

Assuring Low Engineering and Safety Risks During a Project and Beyond

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Types of Risk

- Safety
- Environmental
- Economic
- Reputation
- (Regulatory)



What is risk?

A function of **CONSEQUENCE** and **PROBABILITY**

If the potential **CONSEQUENCE** is high, the actual risk may be unacceptable



L
I
K
E
L
I
H
O
O
D

(10⁻¹)

A

Moderate

High

CR

CR

(10⁻²)

B

Low

High

CR

CR

(10⁻³)

C

Low

Moderate

High

CR

(3x
10⁻⁵)

D

Low

Low

Moderate

High

(10⁻⁶)

E

Low

Low

Low

Moderate

1

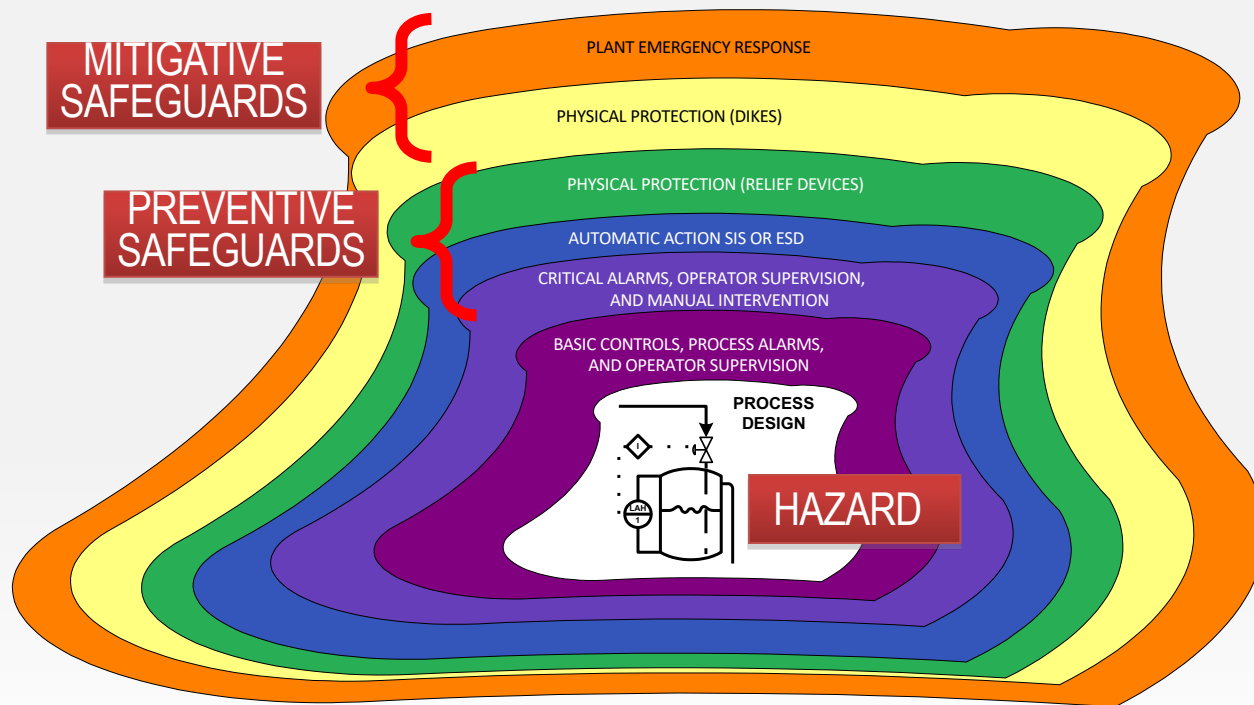
2

3

4

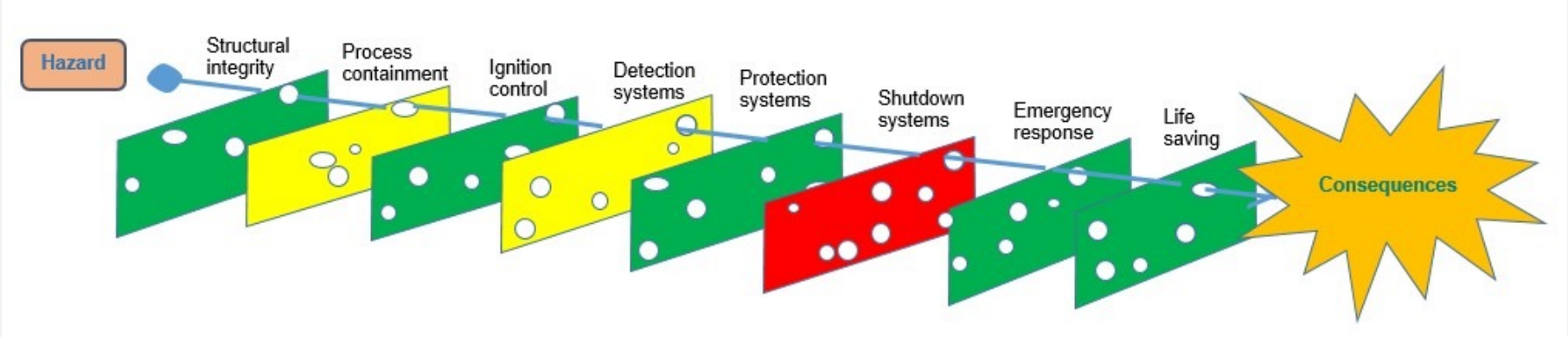


Layers of Protection



Source: CCPS, Layer of Protection Analysis, copyright 2001 AIChE.





Safety Studies

PHA (HAZOP)

