PROCESS HAZARD ANALYSES (PHA) & HAZARD REVIEWS (HR)

CONTRA COSTA HEALTH SERVICES HAZARDOUS MATERIALS PROGRAM

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TABLE OF CONTENTS

AFFECTED PROGRAMS

CalARP Program Level	Hazard Review	Process Hazard Analysis
Program 1	No	No
Program 2	**Yes**	No
Program 3	No	**Yes**
Program 4	No	**Yes***

WHAT SHOULD BE IN A HR/PHA

Program 2 (19 CCR § 2755.2)

- What the HR should include:
  - Hazards of the process/regulated substances
  - Potential accidental releases (human error, equipment malfunction)
  - Safeguards implemented
  - Methods of detecting releases
- HR should also include external events, including seismic events

Program 3 (19 CCR § 2760.2)

- What the PHA should include:
  - Hazards of the process
  - Engineering and administrative controls (and what happens if they fail)
  - "A qualitative evaluation of a range of the possible safety and health effects of failure of controls"
  - External events, including seismic events
  - Human factors
  - Stationary source siting
  - Identification of previous incidents

OTHER HR/PHA REQUIREMENTS - COMMONALITIES

Program 2 (19 CCR § 2755.2)

- HRs shall be documented and identified problems are resolved on a timetable the UPA has agreed to (max 2.5 years or next turnaround)
- HRs shall be updated at least every 5 years
- HRs shall be retained for the lifetime of the process

Program 3 (19 CCR § 2760.2)

- Need a system to resolve PHA recommendations (and document resolution) on a timetable agreed upon with the AA (max 2.5 years or next turnaround) – *language is more detailed with regards to documentation*
- PHAs shall be updated and revalidated by a team at least every 5 years
- PHAs shall be retained for the lifetime of the process

OTHER HR/PHA REQUIREMENTS - DIFFERENCES

Program 2 (19 CCR § 2755.2)

- HR shall be performed by a team familiar with the process; team must include one employee with experience and knowledge of the process
- For process designed to meet industry standards or federal/state design rules, the HR shall, by inspecting all equipment, determine whether the process is designed, fabricated, and operated in accordance with the applicable standards or rules
- HR may be revalidated once between full HRs (redo – reval – redo)

Program 3 (19 CCR § 2760.2)

- PHA shall be performed by a team with expertise in engineering and process operations; team must include one employee with process knowledge and one employee with knowledge of the methodology employed

PROGRAM 4 CHANGES

- 2762.2(a) – completion of PHAs for processes not previously covered shall be completed 3 years from P4 start date (by 10/2020)
- 2762.2(b)(7) – mentions other PHA methods recognized by engineering organizations or governmental agencies
- 2762.2(c)(2) – clarified language regarding the consideration of publicly documented incidents in the petroleum refining and petrochemical industry
- 2762.2(c)(3)-(4) – review of P4-specific requirements as part of the PHA: DMR, HCA

PROGRAM 4 CHANGES

- 2762.2(d) – clarified language regarding PHA team composition
  - Inclusion of at least one "operating employee" currently working the unit or is providing training at the unit
- 2762.2(e) & (f) – must conduct SPA and HCA for each PHA scenario with a potential for a major incident
- 2762.2(i) – PHA recommendations must follow the P4 corrective action work process described in 2762.16(d) and (e)
  - Specified timeline for providing findings and recommendations to the o/o (14 days after completion)
  - Otherwise, similar documentation process with additional clarifications

PHA METHODOLOGIES - 19 CCR § 2760.2(B)

Qualitative

- What-If
- Checklist
- What-If/Checklist
- Hazard and Operability (HAZOP) Study

Quantitative

- Fault Tree Analysis (FTA)
- Failure Mode and Effects Analysis (FMEA)

Or an "appropriate equivalent methodology"

2755.2(c) identifies checklists approved by UPAs as acceptable for HRs

WHAT-IF

Area: **Drawing Number:**			**Meeting Date:** **Team Members:**	
What If	Hazard	Consequence	Safeguards	Recommendations

WHAT-IF

Pros

- Simple - good for smaller processes, can be adapted for larger processes
- Flexible – can be used at any process life cycle stage with available information

Cons

- Heavily dependent on the experience of the team (especially for initial PHAs)
- Not an inherently structured technique

