

# 2<sup>nd</sup> Chemical Process Safety Sharing (CPSS)

*Topic :*

**Safety Critical Elements**

*Present Name :*

**Anucha Pinyopornsawat**

*Position :*

**Section Manager**

*Company:*

**IRPC Public Company Limited.**





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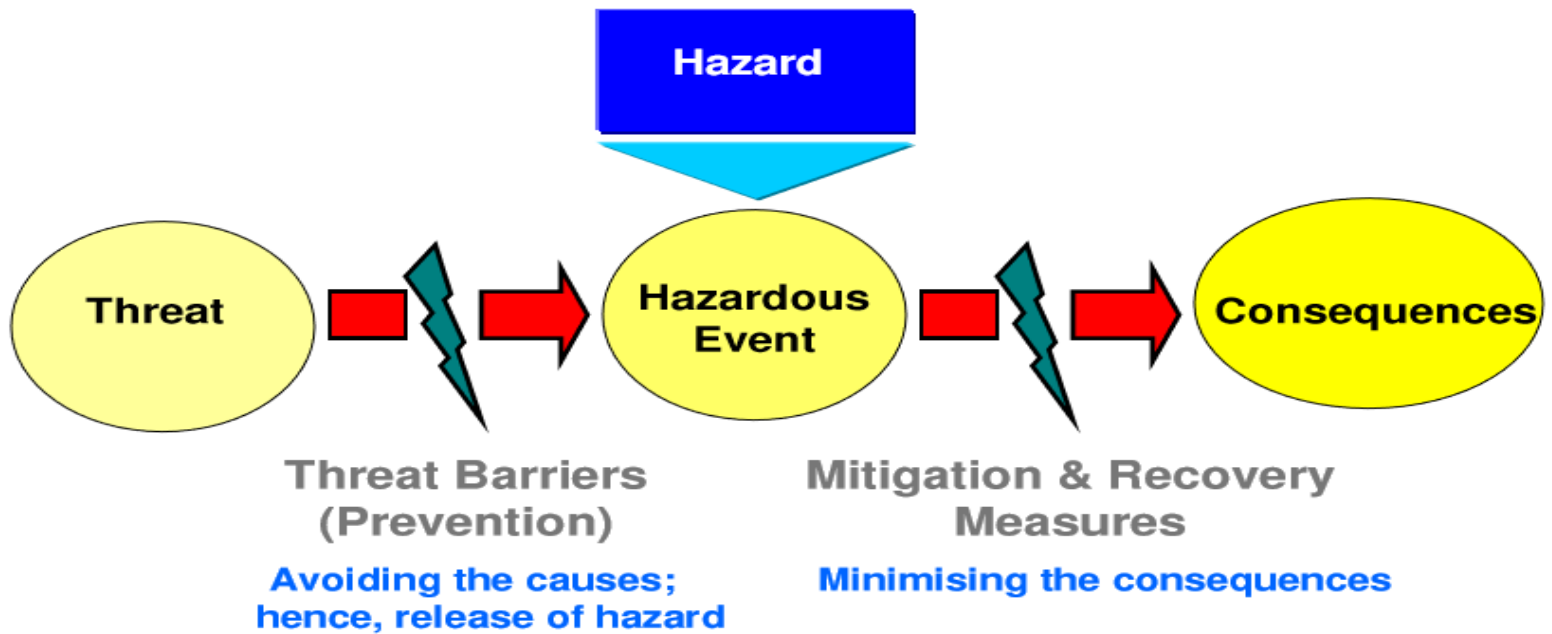
Implement SCE Outcome