Cause → Safeguards (Barriers) → Consequence

team determines Probability



Risk



Safety Studies

LAYERS OF PROTECTION ANALYSIS (LOPA)

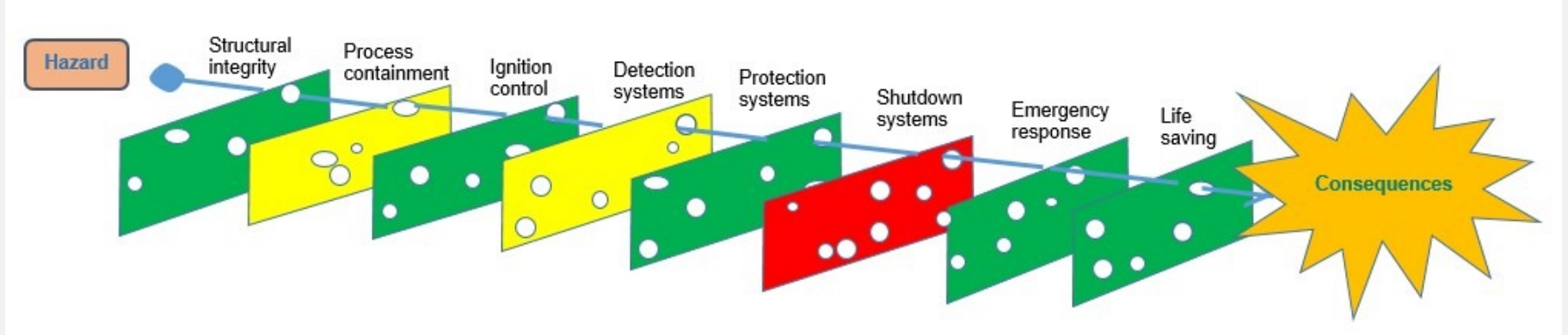
Cause → Safeguards (Barriers) → **Consequence**



Layers of Protection
Calculation of **Probability**

Risk





- Independent
- Effective
- Auditable

Independent Layer of Protection – IPL → instrumentation loop
part of the SIS



Safety Integrity Level - SIL

SIL	RRF	IEC 61511
1	10^{-1}	Proof tests
2	10^{-2}	Proof tests
3	10^{-3}	Proof tests
4	10^{-4}	Proof tests

Process Safety Time



Crucial for Maintaining Low Risk

- Facility Siting
- Management of Change
- Hazards and Risk Register





Your
Logo

Houston, TX

MANAGEMENT OF CHANGE MOC

MOC Workflow

Re-Login

Prefer
ences

?