CHECKLIST

	Aqueous Ammonia	Yes No NA	Comments
1.	Are storage tank(s) painted white or other light reflecting colors and maintained in good order?		
2.	Is storage area free of readily ignitable materials?		
3.	Are storage tank(s) kept away from wells or other sources of potable water supply?		
4.	Are storage tank(s) located with ample working space all around?		
5.	Are storage tank(s) properly vented and away from areas where operators are likely to be?		
6.	Does receiving system include a vapor return?		
7.	Is storage capacity adequate to receive full volume of delivery vehicle?		
8.	Are storage tank(s) secured against overturn by wind, earthquake and/or flotation?		
9.	Are tank bottom(s) protected from external corrosion?		
10.	Is aqua ammonia system protected from possible damage from moving vehicles?		
11.	Are storage tank(s) labeled as to content?		
12.	Are all appurtenances suitable for aqua ammonia service?		
13.	Are all storage tank(s) fitted with liquid level gauges?		
14.	Are liquid level gauge(s) adequately protected from		

CHECKLIST

Pros

- Another simple, easy-to-use approach
- Compliance-focused

Cons

- Development of checklists requires experienced personnel
- Already-made checklists may not cater entirely to the process being reviewed; usually applied with other techniques

WHAT-IF/CHECKLIST

Pros

- Complimentary methods covers some gaps
  - Structured AND Flexible

Cons

- Potentially variable analyses based on team composition/experience

HAZOP

Unit: 4 Gas
Node: (1) INLET LINE
Parameter: Flow
Date: 1/12/14

GW	DEVIATION	CAUSES	CONSEQUENCES	SAFEGUARDS	S	L	R	RECOMMENDATIONS
No	No Flow (initial startup)	1. Valve V1 fails closed mechanically	1.1 Pump deadheaded with leak, possible fire and operator injury	1.1.1. PM program for valves 1.1.2 Fire suppression system 1.1.3 Operators wear fire retardent clothing	3	3	7	1.1.1 Consider providing pressure detection in the inlet line to detect the possibility of deadheading the pump

RISK RANKING

			LIKELIHOOD				
			A	B	C	D	E
			Practically Impossible	Not likely to occur	Could occur or I've heard of it before	It is known to occur or "it has before"	Common or occurs frequently
CONSEQUENCES	1	First Aid Injury	Low	Low	Medium	Medium	High
	2	Medical treatment injury	Low	Medium	Medium	High	Extreme
	3	Lost Time Injury less than 7 days	Medium	Medium	High	Extreme	Extreme
	4	LTI > 7 days PTD or fatality	Medium	High	Extreme	Extreme	Extreme
	5	Multiple PTD or fatalities	High	High	Extreme	Extreme	Extreme

	Low – Monitor and manage
	Medium – Monitor and maintain strict measures
	High – Review and introduce additional controls to lower the level of risk
	Extreme – Do not proceed – Immediately introduce further control measures to lower the risk. Re assess before proceeding

HAZOP

Pros

- Inherently structured methodology
  - Process division by nodes
  - Guideword-Parameter basis
- Variable guideword usage
  - Seven guide-word approach most common

Cons

- More time intensive than previous methodologies

QUICK NOTES ON DATA

- Data only includes active CalARP facilities in CCC
- Time range from 2000-2018
- M&As have resulted in several facilities changing their names, all facilities names are the most current and searchable on CERS
- The data has been "cherry-picked" and the numbers don't matter!