Development Program



# Introduction

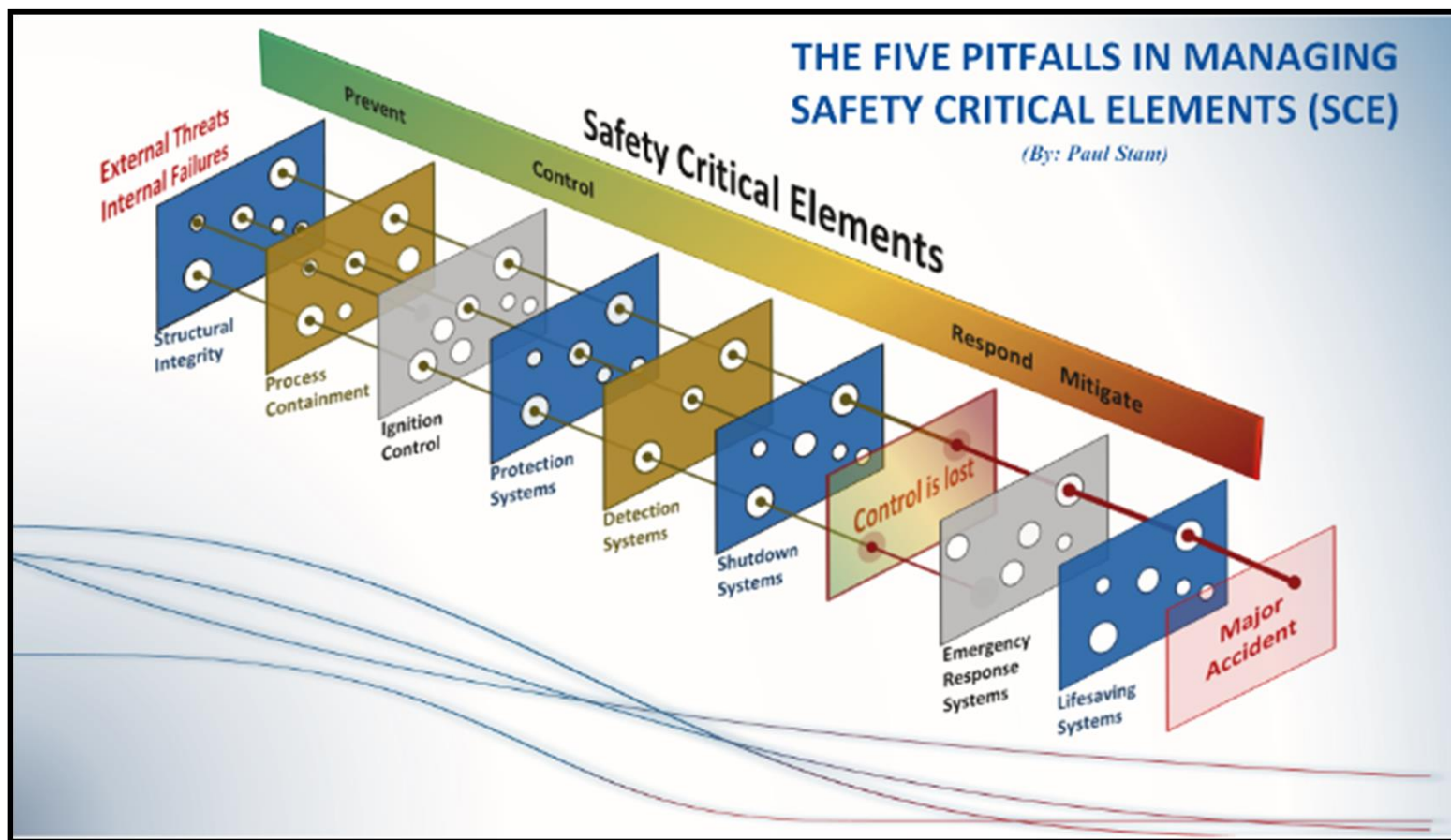
## ◉ Safety Critical Elements





# Introduction

## ◉ Safety Critical Elements

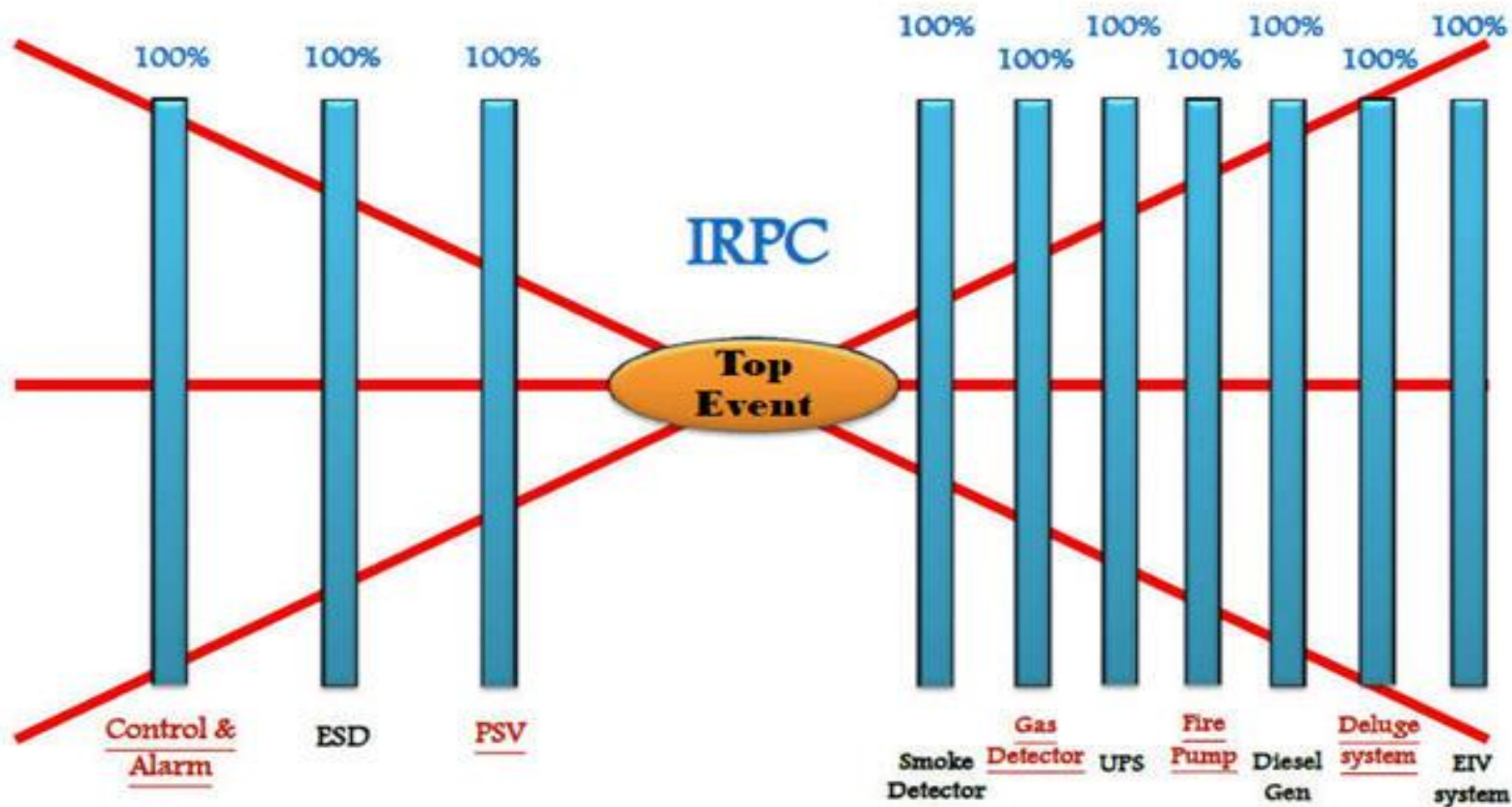






# Introduction

## ◉ Safety Critical Elements



# Safety Critical Elements

## Back Ground

### Operational Excellence Management system : (OEMS)



Figure OEMS.1: PEOPLE framework

## 5.2 Maintenance Approach

Select maintenance approach for each equipment according to its criticality to SSHE and operations performance. Asset registers form the core of the maintenance approach selection, and cover all equipment with particular emphasis on safety and production critical equipment.

Maintenance approach is selected in a three-step process (cf. Figure 5.2a: Selection of maintenance approach)

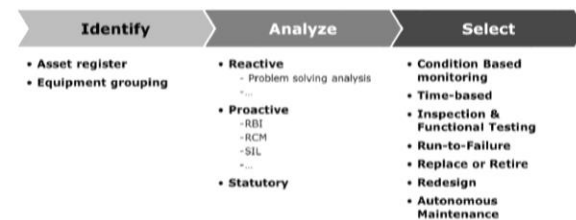


Figure 5.2a: Selection of maintenance approach

### 5.2.1 Equipment identification - This ensures:

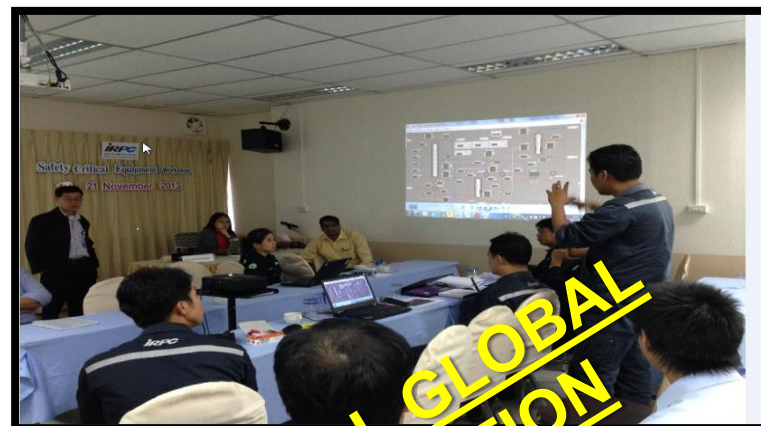
- Identification** of SSHE critical equipment by conducting a risk assessment (including likelihood and impact) on all equipment.
- Comprehensive** coverage for maintenance planning.
- Understanding** of logical relationships between equipment.
- Optimization** of spare-parts inventory.



# Safety Critical Elements

## Back Ground

Operational Excellence Management system : (OEMS)



**PTTEP**



**SHELL GLOBAL SOLUTION**



# Safety Critical Elements



Brief Implement SCE at IRPC



**Step to Implement Safety Critical Elements in IRPC**



Classification SCE  
Equipment

**Follow Up by Road Map**



Test Per plan

**Tracking Monthly Report  
“%PM SCE Compliance”**



Perform as STD

**Technical Data “Performance  
STD for SCE Equipment”**







# Safety Critical Elements



Brief Implement SCE at IRPC



## Step to Implement Safety Critical Elements in IRPC



Classification SCE Equipment



Hazard

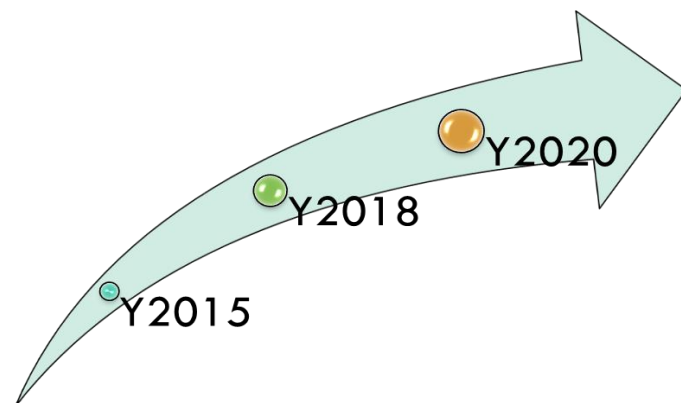
- Hazard Register

Consequence (Major Accident)