Current User: Art Gonzalez with [Full Access] privileges

Environment: Local



View MOC List



View MOC No.

select



Reports



Metrics



NEW Regular Checklist

Detailed Instructions



NEW Project Checklist

Detailed Instructions



Your Logo

Houston, TX

MANAGEMENT OF CHANGE MOC

MOC Workflow

Current User: Art Gonzalez with [Full Access] privileges

Environment: Local

Re-Login

Preferences

?



View MOC List



View MOC No.

select



Reports



Metrics



NEW Regular Checklist

Detailed Instructions



NEW Project Checklist

Detailed Instructions



MOC Form

MOC number OD-3

MOC start 12/ 6/13

MOC Title

MOC Type **PAST DUE!**

Coordinator Art.Gonz Dept/Unit/Area

Temporary MOC yes no

Document/Ref. Equipment

Target Completion

12/31/15

Enter Date Extend

Description of the change (include technical basis for the change)

Hazards Register Link: None

This involves the addition of a parallel purification train to achieve the capacity. With recent improvement in the chemistry, the number of batches per day can be increased to four without modifications to the reactor. Additional feed and product tanks will also be required. PHA to be performed.

The checklist below and the MOC have been partially approved

Checklist	Approval	PSSR		
Items (6) Required (5)	Actions/Comments	Assignee/ Actual		
		Action Complete		
		Files		
Piping group review <input checked="" type="checkbox"/>	Check conflicts in piping routing. 3-D printout attached.	Coord, Elaine Jack	<input checked="" type="checkbox"/> 2/11/18	<input type="button" value="email"/> <input type="button" value="Insert"/> <input type="button" value="View"/>
Commissioning Review <input type="checkbox"/>	FYI. Please review for needs, potential problems.	Demo, Joe	<input type="checkbox"/> 7/27/16	<input type="button" value="email"/> <input type="button" value="Insert"/> <input type="button" value="View"/>
Process Engr. review <input checked="" type="checkbox"/>	Review potential for inadvertent mixing in changing batches.	Hand, Edward Jack	<input checked="" type="checkbox"/> 2/11/18	<input type="button" value="email"/> <input type="button" value="Insert"/> <input type="button" value="View"/>
Project review <input checked="" type="checkbox"/>	Review potential delays.	Gonzalez, Art	<input type="checkbox"/> 7/27/16	<input type="button" value="email"/> <input type="button" value="Insert"/> <input type="button" value="View"/>
Client review <input checked="" type="checkbox"/>	Add client comments.	Harding,	<input type="checkbox"/> 7/27/16	<input type="button" value="email"/> <input type="button" value="Insert"/> <input type="button" value="View"/>
Project Management <input checked="" type="checkbox"/>	Approval required.	Approver,	<input type="checkbox"/> 7/27/16	<input type="button" value="email"/> <input type="button" value="Insert"/> <input type="button" value="View"/>



MOC Title: Expansion of Ethoxylates Unit by 30% Target Completion: 12/31/15
 MOC Type: Construction Change **PAST DUE!**
 Coordinator: Art Gonzalez Art.Gonz <- CHANGE Dept/Unit:
 Temporary MOC: yes no
 Document/Ref.: P&ID 62233 Equipment: Ethoxylates Purification

Fully Searchable!

Description of the change (include technical basis for the change) Hazards Register Link: None
 This involves the addition of a parallel purification train to achieve the capacity. With recent improvement in the chemistry, the number of batches per day can be increased to four without modifications to the reactor. Additional feed and product tanks will also be required. PHA to be performed.

