human Harm criteria is based on an estimated number of people severely impacted (severe injury including fatality).



Risk Matrix: Risk = Consequence Severity times Frequency

Description	Human Harm	Environment	Business Loss	10^-2/year	10^-3/year	10^-4/year	10^-5/year	10^-6/year	10^-7/year
Severity Level-1	Minor Injury On-site (or < 0.01 Person Severely Impacted On-site) Potential for Adverse Local Publicity	Reportable Incident to Environmental Agency OR < 10 kg Very Toxic to Waterway OR < 100 kg NFPA-H4 to Soil < 100 kg Toxic to Waterway OR < 1000 kg NFPA-H3 to Soil < 1000 kg Harmful to Waterway OR < 10000 kg NFPA-H2 to Soil	Property Damage and Business Loss < $50M						
Severity Level-2	Major Injury On-site (or 0.01 to 0.1 Person Severely Impacted On-site) Public Required to Shelter Indoors (or Minor Injury Off-site)	Environmental Contamination Confined to Site OR < 100 kg Very Toxic to Waterway OR < 1000 kg NFPA-H4 to Soil < 1000 kg Toxic to Waterway OR < 10000 kg NFPA-H3 to Soil < 10000 kg Harmful to Waterway OR < 100000 kg NFPA-H2 to Soil	Property Damage and Business Loss $50 M to $500 M						
Severity Level-3	Potential Fatality On-site (or 0.1 to 1 Person Severely Impacted On-site) or Potential Major Injury Off-site	Environmental Contamination of Local Groundwater OR < 1000 kg Very Toxic to Waterway OR < 10000 kg NFPA-H4 to Soil < 10000 kg Toxic to Waterway OR < 100000 kg NFPA-H3 to Soil < 100000 kg Harmful to Waterway OR < 1000000 kg NFPA-H2 to Soil	Property Damage and Business Loss $5 MM to $50 MM						
Severity Level-4	1 to 10 People Severely Impacted On-site 0.1 to 1 People Severely Impacted Off-site	Incident Requiring Significant Off-Site Remediation OR < 10000 kg Very Toxic to Waterway OR < 100000 kg NFPA-H4 to Soil < 100000 kg Toxic to Waterway OR < 1000000 kg NFPA-H3 to Soil > 100000 kg Harmful to Waterway OR > 100000 kg NFPA-H2 to Soil	Property Damage and Business Loss $5 MM to $50 MM						
Severity Level-5	> 10 People Severely Impacted On-site > 1 Person Severely Impacted Off-site	Incident with Significant National Media Attention OR < 100000 kg Very Toxic to Waterway OR < 1000000 kg NFPA-H4 to Soil > 100000 kg Toxic to Waterway OR > 1000000 kg NFPA-H3 to Soil	Property Damage and Business Loss > $50 MM						

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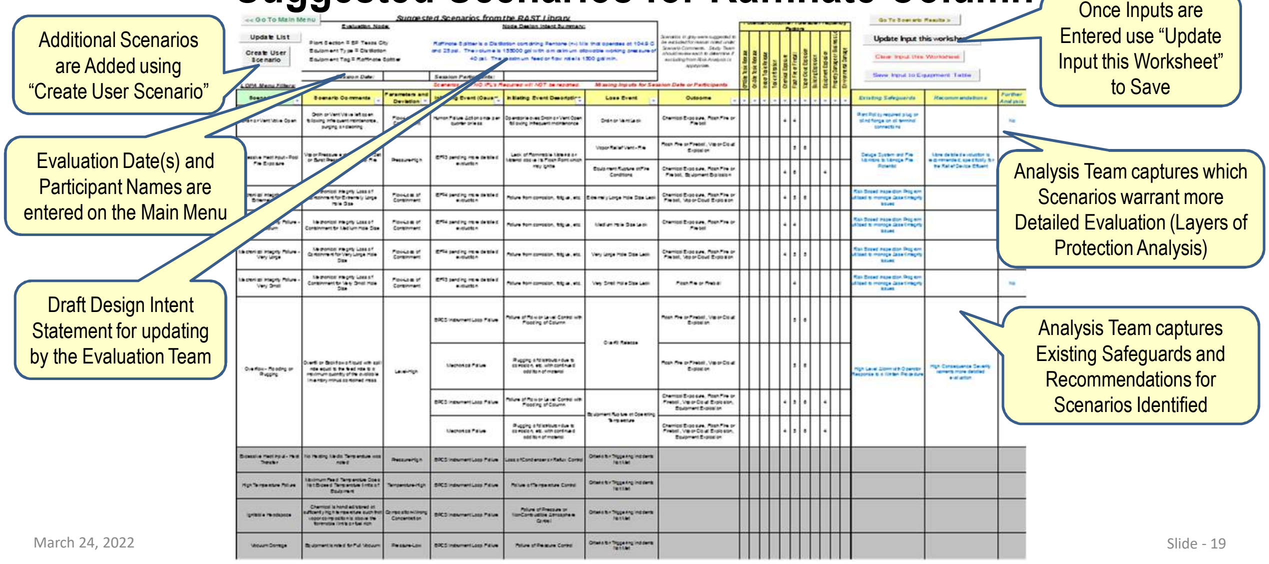
Suggested Scenarios for Raffinate Column