- Loss of Containment (Top Even)

RAM

- Bow-Tie







# Safety Critical Elements

Brief Implement SCE at IRPC

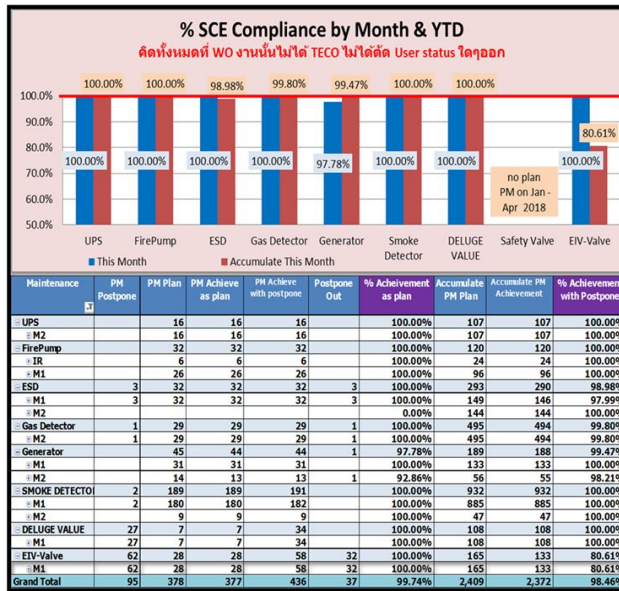
## Step to Implement Safety Critical Elements in IRPC



Test Per plan



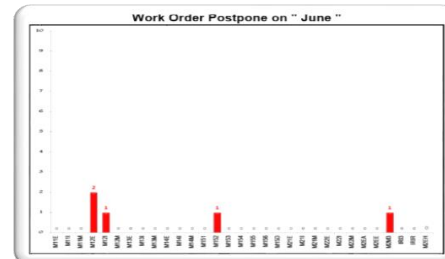
%SCE PM Compliance as of April & YTD Y2018



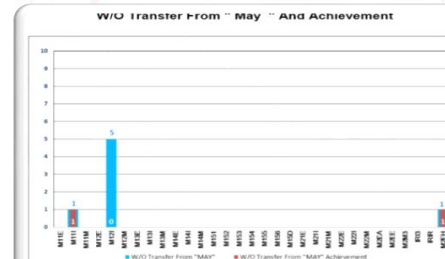
Safety Critical Elements  
Monthly Report  
"June"



Work Order Postpone on "June"



W/O Transfer From "May" And Achievement





# Safety Critical Elements



Brief Implement SCE at IRPC



Step to Implement Safety Critical Elements in IRPC



Perform as STD

4



ข้อมูลเทคนิค (Technical Data)

Template ข้อมูลเทคนิค Technical Data TD

Safety Critical Elements List and Performance Standard

หมายเลขเอกสาร S10328000-3302-rev 0

หน่วยงานรับผิดชอบ แผนกความเชื่อมโยงเครื่องจักรและไฟฟ้า

แก้ไขครั้งที่ 0

เริ่มมีผลบังคับใช้ 1 พฤศจิกายน 2561

สนับสนุนเอกสาร ชื่อเอกสาร S103

Performance  
STD.





# Safety Critical Elements



SCE Classification (Bow Tie)



SCE Assessment

## Safety Critical Element : SCE

### Identification :

A SCE is classified as an equipment, structure or **system whose failure** could cause or contribute to a **major accident**, or whose purpose is to **prevent** or **mitigate** the effect of a major accident.



# Safety Critical Elements

## SCE Classification (Bow Tie)

### SCE Assessment

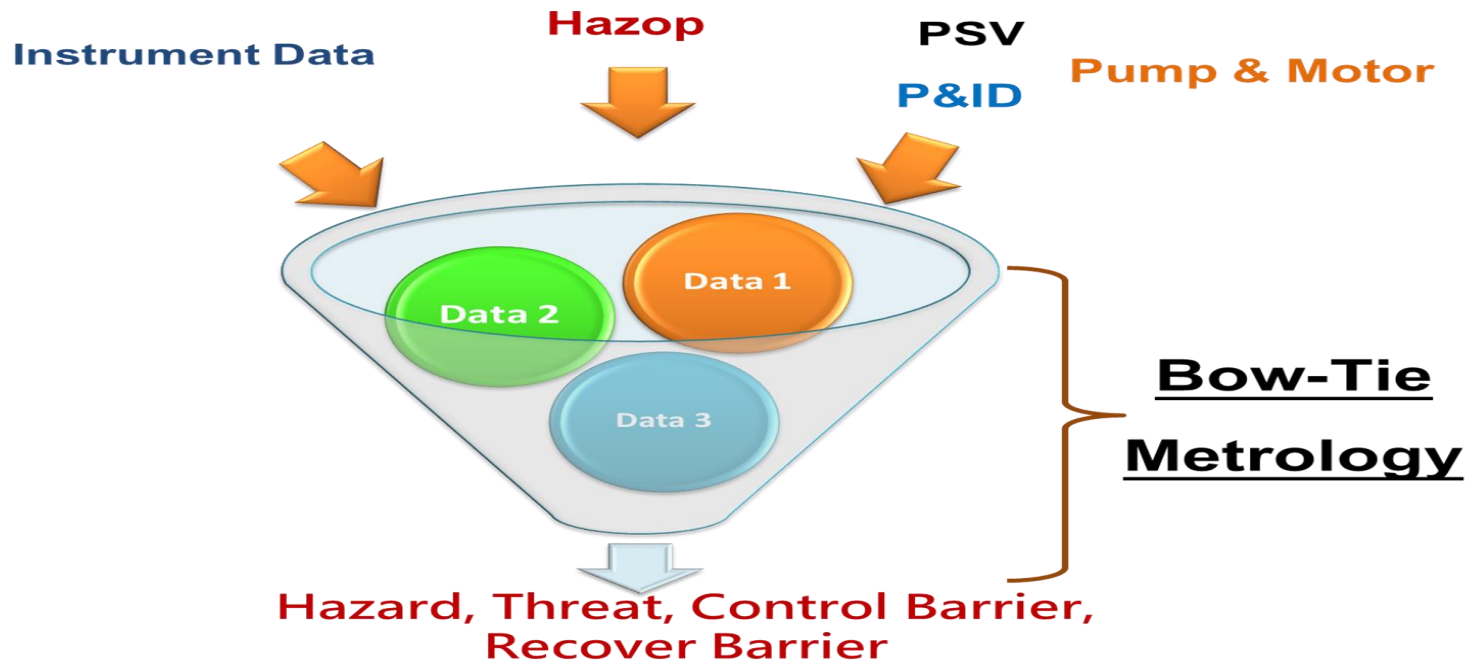




# Safety Critical Elements

SCE Classification (Bow Tie)

SCE Assessment







# Safety Critical Elements

SCE Classification (Bow Tie)

SCE Assessment





# Safety Critical Elements

SCE Classification (Bow Tie)