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Commissioning Review <input type="checkbox"/>	FYI. Please review for needs, potential problems.	Demo, Joe	<input type="checkbox"/> 7/27/16	email Insert View
Process Engr. review <input checked="" type="checkbox"/>	Review potential for inadvertent mixing in changing batches.	Hand, Edward Jack	<input checked="" type="checkbox"/> 2/11/18	email Insert View
Project review <input checked="" type="checkbox"/>	Review potential delays.	Gonzalez, Art	<input type="checkbox"/> 7/27/16	email Insert View
Client review <input checked="" type="checkbox"/>	Add client comments.	Harding,	<input type="checkbox"/> 7/27/16	email Insert View
Project Management <input checked="" type="checkbox"/>	Approval required.	Approver,	<input type="checkbox"/> 7/27/16	email Insert View



MOC Title:

MOC Type: **Construction Change**

Coordinator: Dept/Unit/Area:

Temporary MOC: yes no

Document/Ref.: Equipment:

Description of the change (include technical basis for the change): Hazards Register Link:

Target Completion

 Enter Date Extend

PAST DUE!

The checklist below and the MOC have been partially approved

Checklist Approval PSSR

Approval Levels: Current Approvals:

Final Approver: Final Approval on:

Required Approver: ✓

No.	Approver	Function	Date	
1	Julius Approver	Disc. Manager	3/30/2016	✗
2	Jack	Project Manager	5/15/2016	✗

MOC Title: Expansion of Ethoxylates Unit by 30%

MOC Type: **Construction Change** PAST DUE!

Coordinator: Art Gonzalez Art.Gonz <- CHANGE Dept/Unit/Area: Process Engr.

Temporary MOC: yes no

Document/Ref.: P&ID 62233 Equipment: Ethoxylates Purification

Target Completion: **12/31/15**
Enter Date Extend

Description of the change (include technical basis for the change): Hazards Register Link: None

This involves the addition of a parallel purification train to achieve the capacity. With recent improvement in the chemistry, the number of batches per day can be increased to four without modifications to the reactor. Additional feed and product tanks will also be required. PHA to be performed.

The checklist below and the MOC have been partially approved

Checklist	Approval	PSSR												
<p>Checklist completed on <input type="text"/></p> <p>Project completed on <input type="text"/></p> <p style="text-align: center;">Complete before start up or activation of the change:</p> <p style="text-align: center;">Changes have been reviewed. Enter "yes" or "N/A"</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 16.6%;">In Accordance with Specs</th> <th style="width: 16.6%;">Procedures in Place</th> <th style="width: 16.6%;">PHA Completed</th> <th style="width: 16.6%;">S/U Shift Trained</th> <th style="width: 16.6%;">Verifier Full Name</th> <th style="width: 16.6%;">Date</th> </tr> </thead> <tbody> <tr> <td style="height: 30px;"></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> </tbody> </table> <p>Optional PSSR File <input type="text"/> Insert View</p> <p style="text-align: right;">DATES</p> <p style="text-align: right;">Complete <input type="text"/></p>			In Accordance with Specs	Procedures in Place	PHA Completed	S/U Shift Trained	Verifier Full Name	Date						
In Accordance with Specs	Procedures in Place	PHA Completed	S/U Shift Trained	Verifier Full Name	Date									