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Case Study – BP Texas City
Suggested Scenarios for Raffinate Column

WORKING WITH YOUR EVALUATION TEAM:

- ❑ **Review the suggested list of scenarios. Do these represent what you would expect for a distillation column?**
- ❑ **Are there scenarios that have been "screened out" (shown in gray) that should be considered?**
- ❑ **Are there scenarios missing? (Possibly similar scenarios with different Initiating Events)**
- ❑ **Do you agree with the "worst" Consequence (Tolerable Frequency Factor) for the scenario listed?**

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Risk Analysis Screening Tools (RAST) Overview / Demonstration

Case Study – BP Texas City
Suggested Scenarios for Raffinate Column

WORKING WITH YOUR EVALUATION TEAM:

- ❑ **Utilize an Appropriate Hazard Evaluation Technique (HAZOP, What If, etc.) to capture additional scenarios.**
- ❑ **Capture existing Safeguards and Recommendations for each Scenario. Note the Dates and Names of participants in the Study.**
- ❑ **Select which Scenarios warrant more detailed Risk Evaluation (such as Layers of Protection Analysis).**

March 24, 2022

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Risk Analysis Screening Tools (RAST) Overview / Demonstration

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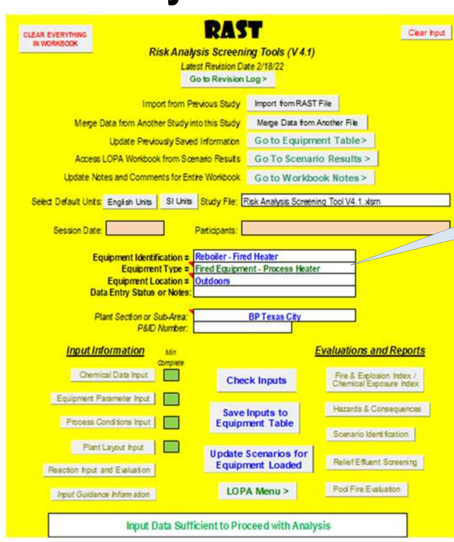
*Enter information for additional equipment associated with the Raffinate Splitter. Enter the Reboiler. As a gas-fired unit, the reboiler will consist of two equipment items, a **fired process heater** and a combustion unit.*



Enter:
- Equipment Identification: **Reboiler – Fired Heater**
- Equipment Type: select, **Fired Equipment – Process Heater**
- Location: **Outdoors**

Since the chemical inputs and location are essentially the same as the Raffinate Splitter, we will not clear data but update entries as needed.