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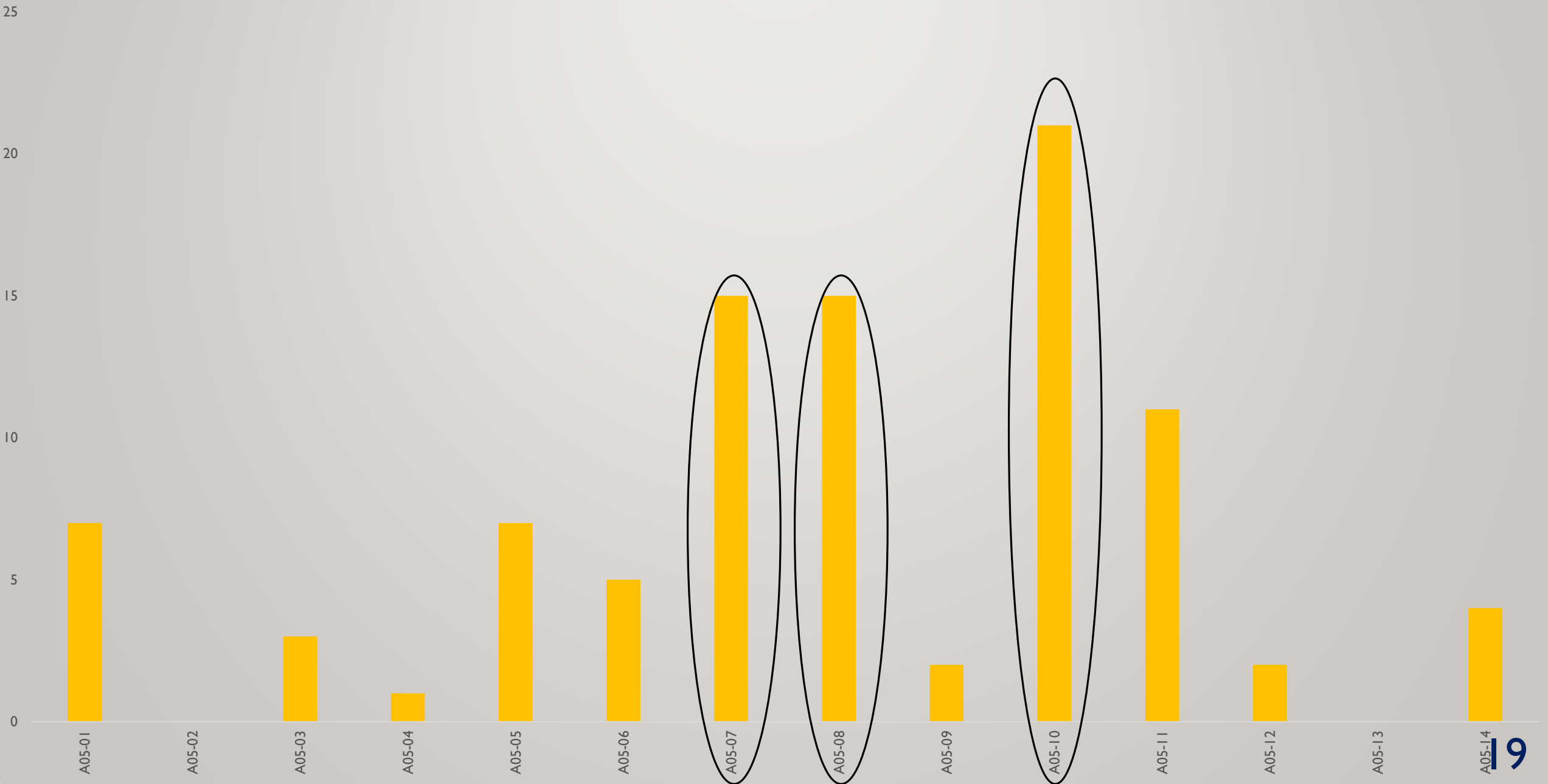