Houston, TX							Dates						
Sort by Coordinator							MOC Start	Target	MOC Approve	Chklst Done	Project Done	Change Done	Post Chklst Done
No.	Dept	MOC Title	Type	Tmp.	MOC Start	Target	MOC Approve	Chklst Done	Project Done	Change Done	Post Chklst Done		
Coordinator: Approver, Julius													
	OD-6	Maintena	Re-range PT-19, T-34 receiver's	Regular	TEMP	1/31/14	7/30/16	8/13/13	8/15/13			!	
Coordinator: Coord, Elaine													
	OD-37	Liquefact	Test moc that signifies that things	Regular	TEMP	6/ 2/16	5/ 3/17					!	
	OD-42		Test of MOC Type requirements	Regular		6/ 5/16	10/15/16					!	
	OD-45	Admin	Test June 29	Regular		6/29/16	2/15/17	7/ 5/16	1/17/18	1/17/18		!	
	OD-59	Operatio	LOTO locks location change	Regular		3/ 1/17	3/15/17					!	
Coordinator: Coordin, James													
	OD-8	Process	For Metrics Illustration	Regular		5/22/15	8/16/15	5/26/15	5/30/15	10/ 1/15	11/ 1/15		
	OD-11	Process	For Metrics Illustration	Regular		4/25/15	8/23/15	5/ 2/15	6/15/15	10/22/15	12/17/15		
	OD-12	Process	For Metrics Illustration	Regular	TEMP	6/10/15	10/ 8/15	9/ 1/15	9/11/15	10/ 1/15	10/ 7/15		
	OD-23	Operatio	For Metrics Illustration	Regular		4/15/14	11/28/15	10/30/11	1/10/15	6/ 1/15	11/28/15		
	OD-27	Process	For Metrics Illustration	Regular		4/27/15	6/29/15	6/29/15	6/30/15	7/10/15	8/11/15		
Coordinator: Demo, Joe													
	OD-2	Maintena	Installation of leak clamp in RX-12	Regular	TEMP	10/11/14	4/12/15	3/30/16	6/15/16	11/30/16	12/30/16		
	OD-4	Maintena	Replacement of pump P-237 with	Regular		12/29/13	1/29/16	11/30/14	12/ 1/14	1/ 1/15	1/11/15		
	OD-7	Process	Replace T-87 base p CANCELLED	Regular	TEMP	2/21/14	5/20/15				4/ 3/14		
	OD-10	Process	For Metrics Illustration	Regular		5/20/15	9/15/15	5/31/15	6/13/15	11/ 1/15	12/ 7/15		
	OD-44		Test after changing workflow	Regular		6/19/16	12/ 1/16	7/10/16	10/10/16			!	
Coordinator: Gonzalez, Art													
	OD-1	Process	Addition of 6 trays to Distillation	Regular		9/27/14	5/13/16	7/ 5/16	7/ 7/16	7/16/16	7/16/16		
	OD-3	Process	Expansion of Ethoxylates Unit by	PROJECT		12/ 6/13	12/31/15					!	
	OD-5	Process	Update of site Emergency Manual	Regular		1/ 7/14	7/12/15					!	
	OD-9	Process	For Metrics Illustration	Regular		4/25/15	8/23/15	11/30/11	12/10/15			!	