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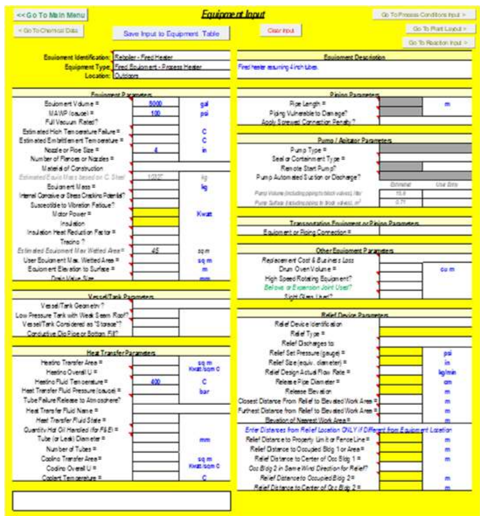
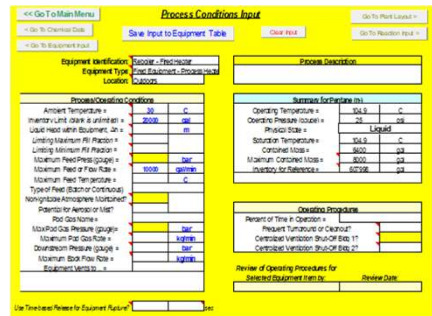
Case Study – BP Texas City

Equipment Input and Process Conditions- Reboiler

For illustration, assume the fired heater consists primarily of 4 inch tubes with a total volume of 8000 gal. Use 100 psig for the MAWP, 400 C as the combustion gas temperature, and 10,000 gal/min circulation rate. Limit the total inventory to liquid in the reboiler, piping and bottom of the Raffinate Splitter, roughly 20,000 gal.





Select Save Inputs to Equipment Table (blue macro button)..

Risk Analysis Screening Tools (RAST) Overview / Demonstration

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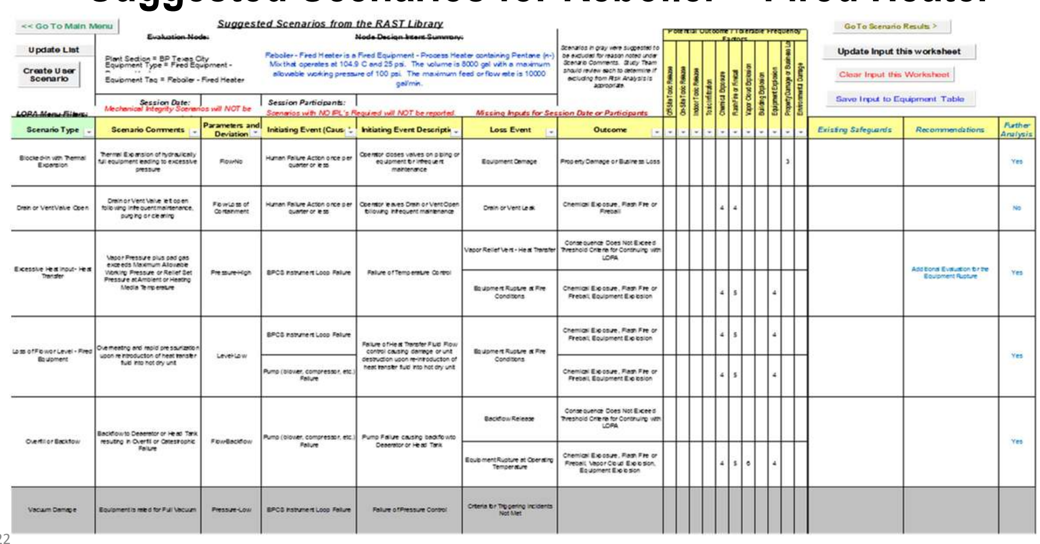
Suggested Scenarios for Reboiler – Fired Heater



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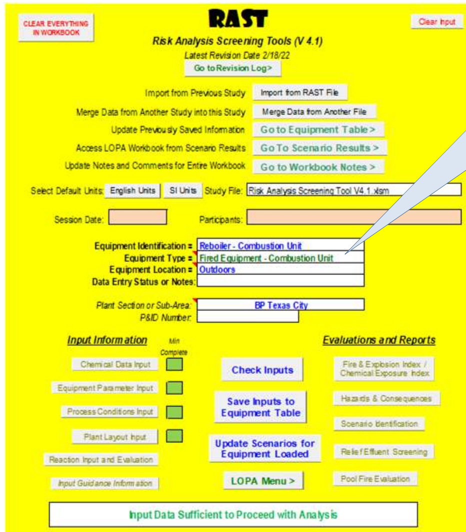
Enter information for additional equipment associated with the Raffinate Splitter. Enter the Reboiler. As a gas-fired unit, the reboiler will consist of two equipment items, a fired process heater and a ***combustion unit****.*



Enter:

- Equipment Identification: **Reboiler – Combustion Unit**
- Equipment Type: select, **Fired Equipment – Combustion Unit**
- Location: **Outdoors**

Again, the chemical inputs and location are essentially the same as the Raffinate Splitter, we will not clear data but update entries as needed.