SCE Assessment

**Hazard - - ?**

**Top Event - - ?**

**Threats - - ?**

**Consequence - - ?**

**Barrier - - ?**



**GTC**



**ptt**  
**ES**



**SCG**  
CHEMICALS

**IRPC**

# Safety Critical Elements

## SCE Classification (Bow Tie)

### SCE Assessment

Hazard



Threats

- Gate left open
- Corroded fence
- Rotting posts
- Bull jumps the fence

Consequences

- Injury / fatality
- Damage to assets

**Top Even**

- Bull go to  
out site

**Barrier**

- Door,  
Fence

# Safety Critical Elements

## SCE Classification (Bow Tie)

### SCE Assessment

## HAZARD

### Safety Critical Element : SCE



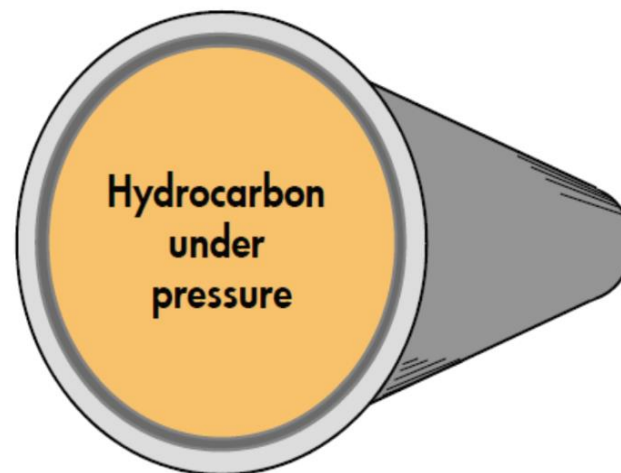
**HAZARD**



Hazard – the potential to cause harm

- $H_2S$
- $CO_2$
- Benzene
- Nitrogen
- Lightning
- Other examples??

Hazard – the potential to cause harm



# Safety Critical Elements

## SCE Classification (Bow Tie)

## SCE Assessment

### Identify

#### THE SCOPE OF HAZARD IDENTIFICATION

The boundaries must be clearly defined. Overlaps are therefore avoided and focus is maintained on the discussion about what is within the boundary.



Bulk Storage



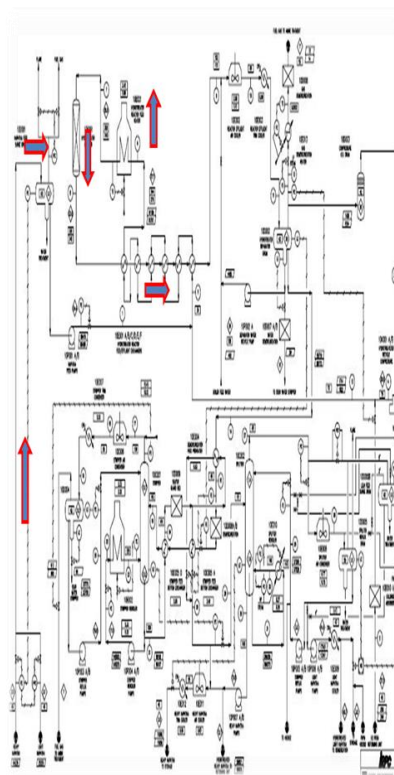
Truck



Blending Packaging Warehouse

Process Unit or Work Activity

- Where does the hazard occur?
- Identify the process flow or business workflow and separate the flow into logical blocks or "nodes" (see the example above).
- Group similar conditions.
- Carry out a hazard identification on each block (in some cases, hazards may be relevant to multiple blocks and may have to be analysed separately in these blocks).



Hazard	Phase	Location
Naphtha	Liquid	10D001, 10P001A/B, 10C002, 10E008, 10B002, 10E005A/B, 10P003, 10P004A/B, 10D009, 10P005/6/7, 10E009, 10E011, 10E012, 12F001
H <sub>2</sub> + HCl (5ppm)	Vapour	10D010
Naphtha + H <sub>2</sub>	Mixed	10E001A-F, 10B001
Naphtha+H <sub>2</sub> +H <sub>2</sub> S (>1000ppm)	Mixed	10R001, 10E001A-F, 10C001, 10D002
Naphtha+H <sub>2</sub> +H <sub>2</sub> S (>1000ppm)	Mixed	10R001, 10E001A-F, 10C001, 10D002
Naphtha+Fuel gas	Vapour	10E006, 10E007, 10D004
DMDS (use only during start up)	Liquid	10T002
Fuel gas	Vapour	10D08, 12D009, 10B001, 10B002, 10D001, 12B001
Fuel oil	Liquid	10B001, 10B002, 12B001-5
High pressure steam (25 bars)		10E010, 10B001, 10B002, 12B001-005, 11E003, 11E006, 11E009
Hot & high pressure boiler feed water (115C, 30bars)	Liquid	10E001, 10E002
H <sub>2</sub> + H <sub>2</sub> S (>1000ppm)	Vapour	10K001, 10D003
Treated Light Naphtha	Liquid	11A001A/B
Isomerate	Liquid	11A001A/B, 11A002A/B, 11D001, 11P001A/B, 11C001, 11E006, 11E007, 11E008, 11E009, 11B001, 11E010, 11E011