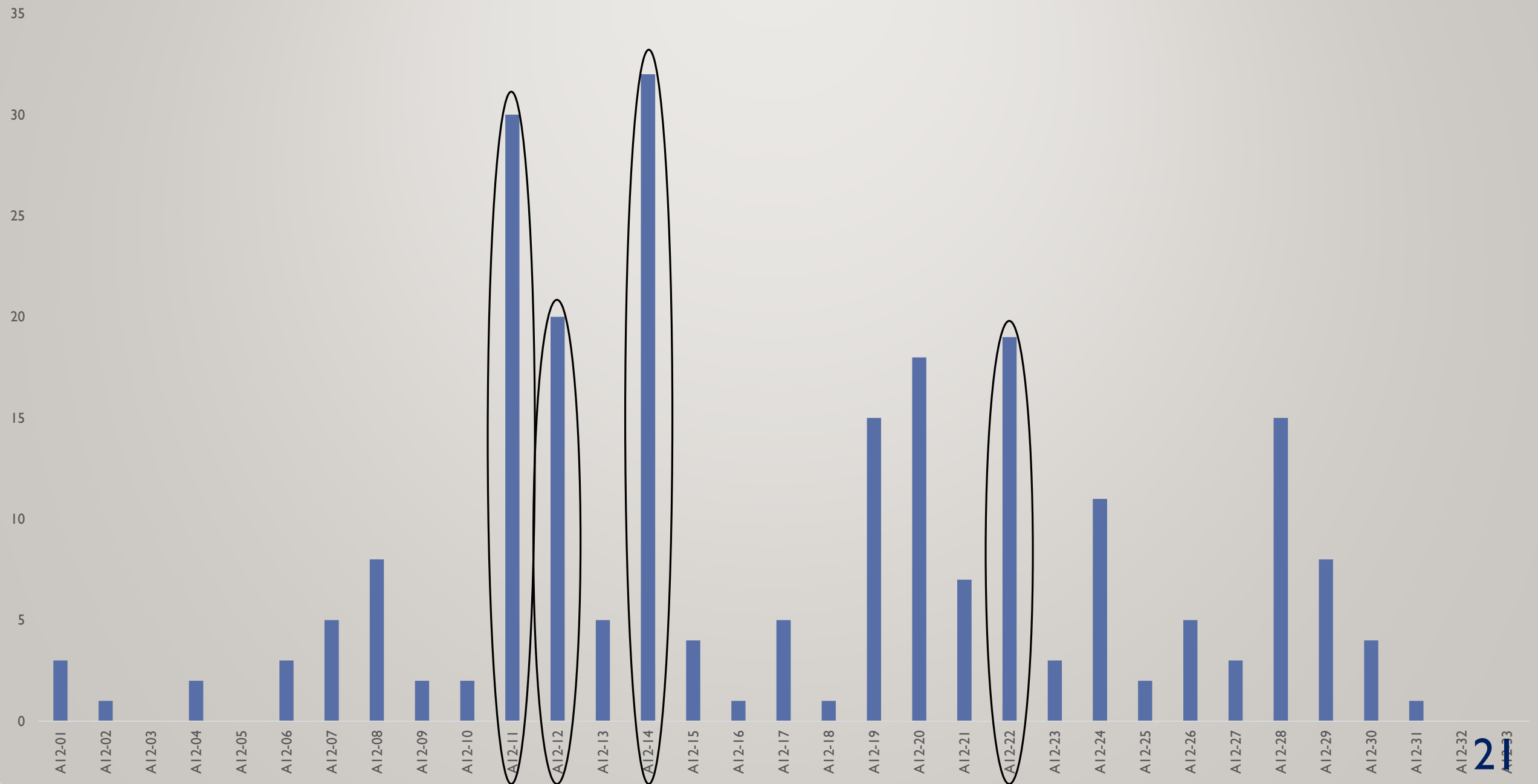
Program 2 Requirements