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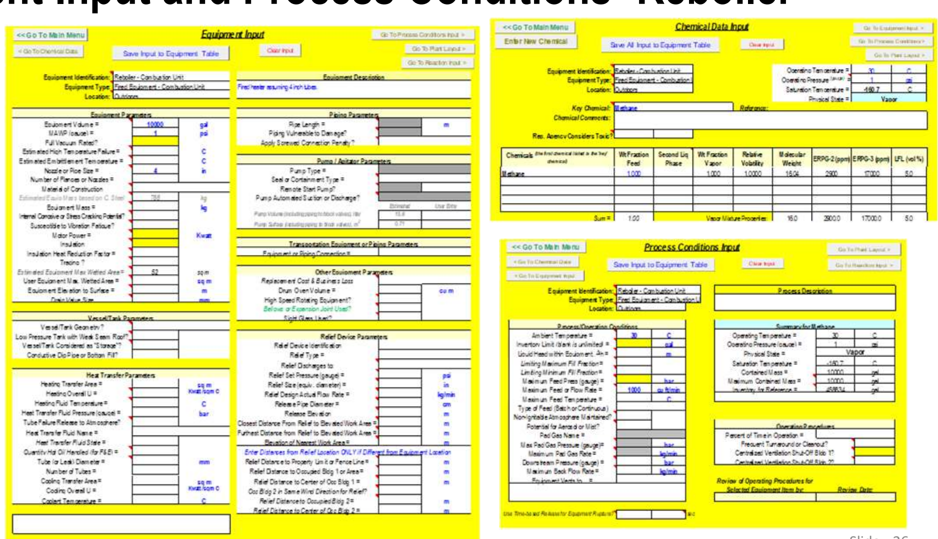
Equipment Input and Process Conditions- Reboiler

For illustration, assume the combustion unit is approximately 10,000 ft^3 and operates under slight vacuum. Use a MAWP of 1 psig and a maximum of 1000 standard ft^3/min fuel as natural gas.

Select Save Inputs to Equipment Table (blue macro button)..



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Case Study – BP Texas City
Suggested Scenarios for Reboiler – Combustion Unit

<< Go To Main Menu

Update List

Create User Scenario

Suggested Scenarios from the RAST Library

Evaluation Node:
Plant Section = BP Texas City
Equipment Type = Fired Equipment -
Equipment Tag = Reboiler - Combustion Unit

Node Design Intent Summary:
Reboiler - Combustion Unit is a Fired Equipment - Combustion Unit containing Methane that operates at 30 C and 1 psi. The volume is 10000 gal with a maximum allowable working pressure of 1 psi. The maximum feed or flow rate is 1000 cu ft/min.

Session Date:
Session Participants:

Scenarios in gray were suggested to be excluded for reason noted under Scenario Comments. Study Team should review each to determine if excluding from Risk Analysis is appropriate.

Go To Scenario Results >

Update Input this worksheet

Clear Input this Worksheet

Save Input to Equipment Table

LOPA Menu Filters:
Mechanical Integrity Scenarios will NOT be
Scenarios with NO IPL's Required will NOT be reported.
Missing Inputs for Session Date or Participants