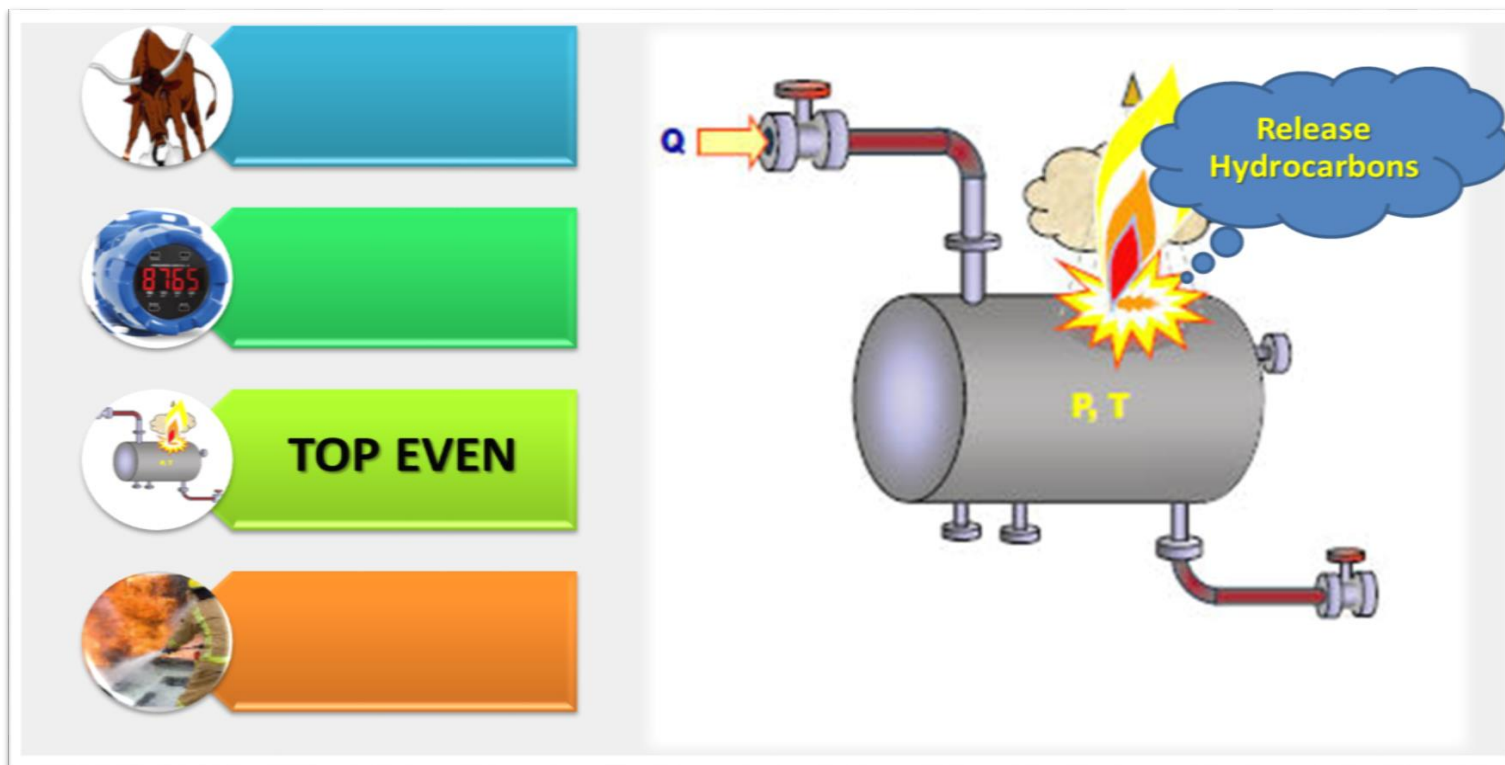


# Safety Critical Elements

SCE Classification (Bow Tie)

SCE Assessment

TOP EVEN

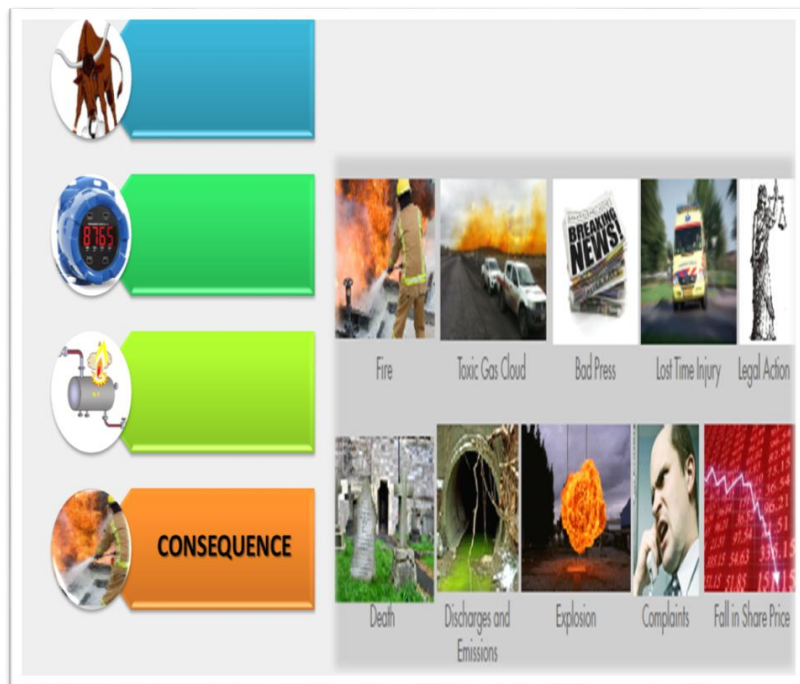


# Safety Critical Elements

## SCE Classification (Bow Tie)

### SCE Assessment

### CONSEQUENCE



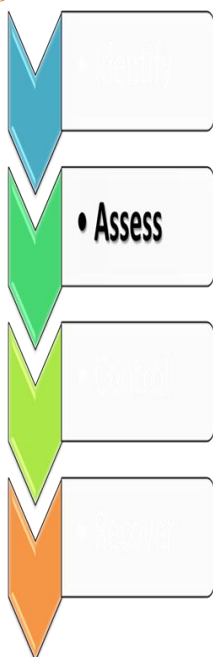
### Typical Major Hazards

- Hydrocarbons – fires/explosions/blowouts/oil spills
- Toxic materials – toxic releases
- Air/marine/land transport – helicopter/boat/road accidents
- Shipping activities – marine collision

# Safety Critical Elements

## SCE Classification (Bow Tie)

## SCE Assessment



**Hazards and Effects Register**

Hazard No.	Hazard	Location	Treats	Top Event	Consequences	Potential Risk P A E R	Control Measure ALARP Doc.	Comments
1	Shylene	OTU	External Corrosion	Loss of Containment	Gas leak	3B 4B 3B 4B	Process to Production	Include Remedial or
			Internal Corrosion					past incidents in this
			Impact Traffic					element that support
			Failure of Equipment		Fire	4B 5B 3B 4B	Route	to assessment
			Failure of Piping					
			Failure of Piping		Vapour Cloud Explosion	4B 5B 3B 4B	Route	
2	Pressure of	Side Valve	Not following work procedures	Loss of Control (LOC)	Leakage	4B 5B 3B 4B	Health & Safety	
3	Asbestos	Administration	Material not identified	Overexposure	Health Impairment	4B 5B 3B 4B	Health & Safety	
			Lack of work procedures					

### REMINDER: RISK ASSESSMENT

In the Risk Assessment stage of the HEMP process, we have learned about using the RAM to assess risks.

SEVERITY		CONSEQUENCES				INCREASING LIKELIHOOD				
		People	Assets	Environment	Reputation	A	B	C	D	E
						Never heard of in industry	Heard of in industry	Has happened in the organisation or more than once per year in the industry	Has happened at the location or more than once per year in the organisation	Has happened more than once per year at the location
0	No injury or health effect	No damage	No effect	No impact						
1	Slight injury or health effect	Slight damage	Slight effect	Slight impact						
2	Minor injury or health effect	Minor damage	Minor effect	Minor impact						
3	Major injury or health effect	Moderate damage	Moderate effect	Moderate impact						
4	FTD or up to 3 fatalities	Major damage	Major effect	Major impact						
5	More than 3 fatalities	Massive damage	Massive effect	Massive impact						

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Top Event	Consequences	Risk Potential				ALARP determination
		P	A	E	R	
Loss of containment (LOC)	Fire/explosion	4B	4B	3B	4B	
LOC	Fire/explosion	5C	5C	3C	4C	Bow Tie
LOC	Fire/explosion	5C	5C	3C	4C	Bow Tie
LOC	Fire/explosion	5C	5C	3C	4C	Bow Tie
LOC	Injury/fatality	4C	0C	2C	3C	
LOC	Fire/explosion	4C	4C	3C	4C	
LOC	Spill to water/land	0C	0C	3C	1C	
LOC	Fire/explosion	4C	4C	3C	4C	
LOC	Spill to water and/or land leading to minor impact on environment and reputation. Toxic to aquatic organisms.	0C	2C	2C	2C	
LOC	Injury/fatality	4C	2C	0C	1C	
LOC	Injury/fatality	4C	2C	0C	1C	
LOC	Fire/explosion	4C	5C	2C	3C	Bow Tie
LOC	Injury/fatality	4C	0C	2C	3C	
LOC	Fire/explosion	4B	4B	3B	4B	
LOC	Vapour Cloud Explosion, BLEVE	4B	4B	3B	4B	



# Safety Critical Elements

SCE Classification (Bow Tie)

SCE Assessment

## THREAT



Threat

- The pathway or mechanism which **enables or releases** the hazard to cause harm

Threat – that which enables / releases the hazard

- External Impact
- Overpressure
- High Temperature
- Runaway reaction
- Human Factors
- Other examples?