PROGRAM 2 – COMMON ISSUES

- A05-10 – Resolving HR action items **in a timely manner** (and **documenting the results**)
- A05-07 – **Inspecting equipment** to ensure the process is designed to industry standards, federal or state design rules
- A05-08 – Hazard review considers external events, including a **seismic review**

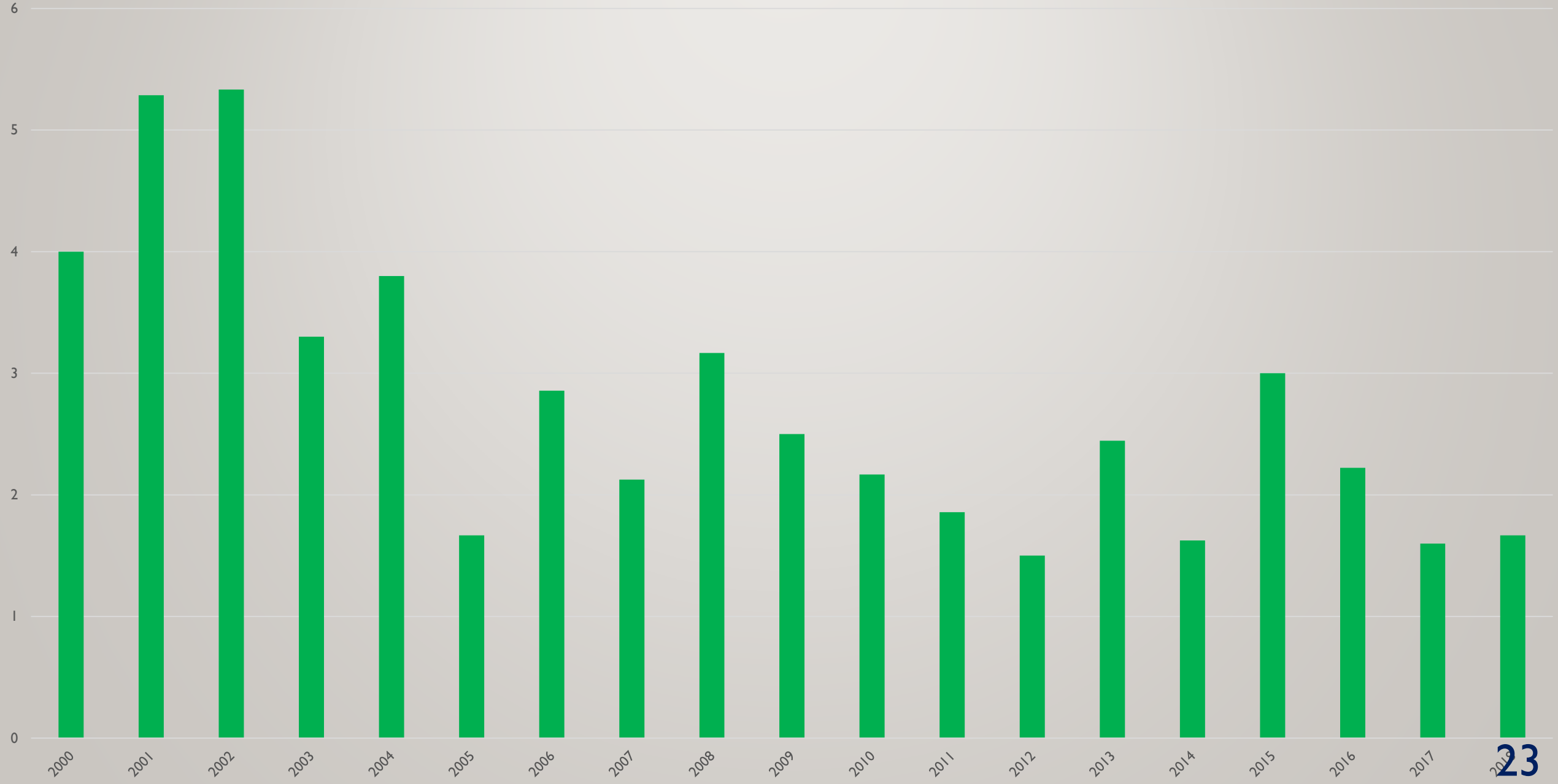
Program 3 Requirements



PROGRAM 3 – COMMON ISSUES

- A12-14 – PHA addresses applicable external events, **including seismic events**
- A12-11 – PHA addresses covered process and stationary source **siting**
- A12-12 – PHA addresses **human factors**
- A12-22 – **Communication** of PHA recommendations to affected employees