Scenario Type	Scenario Comments	Parameters and Deviation	Initiating Event (Caus	Initiating Event Descripti	Loss Event	Outcome	Off-Site Toxic Release	On-Site Toxic Release	Indoor Toxic Release	Toxic Infiltration	Chemical Exposure	Flash Fire or Fireball	Vapor Cloud Explosion	Building Explosion	Equipment Explosion	Property Damage or Business Lo	Environmental Damage	Existing Safeguards	Recommendations	Further Analysis
Fuel Accumulation during Light Off	Accumulation of unburned fuel may cause an undesired fire or explosion. The fuel and air valves should be in their proper firing positions	Flow-High	BPCS Instrument Loop Failure	Failure of Primary Fuel Flow during ignition extinguishing the flame with potential for delayed re-ignition. (Credit for time at risk for infrequent Light Off may apply.)	Equipment Rupture - Deflagration	Flash Fire or Fireball						3							Hazards are managed by the site Burner Management Program such that Further Analysis is not warranted.	No
			Mechanical Failure	Ignitor Failure with continued addition of fuel from pilot and delayed ignition. (Time at risk may not apply as ignitor failure can occur at any time prior to use.)		Flash Fire or Fireball						3								
Fuel Accumulation during Operation	Accumulation of unburned fuel into a hot combustion chamber where components may be above the autoignition temperature.	Flow-High	BPCS Instrument Loop Failure	Failure of Combustion Air Flow with Continued Addition of Fuel	Equipment Rupture - Deflagration	Flash Fire or Fireball						3								No
			Mechanical Failure	Loss of combustion air from Blower or Damper failure with continued addition of fuel		Flash Fire or Fireball						3								
Fuel Accumulation while Down	Accumulation of unburned fuel into a cold combustion chamber may cause an undesired fire or explosion	Flow-High	BPCS Instrument Loop Failure	Primary Fuel or Waste Vent Valve Leaks while down	Vent Release	Flash Fire or Fireball						4								Yes
					Equipment Rupture - Deflagration	Flash Fire or Fireball						3								
High Fuel Flow or Energy Content	Feeding more fuel than expected may result in equipment damage if condition is left unchecked for an extended period of time	Flow-High	BPCS Instrument Loop Failure	High Primary Fuel or Waste Flow causing over firing and damage to the combustion chamber	Equipment Damage	Property Damage or Business Loss										3				No

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Suggested Scenarios for Reboiler

WORKING WITH YOUR EVALUATION TEAM:

- ❑ **Review the suggested list of scenarios. Do these represent what you would expect for a fired reboiler?**
- ❑ **Are there scenarios that have been "screened out" (shown in gray) that should be considered?**
- ❑ **Are there scenarios that do not apply? (Overflow of the deaerator may not apply as this unit is not a steam boiler. If so, this scenario would be recommended to be omitted from further evaluation.)**
- ❑ **Are there scenarios missing? (Possibly similar scenarios with different Initiating Events)**

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Case Study – BP Texas City
Suggested Scenarios for Reboiler

WORKING WITH YOUR EVALUATION TEAM:

- ❑ Do you agree with the "worst" Consequence (Tolerable Frequency Factor) for the scenario listed?
- ❑ Utilize an Appropriate Hazard Evaluation Technique (HAZOP, What If, etc.) to capture additional scenarios.
- ❑ Capture existing Safeguards and Recommendations for each Scenario. Note the Dates and Names of participants in the Study.
- ❑ Select which Scenarios warrant more detailed Risk Evaluation (such as Layers of Protection Analysis).

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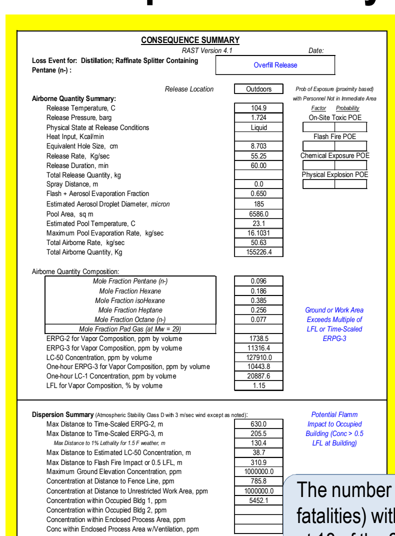
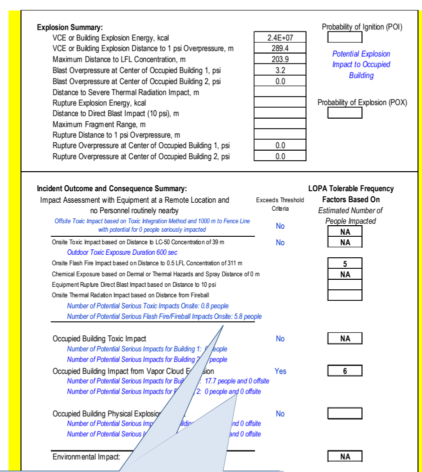
Case Study – BP Texas City
Consequence Analysis

For the Raffinate Splitter, select **Overfill Release** as the Loss Event. This represented a "worst" Consequence for the unit with a Tolerable Frequency Factor of 5. Note that a Vapor Cloud Explosion was listed as a potential Incident Outcome.