GTC



ptt  
ES



SCG  
CHEMICALS

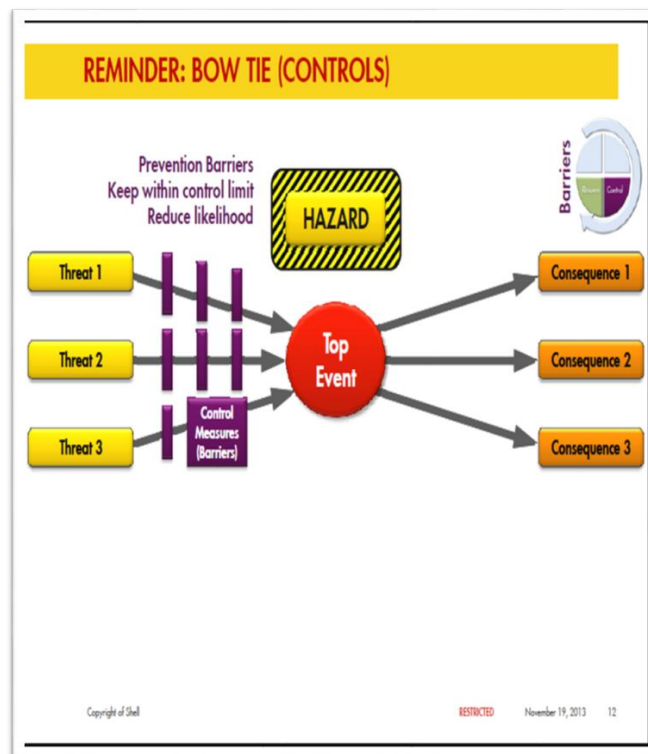
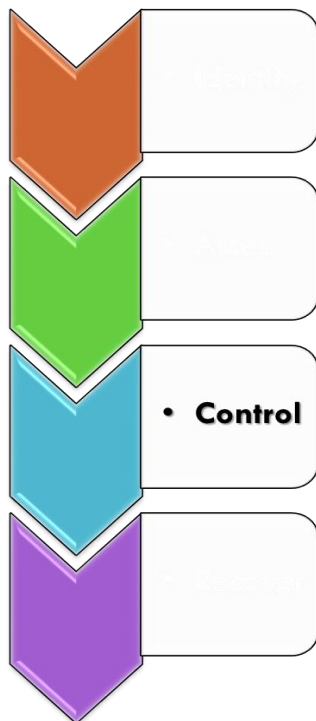
IRPC



# Safety Critical Elements

## SCE Classification (Bow Tie)

## SCE Assessment



### BOW TIE – BARRIER VALIDITY

- In order for a Barrier in a Bow Tie to be considered **valid** it must be: **Effective**, **independent** and **auditable**:
  - **Effective** – The Barrier prevents the consequence when it functions as designed (i.e. big enough, fast enough, strong enough. It must function as intended when intended). Active barriers must have a Sensor, Logic and Actuator.
  - **Independent** – The Barrier also needs to be independent of the initiating event (threat) as well as the components of any other Barrier already validated for the same condition. Barriers cannot be considered independent from one another if there is a Common Cause Failure.
  - **Auditable** – The Barrier can be evaluated to verify that it can operate correctly when it is called upon (e.g. inspection, testing and record keeping).
- In many cases, barriers are only **partially valid (PV)**. Therefore they need the assistance/support of another barrier to fully address the threat or consequence. When a PV barrier is found, an attempt should be made to combine it with a barrier that will make it valid.

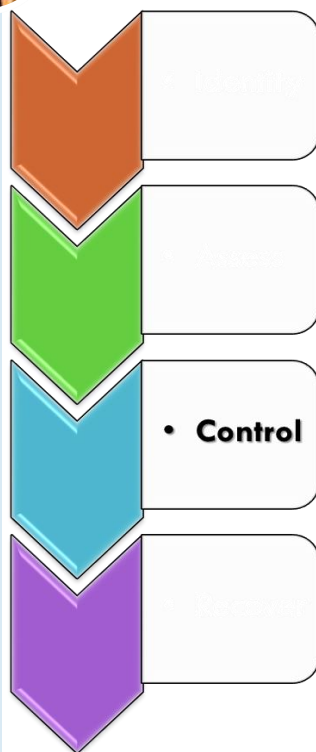




# Safety Critical Elements

## SCE Classification (Bow Tie)

### SCE Assessment



#### BARRIER VALIDITY – EFFECTIVENESS

- In order for a Barrier to be considered **valid**, it must be **effective**:
  - The Barrier prevents the consequence when it functions as designed:
    - big enough,
    - fast enough,
    - strong enough.
  - A barrier must be protected from the consequences of the release of another hazard and perform as intended when impacted by another threat condition.
- For instance, a boundary isolation valve must be protected from fires and explosion either by its location or by a protective enclosure.



#### BARRIER VALIDITY – AUDITABILITY (EXAMPLES)

- In order for a Barrier to be considered **valid**, it must be **auditable**:
  - Level Float – normally runs to failure and is then repaired. This does not meet the requirements of auditable.
  - Level Float – is tested on a yearly (or other set frequency) basis, then determine if it meets the required reliability criteria\*. This does meet the requirements of auditable – test records for the instrument are maintained in a system.



#### BARRIER VALIDITY – INDEPENDENCE

- In order for a Barrier to be considered **valid**, it must be **independent**:
    - The Barrier is independent of the initiating event of the threat as well as the components of any other Barrier already validated for the same condition.

Example: Tank inventory management is not a valid barrier when the threat is overfill due to mistakes in the dipping of the tank.

  - The Barriers cannot be considered independent from one another if there is a Common Cause Failure.
- Example: The high level alarm and the high-high level alarm are on the same transmitter, therefore they are not independent.

**Note:**  
Loss of Power, Loss of Steam, Loss of Air don't affect independence as they usually result in total shutdown of plant equipment. There may be exceptions to this however (e.g. Ship-shore or pipeline transfer operations)