↑ Click to see more information for an MOC



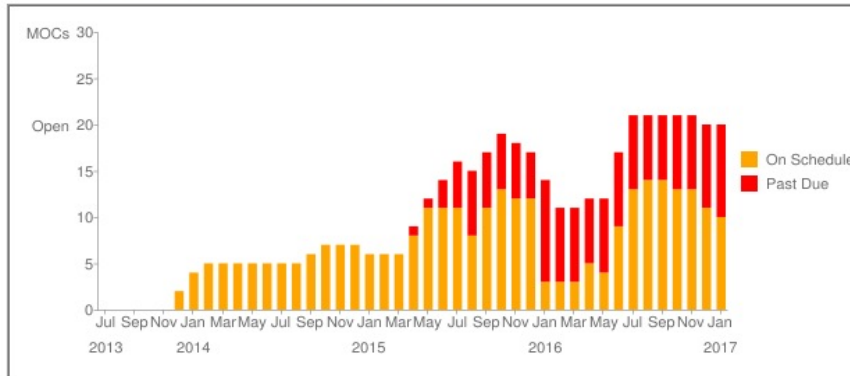
Metrics

Interval start: 7/20/2013
Interval end: 1/31/2017

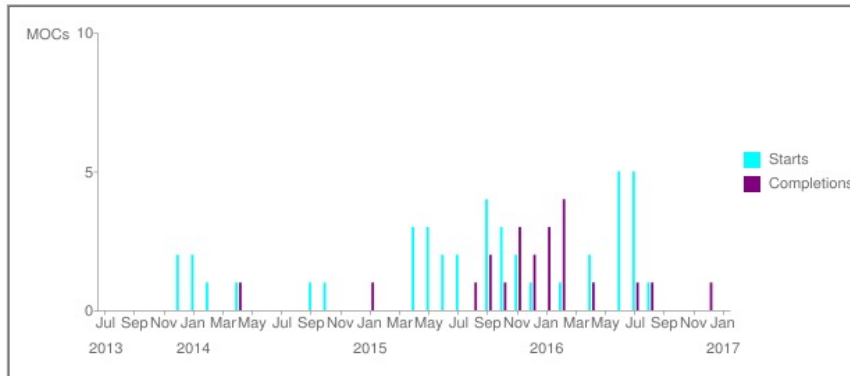


CLOSE

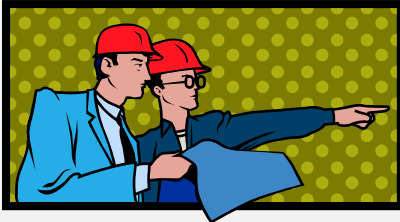
Open MOCs Show Past Due MOCs



Starts and Completions



Where is the information?



- P&IDs
- Cause and Effect table or Control Schemes
- PHA/LOPA reports
- MOC database
- Instrument database
- Equipment database
- Procedures

Where is the correct information?



Can you find it?



The Hazards and Risks Register

- Cause-consequence pairs
- Safeguards/IPLs (values)
- Recommendations
- Resolutions (history)
- Status
- Metrics



HAZARDS REGISTER
CO Production

Total Items: 4454 [Shown: 2]
Open: 7 (0%) [1]
Deferred: 237 (5%) [] **Past Due:** 258 (6%) [1]
MOC: 14 (0%) []
Closed: 4196 (94%) [1]

Items with Action Plans: 1704 [2]
With Action: 1654 (97%) [2] **Open:** 183 (11%) [1]
Past Due: 183 (11%) [1]


Recommendations

 New
  Delete
  Show All
  Find
  XLS
  PDF
  Print

ID	Source Study	Consequence (Hazard)	System	Sub-system	Cause	Cons Type	Safeguards/IPLs	IPLs	PFDs	Prob	Mitigated Risk	Risk	Reference	PFID Gap	Action Plan (Recommendation)	Owner	Target Date	History	Action/Resolution	
2646	EPC CO Purification LOPA May 2017	Potential loss of containment with potential fire	CO Production	4 Cold Box	Thermal stress of the plate fin heat exchanger (HEX -76) during startup and shutdown or upsets resulting in fatigue failure, generating a leak	3	Safety and Health			.001	M		P&ID 2531	.03	1270. (7) See Cold Box HAZOP Recommendations 12 and 13 (differential temperature alarming and temperature trending). 1271. (8) Verify fatigue life (PFD/MTBF) of heat exchangers, e.g., how many cycles until the exchanger fails. 1272. (9) Assure O&M procedures address and that operators are trained to operate the exchangers in a way that prevents overstressing (i.e. heat up and cool down rates). See Liquefaction HAZOP	Process	10/18/17	*	TI-83 added to DCS and addition of TDI-243 and TDI-244 with rate of change alarms to alert panel operator.	
	Link			Deviation	Freq Initiating Event 1.0E-2 Freq Enabling Event 1 Freq Init Modifier 0.1 Vendor confirmed only			4Thermal stress of the plate fin heat exchanger (HEPotential loss of containment with potenSafety3												
2652	EPC CO Purification LOPA May 2017	Potential loss of containment inside the cold box resulting in rupture of the cold box and dispersal of perlite insulation and cold vapor/liquid	CO Production	6 Cold Box	Thermal stress of the plate fin heat exchanger (HE -672) during startup and shutdown or upsets resulting in fatigue failure or mechanical defect, generating an external leak.	4	Economic	2) Gas detectors in the area tied to the SIS initiate area shutdown 1) Multiple shift operators monitoring restart procedures.	2) 1.0E-1 1) 1.0E-1	.0001	H		P&ID 2531	.01	1282. (7) See Cold Box HAZOP Recommendations 12 and 13 (differential temperature alarming and temperature trending). 1283. (8) Verify fatigue life (PFD/MTBF) of heat exchangers, e.g., how many cycles until the exchanger fails. 1284. (9) Assure O&M procedures address and that operators are trained to operate the exchangers in a way that prevents overstressing (i.e. heat up and cool down rates).	Process	10/18/17	*	TI-83 added to DCS and addition of TDI-243 and TDI-244 with rate of change alarms to alert panel operator. TDI-243 and TDI-244 with independent local indication are monitored by multiple outside operators during start up as a standard operating procedures	
	Link			Deviation	Freq Initiating Event 1.0E-2 Freq Enabling Event 1 Freq Init Modifier 0.1 Vendor confirmed only			6Thermal stress of the plate fin heat exchanger (HEPotential loss of containment inside theEConot4												