Ensure Count - All Facilities, Normalized



Horizontal Auditing with PHAs

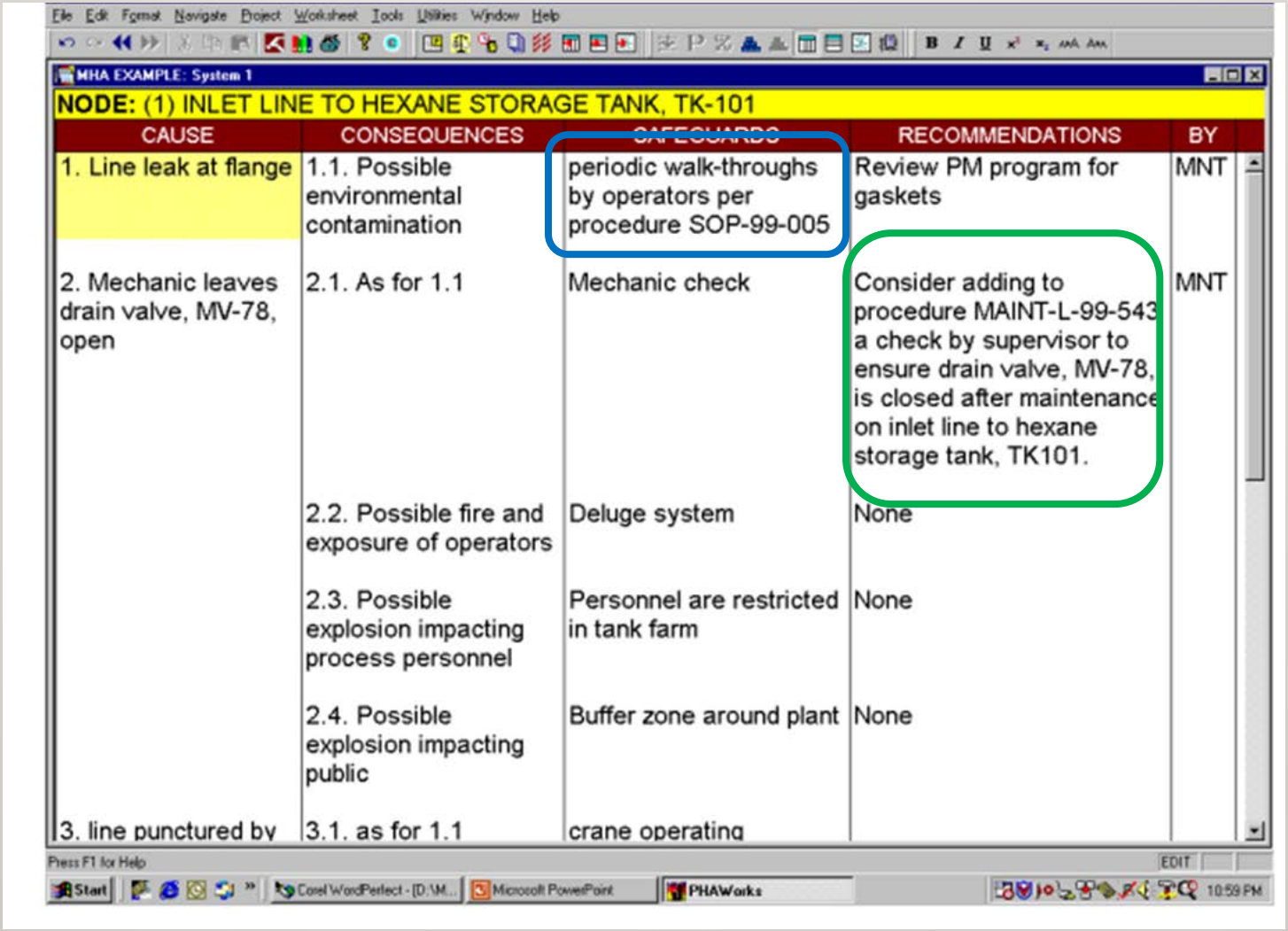
PHA IMPACT ON OTHER TOPICS

- Mechanical Integrity
  - Are the identified safeguards adequately maintained per relevant codes/standards/OEM recommendations?
- Management of Change/Pre-Startup Safety Review
  - Are all relevant changes recorded in the PHA?
- Incident Investigations
  - Are all relevant incidents considered in the PHA, including industry incidents?
  - Does the PHA discuss any near-misses?
  - Was the PHA updated for new incidents?

THERE IS MORE TO PHAS? YES!

- CCHSHMP APPROACH
- Digging for relevant information – PHA as an auditing focal point
  - Operating procedures identified as safeguards
  - Relief and other safety devices- maintenance records review
  - Sections of the process with multiple MOCs – potential for P&ID walkdown

WHAT TO REVIEW



MHA EXAMPLE: System 1

NODE: (1) INLET LINE TO HEXANE STORAGE TANK, TK-101

CAUSE	CONSEQUENCES	SAFEGUARDS	RECOMMENDATIONS	BY
1. Line leak at flange	1.1. Possible environmental contamination	periodic walk-throughs by operators per procedure SOP-99-005	Review PM program for gaskets	MNT
2. Mechanic leaves drain valve, MV-78, open	2.1. As for 1.1	Mechanic check	Consider adding to procedure MAINT-L-99-543 a check by supervisor to ensure drain valve, MV-78, is closed after maintenance on inlet line to hexane storage tank, TK101.	MNT
	2.2. Possible fire and exposure of operators	Deluge system	None	
	2.3. Possible explosion impacting process personnel	Personnel are restricted in tank farm	None	
	2.4. Possible explosion impacting public	Buffer zone around plant	None	
3. line punctured by	3.1. as for 1.1	crane operating		

WHAT TO REVIEW CONTINUED

Node 1. (HP Gas) Production header through high-pressure separator (V-101) to gas export pipeline **Design conditions/parameters: MAWP = 1200 psig @ 300°F**						
Causes	Consequences	S	E	A	Safeguards	
1. Failure of control loop LIC – 101A such that valve is open too much.	1. Potential for gas blowby into the low-pressure separator V-102. Potential for overpressure of low-pressure separator. Potential for loss of mechanical integrity. Potential for rupture of vessel or associated piping. Potential release of flammable materials. Potential fire or explosion.	5	3	4	1. Relief valve PSV-102, which is sized for gas blowby. 2. Low-level shutdown LT-101B closes low-pressure separator inlet SDV-102A. 3. Operator response to low-level alarm LT-102A, not independent from control loop-failure. 4. High-pressure shutdown PT-102B closes SDV-102A. No credit taken for this IPL due to shared final element with LT 101B low-level shutdown.	
2. Invert and opening of bypass around control LV-101A	1. Potential for gas blowby into the low-pressure separator V-102. Potential for overpressure of low-pressure separator. Potential for loss of mechanical integrity. Potential for rupture of vessel or associated piping. Potential for release of flammable materials. Potential fire or explosion.	5	3	4	1. Relief valve PSV-102, which is sized for gas blowby. 2. Low-level shutdown LT-101B closes low-pressure separator inlet SDV-102A. 3. Operator response to low-level alarm LT-101A 4. High-pressure shutdown PT-102B closes SDV-102A. No credit taken for this IPL due to shared final element	

PHA REVALIDATIONS

- A good revalidation will have a listing of MOCs
- PHA nodes that have multiple MOCs = Good P&ID Walkdown Candidates
- Incident Reviews in PHAs = Potential Incidents to follow up on (PHA age dependent)

THERE IS MORE TO PHAS? YES!