The distance to 1 psi overpressure is estimated at 273 m and overpressure at the distance to the wooden trailers is estimated at 3.2 psi.





The number of people severely impacted (likely fatalities) within the wooden trailers is estimated at 18 of the 20 occupants plus 6 people outdoors.

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Risk Analysis Screening Tools (RAST) Overview / Demonstration

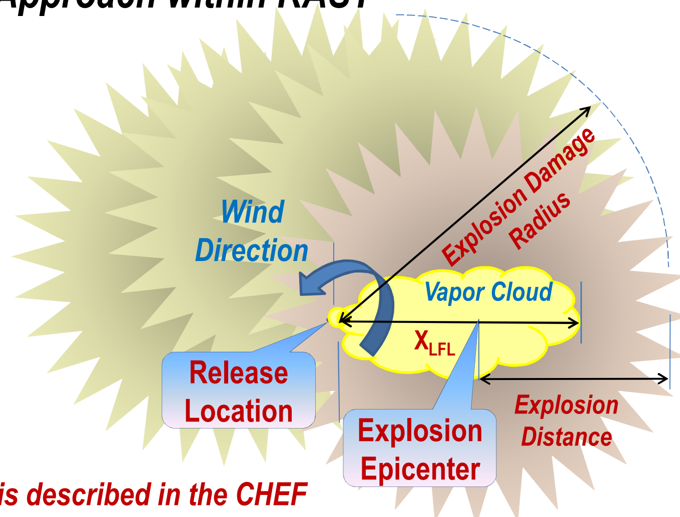
Vapor Cloud Explosion

Simple Modeling Approach within RAST

The entire vapor cloud is considered a single Potential Explosion Site with epicenter at the center of the flammable cloud (0.5 X_{LFL}).

An single overall level of congestion and confinement for the entire cloud is used.

Wind direction is assumed toward greatest population or building with highest occupancy.



Methodology is described in the CHEF Manual and training materials

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CPS Center for Chemical Process Safety — An AIChE Technology Alliance

Risk Analysis Screening Tools (RAST) Overview / Demonstration

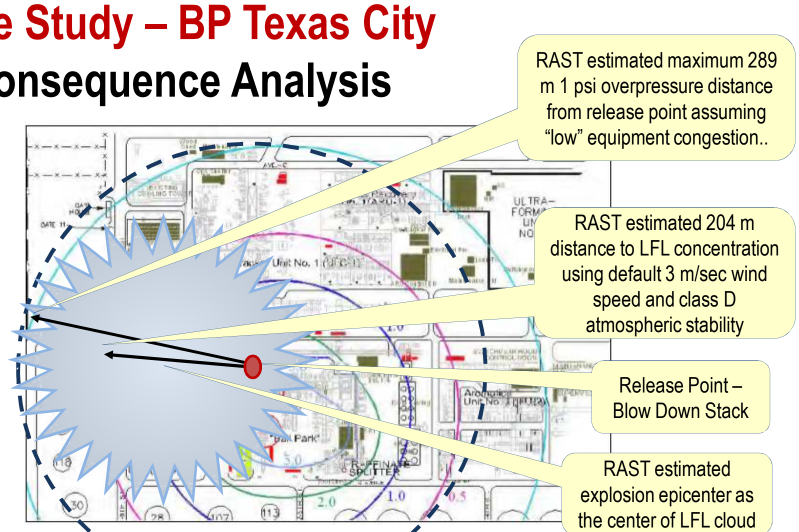
Case Study – BP Texas City

Consequence Analysis

A simplification in RAST is wind direction toward the highest population. This is quite reasonable in Risk Analysis where the wind direction is unknown.

In the actual incident, the wind direction was toward the southeast rather than west toward the wooden trailers.