FileMaker Pro Advanced

File Edit View Insert Format Records Scripts Tools Window Help

CO Production Plant Hazard Register 3/13

Hazard Items

change project

View Register

2 record(s)

2

New Delete Show All Find XLS

Item **2652** Consequence Level: **4** Type: **Economic** Study Type: **LOPA** Link Wsh:

Topic: **CO Production** Subtopic: **Cold Box**

Consequence/Hazard:

Potential loss of containment inside the cold box resulting in rupture of the cold box and dispersal of perlite insulation and cold vapor/liquid

Cause/Reason:

Thermal stress of the plate fin heat exchanger (HE-672) during startup and shutdown or upsets resulting in fatigue failure or mechanical defect, generating an external leak.

Action Plan:

1282. (7) See Cold Box HAZOP Recommendations 12 and 13 (differential temperature alarming and temperature trending). Ref.: P&ID 2531

1283. (8) Verify fatigue life (PFD/MTBF) of heat exchangers, e.g., how many cycles until the exchanger fails. Risk Rank: **H**

1284. (9) Assure O&M procedures address and that operators are trained to operate the Target date: **10/18/2017**

Resolution:

TI-83 added to DCS and addition of TDI-243 and TDI-244 with rate of change alarms to alert panel operator. Owner: **Process**

TDI-243 and TDI-244 with independent local indication are monitored by multiple outside operators during start up as a standard operating procedures. Doc.: **1282. MOC 110**

Status: **Open**

Date Entered: 10/8/2014

Safeguards/IPLs Recommendations Actions Comments

Freq.	Init. Event	Enabling Event	Freq Init Modifier	Total Event
1.0E-2		1	0.1 Vendor confirmed only harmful after	1.0E-6
Safeguard/IPL		Type	IPL pfd	SIL Rec
1	TI-52 added to DCS and addition of diff TDI-88 and TDI-89	IPL	1.0E-1	<input checked="" type="checkbox"/>
11633				
2	Gas detectors in the area tied to the SIS initiate area shutdown	IPL	1.0E-1	<input type="checkbox"/>
11740				
1	Multiple shift operators monitoring restart procedures.	IPL	1.0E-1	<input type="checkbox"/>
12276				



Status: **Open**

Date Entered: 10/8/2014

Safeguards/IPLs Recommendations Actions Comments

Freq. Init. Event Enabling Event Freq Init Modifier Total Event
 1.0E-2 1 0.1 Vendor confirmed only harmful after 1.0E-6

Safeguard/IPL	Type	IPL pfd	SIL	Rec
1 11633 TI-52 added to DCS and addition of diff TDI-88 and TDI-89	IPL	1.0E-1		<input checked="" type="checkbox"/>
2 11740 Gas detectors in the area tied to the SIS initiate area shutdown	IPL	1.0E-1		<input type="checkbox"/>
1 12276 Multiple shift operators monitoring restart procedures.	IPL	1.0E-1		<input type="checkbox"/>

11633				
2 11740	Gas detectors in the area tied to the SIS initiate area shutdown	IPL	1.0E-1	<input type="checkbox"/>
1 12276	Multiple shift operators monitoring restart procedures.	IPL	1.0E-1	<input type="checkbox"/>