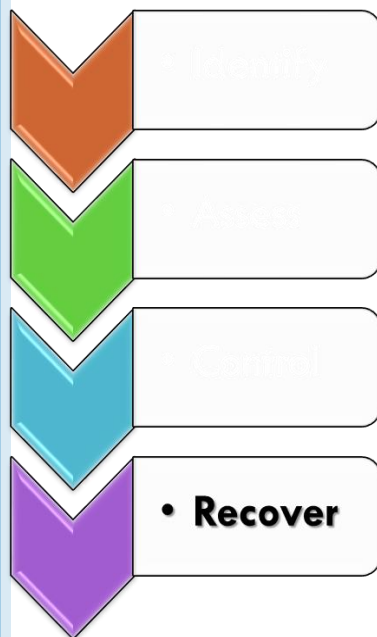
# Safety Critical Elements



## SCE Classification (Bow Tie)



## SCE Assessment

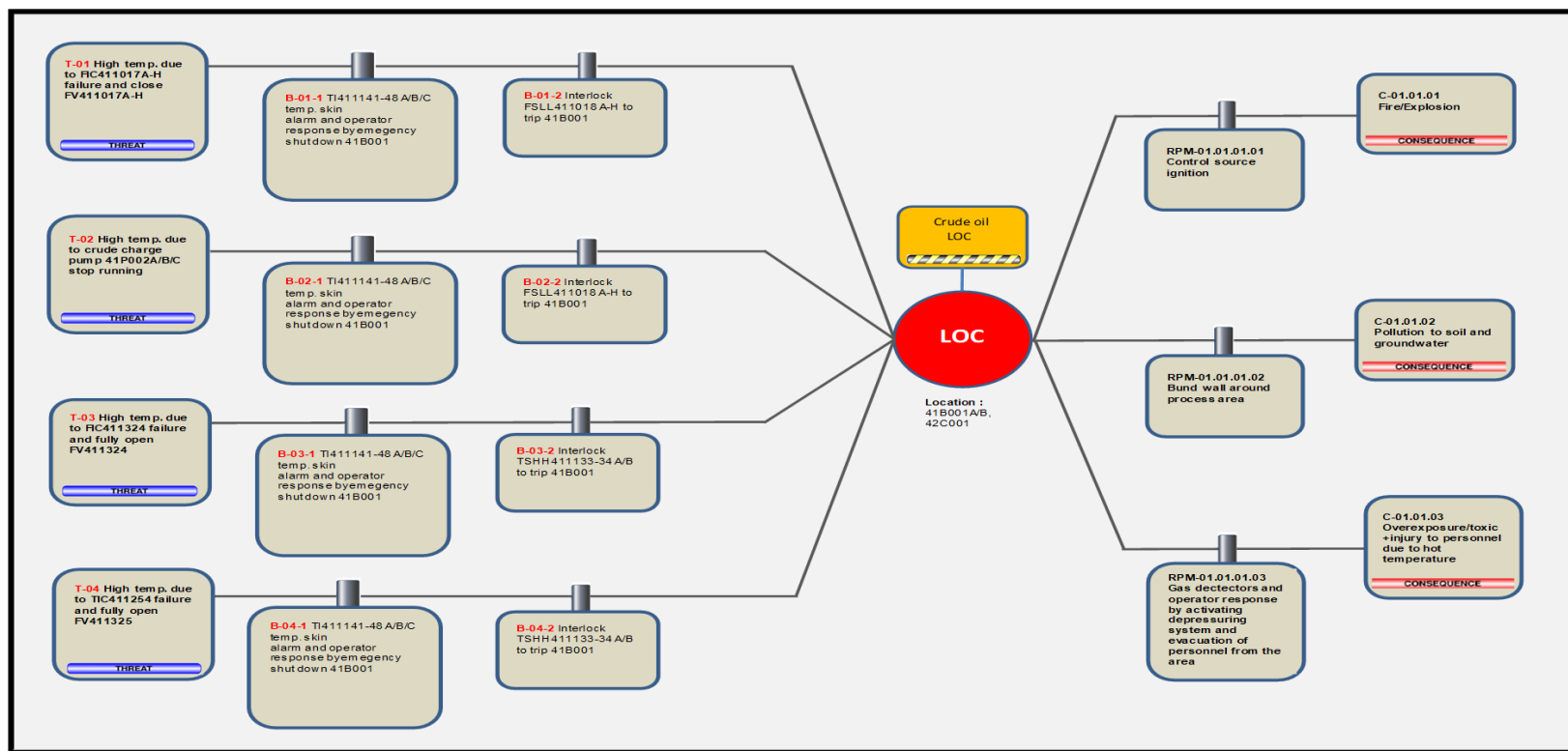


- Fire Pump
- UPS
- Fire & Gas System
- Diesel Gen
- Deluge system
- EIV System

# Safety Critical Elements

## SCE Classification (Bow Tie)

## SCE Assessment



# Safety Critical Elements

Implement SCE Outcome

SCE Gap Closing

**SCE Gap:**

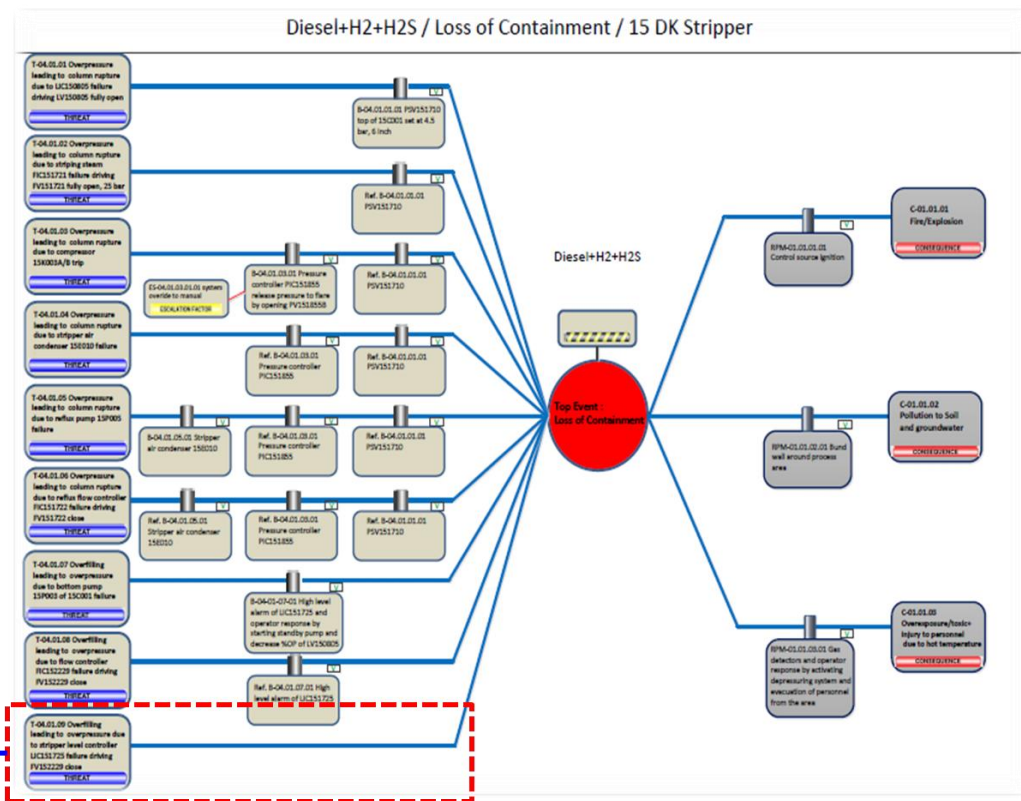
**– Add Equipment ???**



**Hazop**

**SIL  
Assessment**

**Other**



# Safety Critical Elements

## Implement SCE Outcome

### Task and Test interval

#### List of Safety Critical Equipments and Critical Human Interventions

Location: 02C001, 02E001A/B, 02D001, 02E002A/B, 02D002, 03D001

Bow Tie Reference	Threat Detail	Barrier	SCE Tag Numbers	Escalation Factor	Critical Human Intervention
T-07.01.01	Overpressure due to FIC020106 failure to close FV020610	B-07.01.01.01 High pressure alarm of PT020103 at 1.25 barg and operator response by opening reflux valve FV020610 (N)	PT020103		
		B-07.01.01.02 Pressure controller PIC020732 at SP 0.55 barg by open PV 020732A releasing pressure to flare	PIC020732	B-07.01.01.02.01 System override to manual	
		B-07.01.01.03 PSV020101 and PSV020121 Top of 02C001 set at 4.4 bar, 10x8 inch and 10x6 inch, PSV020102 and PSV020122 Top of 02C001 set at 4.5 bar and 4.7 bar, 10x6 inch and 10x8 inch.	PSV020101 10x8 inch PSV020121 10x6 inch PSV020102 10x6 inch PSV020122 10x8 inch		

### Task



### SOP





# Safety Critical Elements

Implement SCE Outcome

SCE Gap Closing

Location : 41E001A/B,  
41E002-7, 41E008A/B,  
41D001/2, 41E009,  
41D007, 41P002A-C,  
41E010-12, 41E013A/B,  
41E023, 41E024A/B,  
41E014A/B/E/F