- CCHSHMP APPROACH
- Digging for relevant information – PHA as an auditing focal point
  - Operating procedures identified as safeguards
  - Relief devices- maintenance records review
  - Sections of the process with multiple MOCs – potential for P&ID walkdown
  - Identifying potential Safeguard Protection Analysis candidates through risk-ranked scenarios

TERMS

Safeguard

Initiating Cause

Independent Protection Layer (IPL)

Safety Instrumented System (SIS)

SAFEGUARDS VS. IPL

- All IPLs are safeguards, but not all safeguards are IPLs
- Independence is a key distinction
- LOPA deals with IPLs not safeguards

SAFEGUARDS VS. IPL

- Emergency Response Program
- Training
- Procedures
- Operator Intervention
- Safety Devices (non independent)
- Safety Devices (independent)
- Safety Instrumented Systems
- Interlocks
- Operator Intervention

3 ENOUGH'S FOR IPLS

- ☑ Big enough?
- ☑ Fast Enough?
- ☑ Strong Enough?

GROUP ACTIVITY

SAFEGUARDS

Unit: 4 Gas
Node: (1) INLET LINE
Parameter: Flow
Date: 1/12/14

GW	DEVIATION	CAUSES	CONSEQUENCES	SAFEGUARDS	S	L	R	RECOMMENDATIONS
No	No Flow (initial startup)	1. Valve V1 fails closed mechanically	1.1 Pump deadheaded with leak, possible fire and operator injury	1.1.1. PM program for valves 1.1.2 Fire suppression system 1.1.3 Operators wear fire retardent clothing	3	3	7	1.1.1 Consider providing pressure detection in the inlet line to detect the possibility of deadheading the pump
No	More Flow (normal operation)	2. Blind in inlet line fails mechanically	2.1 Leak into charging area with possible fire and operator injury	2.1.1. Fire suppression system 2.1.2 Operators wear fire retardent clothing	3	4	8	None needed
No	More Flow (normal shutdown)	3. Same as 2						

Cause	Consequence	Risk Ranking	Safeguards
Failure of FIC-201, such that the valve goes to the closed position and the quench flow is stopped.	Higher bed inlet temperatures Thermal runaway reaction resulting in reactor and outlet temperatures in excess of MAWT. Loss of containment of process material. Potential Fire. Potential Fatality.	5	Operator intervention based on high outlet temperature alarms (TAH-204,205, 206, and 207) Operator intervention based on low quench flow alarm FAH-201 SIS ABC-123 stops inlet flow upon high temperature detection

Company: XYZ Session Date: 9/10/11 Node 5: Tank Drawing: D1234-5				
Deviation	Causes	Consequences	RR	Safeguards
No Flow	Valve inadvertently closed	Potential release of toxic vapor to atmosphere resulting in potential personnel exposure/impact	4	Procedure SOP-37, step 4.3 states to verify valve is open
Low Level	Low level in the Chemical Storage Tank, possible LI malfunction	Potential Loss of Suction to forwarding pump, pump cavitation, possible loss of containment, personnel exposure	3	1. Operator rounds include monitoring of the tank level, once per shift.

No.: 2 XXXX storage spheres xxx-T-XX A/B/C/D/E/F/G/H/I/J/K/L (1 of 12)							
#	Dev	Causes	Consequences	S	E	A	Safeguards
2.1	High Level	Too much flow to one sphere from XX Plant (through their pump; about 40 bar MDH)	High Pressure (see 2.5)				High level SIF with level sensors voted 2oo2, to close inlet valve Overflow thru pressure equalization line to other spheres (through normally open [NO] valve)
		Misdirected flow – Liquid from xxx Plant(s) to spheres (see 1.4)	Overpressure of sphere not credible from high level, for normal operating pressure of the column (which is 1.75 MPa), unless all spheres are liquid filled and then thermal expansion of the liquid could overpressure the spheres				High Level SIF with level sensors voted 2oo2, to close inlet valve Overflow thru pressure equalization line to other spheres (through normally open [NO] valve) Spheres rated for 1.95 MPa (19.5 bar, approx.) and the highest pressure possible from the column feeding the spheres is 1.75 MPa Level indication and high-level alarm in DCS, used by operators to manually select which tank to fill
			Overflow into the equalization line will interfere with withdrawal from the column, but this is an operational upset only				
			Excessive pressure on inlet of high-pressure liquid pumps, leading to excess load on pumps and trip of pumps on high pumps, causing trips of xxx, xxx, etc – significant operability issue				
2.2	Low Level	Failing to switch from the sphere with low level in time (based on level indication)	Low/no flow – Liquid from spheres through high pressure product pumps to the vaporizer (see 4.2)				Level indication and low-level alarm, inspected yearly, per regulation Feeding from two spheres always, so unlikely for BOTH spheres to have low-level at the same time Two level indication SIS level transmitter, with low level alarm, with more than 60 min available to switch tanks (SIF driven alarm and response)
			Low/no flow – Unqualified liquid from spheres back to Plant (see 6.2)				