Wind Direction represents a key difference between estimates for Risk Analysis versus Incident Investigation. *Blast overpressure at the wooden trailers would likely have been higher is wind direction was toward the trailers.*



REPORT NO. 2005-04-I-TX , US Chemical Safety Board, Figure H-2 Blast Overpressure Map

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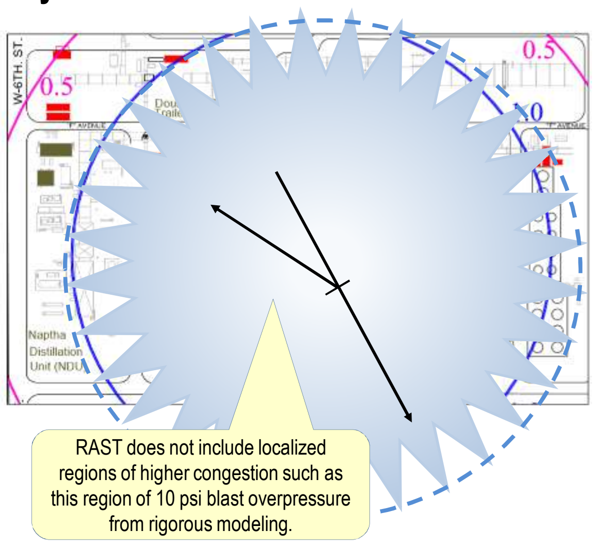
An AIChE Technology Alliance CCPS Center for Chemical Process Safety

Case Study – BP Texas City

Consequence Analysis

If we account for wind direction, the trailers would be roughly 115 m from the RAST estimated explosion epicenter versus an epicenter nearly 50 m beyond the trailers. The estimated overpressure at the trailers would be 1.6 psi (versus 2.5 psi estimated by CSB) and number of occupants severely impacted (fatalities) would be approximately 12.

Adjusting for wind direction, the 1 psi overpressure contour from RAST (dashed blue line) closely approximates the detailed modeling in the CSP report (the solid blue line). However **RAST does not consider localized regions of higher congestion** leading to regions of higher blast overpressure. The CSB report also noted that flow from the safety values may have been 8500 gal/min for 6 minutes until the valves closed versus the 1500 gal/min feed rate which would increase the distance to 1 psi blast overpressure.



Risk Analysis Screening Tools (RAST) Overview / Demonstration

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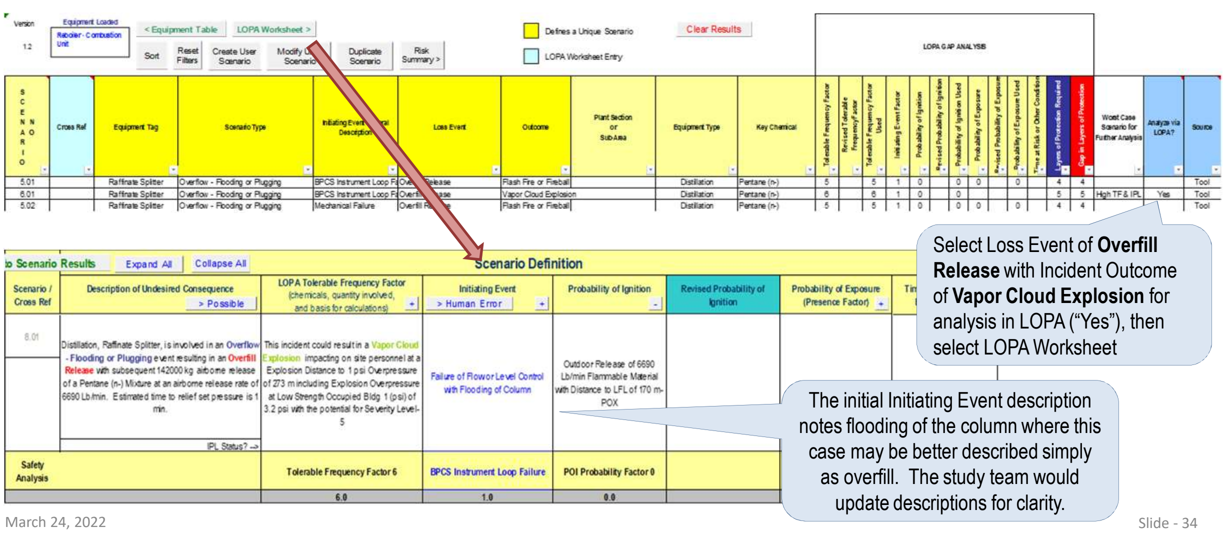
Case Study – BP Texas City