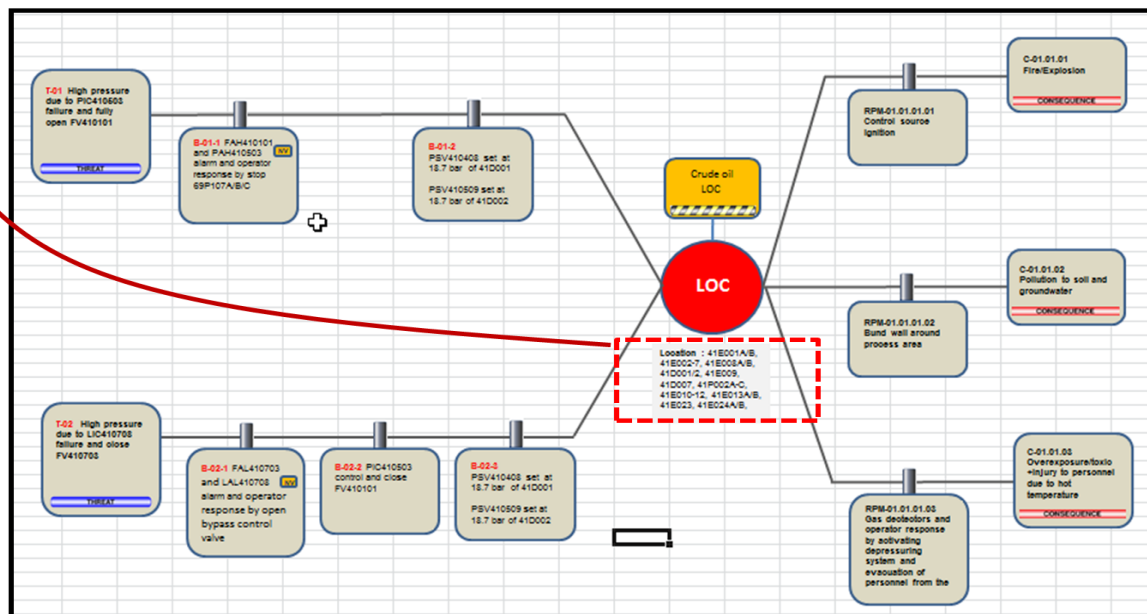
**RBI TEAM**

**SCE ↔ Corrosion  
(High)**

**Failure Mode**

**Bow - Tie**

## Implement SCE + Corrosion (RBI)



# Safety Critical Elements

Implement SCE Outcome

Implement on SAP

EQ (t-code:ie02)

**Change Equipment : General Data**

Class overview Measuring points/counters

Equipment DCC-31K001-BV1 Category I Instrument

Description BOOT VALVE OF 31K001-MOTOR (SCE) Intern.note

Status INST

Valid From 23.09.2016 Valid To 31.12.9999

General Location Organization Structure Class and Docs SerData Warranty and Partner

**General data**

Class CONTROL\_VALVE Control valve

Object type VALVE VALVE

Author/Group

Weight Size/dimension

Inventory no. Start-up date 01.01.2007

**Reference data**

Acquist/Value Acquisition date

**Manufacturer data**

Manufacturer EXPO SAFETY Manu/Country

Model number 150/BOOT VALVE Consty./mth

ManuPartNo.

ManuSerialNo.

**IRPC**

IRPC Public Company Limited

Work Order No.: 10364946 : Repair Case อุปกรณ์

Order Type : PM01 : Maintenance Unplanned Work

Sub Order Number:

Superior Order No. Standing Order No. (for Recodition):

Notification no.: 10429678 Notification Type : M1 IRPC Maint. Request

Functional Location : CLD1-43 -T4301 -DV01 : DELUGE VALVE SYSTEM (SCE)

Equipment No. Serial No. :

Equipment ABC Indicator :

Work Description : Repair อุปกรณ์

Reported Date : 10.10.2016

Reported by : 3574

Planner Group : 14E

Work Center : 14E-HTC1

Maint. Act. Type : Corrective Maintenance

Issue By :

Priority : 15 days finish

Malfunction Start : 10.10.2016

Basic Start : 10.10.2016

Basic Finish : 25.10.2016

**Planned Operation** Purchaser Requisition No. :

Op	CtrlKey	Description	MH	Number	Duration	Unit	Act Type
0010	PM01	Repair SCE Case	0	0	0	H	134041

**Component** Reservation No. :

Item	Opa	Component	Description	Qty	Unit	SLoc	Batch

**Maintenance Approval**

PM SUPER	1st Approve	2nd Approve	Order Approve/Recodition Order Approve ( for Production )

Safety Permit / ใบอนุญาตทำงานปลอดภัยที่จะใช้

☐ Hot Work Permit ☐ Confined Space Permit

ห้ามเข้าใกล้การทำงานหรือซ่อมบำรุงและเครื่องจักรต่างๆ ที่มีความเสี่ยงต่อการเกิดอุบัติเหตุ

ก่อนแล้ว เห็นว่า ปลอดภัยสามารถดำเนินการได้

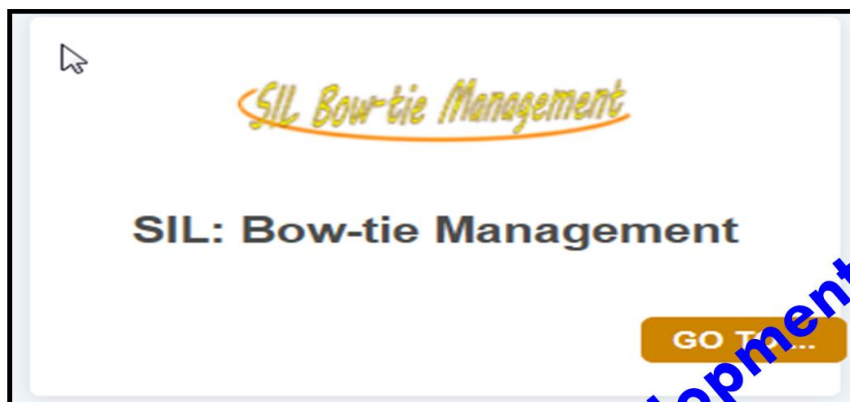


# Safety Critical Elements

## SCE Development Program

### Program Development

#### Program Bow Tie Management



#### Program SCE Postpone Management

Postpone No.	Order Number	Plant	FL No.	EQ No.	Description	Type	Condition	Plan Month	Postpone Month	BY	Risk Level	Status
P-014	11	PLEH	SAN1-GAS_DETECT	SAN1-TY28102	Smoke&Fire Detector	M	P	09/2018	10/2018	scs ve shesawf	L	Waiting for appn
P-014	11	PLEH	SAN1-GAS_DETECT	SAN1-TY28102	Smoke&Fire Detector	M	P	09/2018	10/2018	scs ve shesawf	L	Waiting for appn
P-016	11	PLEH	SAN1-GAS_DETECT	SAN1-TY28102	Smoke&Fire Detector	M	P	09/2018	09/2018	scs ve shesawf	M	Waiting for appn
P-017	11	PLEH	SAN1-COR	SAN1-TY28101	Smoke&Fire Detector	M	O	09/2018	11/2018	scs ve shesawf	M	Waiting for appn
P-020	1	PLEH	SAN1-28	SAN1-TY28101	Control&Alarm	P	O	10/2018	11/2018	scs ve shesawf	M	Waiting for appn
P-024	10220020	IRRE	PP-65-ESP001A	GA-SW-008	PSV	P	P	03/2018	6/2018	scs ve shesawf	M	Waiting for appn
P-026	11111111	IRRS	VGOH-DUMBY	UTF-78F005	ESD	P	P	12/2018	3/2019	scs ve shesawf	M	Waiting for appn

Development Program





**Thank you for your attention**