Project ID	Item ID	IPL ID	IPL type	n_ID_IPL	IPL/Safeguard Description	IPL pfd	From Rec. SIL	IPL or Safeguard			
3	2671	11455	CO Production	LOPA	HAZOP Link 313	2	Relief to flare via PIC-79B through PV-79B	1.0E-1	created 4/14/2015 modified 10/2/2018	IPL	.1
3	2645	11626	CO Production	LOPA	HAZOP Link 198	1	TI 5352 added to DCS and addition of TDI 5238 and TDI 5352	1.0E-1	created 4/14/2015 modified 5/15/2015	IPL	.1
3	2646	11627	CO Production	LOPA	HAZOP Link	1	TI-88 added to DCS input and diff. TDI-83 and TDI-93 also added	1.0E-1	created 4/14/2015 modified 9/29/2018	IPL	.1
3	2647	11628	CO Production	LOPA	HAZOP Link 208	1	TSLL5258 shuts down the Lean Gas Booster Compressor 5K501	1.0E-2	created 4/14/2015 modified 1/27/2016	IPL	.01
3	2647	11629	CO Production	LOPA	HAZOP Link 208	2	TSLL-219 closes XV-35, XV-91 and XV-92	1.0E-1	created 4/14/2015 modified 10/2/2018	IPL	.1
3	2652	11633	CO Production	LOPA	HAZOP Link	1	TI-52 added to DCS and addition of diff TDI-88 and TDI-89	1.0E-1	created 4/14/2015 modified 9/29/2018	IPL	.1
3	2654	11634	CO Production	LOPA	HAZOP Link 238	1	TI-352 added to DCS and addition of TDI-238 and TDI-89	1.0E-1	created 4/14/2015 modified 10/2/2018	IPL	.1
3	2657	11636	CO Production	LOPA	HAZOP Link 258	1	PSHH-73 closes XV-76 on steam line	1.0E-1	created 4/14/2015 modified 10/2/2018	IPL	.1



The Hazards Register

- Searchable (cause/consequence)
- Searchable (protections – how many, how good)
- Searchable (what did we recommend?)
- Searchable (cause and effect, in how many places?)
- Why? (why was it there in the first place?)
- Why? (why was it changed?)
- Who?
- When?



The Hazards Register

- Uniqueness of data
- Communicate
- Export data
- Track your open action items
- Track your critical maintenance



Maintain your safeguards

- Know where they are
- Know what they do
- Know where they come from!

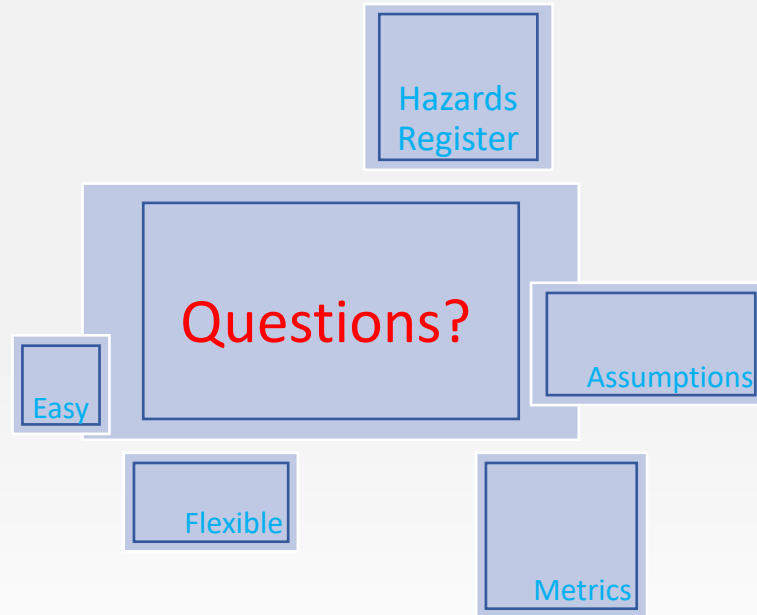


The Hazards Register

Does it work?



jc@knowledge1.net



Safety Analyses

Conduct a good safety analysis

- Have **COMPETENT** people do the analysis