Risk Analysis / Layers of Protection Analysis (LOPA)



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Risk Analysis Screening Tools (RAST) Overview / Demonstration

Case Study – BP Texas City

Risk Analysis / Layers of Protection Analysis (LOPA)

< Back to Scenario Results	Expand All	Collapse All	Scenario Definition				
Protection Gap	Scenario / Cross Ref	Description of Undesired Consequence > Possible	LOPA Tolerable Frequency Factor (chemicals, quantity involved, and basis for calculations) +	Initiating Event > Human Error +	Probability of Ignition +	Probability of Exposure (Presence Factor) +	Time at Risk or Other Enabling Condition / Conditional Modifier
Revised Instrumented Protection Credits Taken	8.01	Distillation, Raffinate Splitter, is involved in an Overflow - Flooding or Plugging event resulting in an Overfill Release with subsequent 155000 kg airborne release of a Pentane (n-) Mixture at an airborne release rate of 6700 Lb/min. Estimated time to relief set pressure is 1 min. IPL Status? -->	This incident could result in a Vapor Cloud Explosion impacting on site personnel at a Explosion Distance to 1 psi Overpressure of 289 m including Explosion Overpressure at Low Strength Occupied Bldg 1 (psi) of 3.2 psi with the potential for Severity Level-5	Failure of Flow or Level Control with Flooding of Column	Outdoor Release of 6700 Lb/min Flammable Material with Distance to LFL of 204 m- POX		
	Safety Analysis		Tolerable Frequency Factor 6	BPCS Instrument Loop Failure	POI Probability Factor 0		
0.0			6.0	1.0	0.0	0.0	

The probability of ignition in RAST is estimated at greater than 0.1 due to the large size of the flammable cloud footprint. In addition, the probability of explosion (POX) is taken as the probability of ignition since the likelihood an ignited cloud will result in a vapor cloud explosion is not known. Hence, there is no risk reduction credit taken.

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Risk Analysis Screening Tools (RAST) Overview / Demonstration

Case Study – BP Texas City

Risk Analysis / Layers of Protection Analysis (LOPA)

	Not Allowed								
BPCS Control or Human Response to Alarm +	BPCS Control or Human Response to Alarm +	SIS Function A +	SIS Function B +	Pressure Relief Device	SRPS 1	SRPS 2	SRPS 3	Notes / Comments	Issues to Resolve
PCV-5002 Pressure Control for Raffinate Reflux Drum	LHS-5020 Blowdown Drum High Level Alarm	LHS-5102 Raffinate Splitter High Level Alarm with automated action to stop feed			Restricting personnel in locations adjacent to the unit during start-up may adequately mitigate the consequence to meet LOPA criteria for IPL				
BPCS Independent of Initiating Event	Human Response to Abnormal Condition Alarm > 1/4 hr to respond	SIS - SIL 1			Restricted Access to a Hazardous Area				
1	1	1			1				

The existing safeguards were close to sufficient for managing this scenario to a tolerable risk level had they been adequately maintained and some actions automated rather rely only on operator response to an alarm. In addition to those listed in the LOPA worksheet, several other alarms existed (such as high pressure) that may have contributed to reducing the overall scenario frequency if the potential for column overfill would have been recognized.

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Risk Analysis Screening Tools (RAST)
Case Study – BP Texas City

Risk Analysis and Incident Investigation often use similar methods to better understand the scenario. Risk Analysis "anticipates" what could go wrong and what the potential "worst" consequences may be. For Incident Investigation, the Incident Outcome and Consequences are known in addition to the actual weather conditions and wind direction.

For the Raffinate Splitter, RAST did suggest column overfill as one of many scenarios to consider. RAST also recognized that a Vapor Cloud Explosion could be a feasible Incident Outcome for an Overfill loss event. RAST was conservative in estimating blast damage as actual wind direction was <u>not</u> toward the wooden trailers. However, the "order of magnitude" estimate of consequences seems reasonable. The estimated number of people severely impacted in RAST was higher than the actual incident (24 versus 15 fatalities and 66 seriously injured).

Questions?