SO YOU HAVE BEEN INVITED TO A PHA


THE ROOM WHERE IT HAPPENS

PHA IMPACT ON OTHER TOPICS

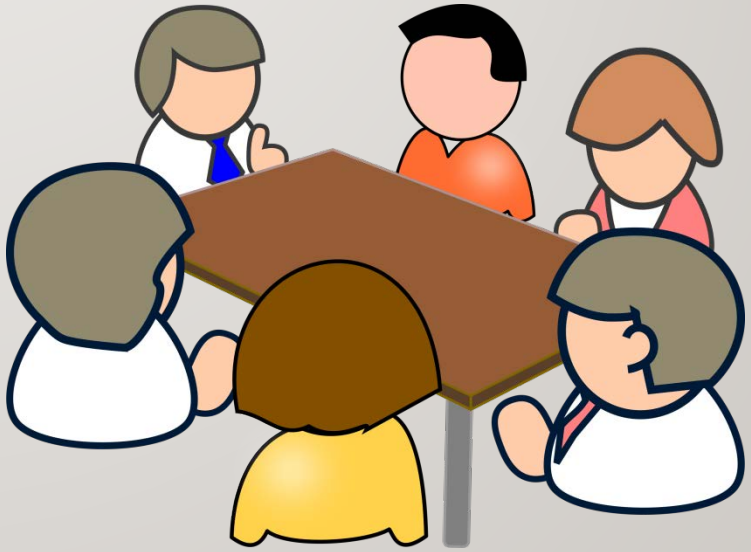
- Employee Participation
  - Take a look at the PHA team composition, does it include the relevant perspectives?
- Identifying key personnel
  - PHA team provides a pool of potential interview candidates

ONCE THE PHA STARTS

- Your role is to be an observer
- This does not mean you cannot speak up

CANT KEEP UP?

FORGET TO WALK?



EXTERNAL CHECKLIST??

Process Hazard Analysis Facility Siting Checklist

Facility: _____ Date: _____

Team Members: _____

Note: For compliance, OSHA expects specific justification for each individual situation/condition.

Item	Question	Answer (Y, N, N/A)	Justification	Recommendations
GENERAL CONSIDERATIONS				
1.	If plant contains flammables above PSM/RMP/CalARP TQ, are they located outdoors to reduce risks?			
2.	Is plant exposed to hazards from neighboring plants?			
3.	Are there detection systems and/or alarms in place to assist in warning neighboring plants and the public if a release occurs?			
4.	Does site security prevent access by unauthorized persons while not hindering emergency services (e.g., fire fighters, paramedics)?			
5.	Are there below-ground-level locations (pits, ditches, sumps) where toxic or flammable materials can collect?			
6.	Are emergency shutdown switch locations protected against potential hazards, in easily accessible locations, and provided with knocking guards?			
7.	Can transportation of hazardous materials or impact of spillage be reduced by suitable site location?			
8.	Other general site concerns (specify)?			
BUILDING PROTECTION				
9.	Is ground or paving sloped so that flammables will not accumulate beneath vessels?			
10	Could drainage system cope with both storm water and fire fighting water?			

22 characters (an approximate value).

RISK RANK!!!!

Node 1. (HP Gas) Production header through high-pressure separator (V-101) to gas export pipeline
Drawing: D-254-002 C
Design conditions/parameters: MAWP = 1200 psig @ 300°F
Design ID:
Deviation: 6 Less level

Causes	Consequences	S-S	S-E	S-C	Safeguards	Cause likelihood	Unmitigated risk rankings		
							Safety	Environment	Asset
1. Failure of control loop LIC-101A such that valve is open too much.	1. Potential for gas blowby into the low-pressure separator V-102. Potential for overpressure of low-pressure separator. Potential for loss of mechanical integrity. Potential for rupture of vessel or associated piping. Potential release of flammable materials. Potential fire or explosion.	5	3	4	1. Relief valve PSV-102, which is sized for gas blowby. 2. Low-level shutdown LT-101B closes low-pressure separator inlet SDV-102A. 3. Operator response to low-level alarm LT-102A, not independent from control loop failure. 4. High-pressure shutdown PT-102B closes SDV-102A. No credit taken for this IPL due to shared final element with LT-101B low-level shutdown.	3	5	3	4
2. Invert and opening of bypass around control LV-101A	1. Potential for gas blowby into the low-pressure separator V-102. Potential for overpressure of low-pressure separator. Potential for loss of mechanical integrity. Potential for rupture of vessel or associated piping. Potential for release of flammable materials. Potential fire or explosion.	5	3	4	1. Relief valve PSV-102, which is sized for gas blowby. 2. Low-level shutdown LT-101B closes low-pressure separator inlet SD-102A. 3. Operator response to low-level alarm LT-101A. 4. High-pressure shutdown PT-102B closes SDV-102A. No credit taken for this IPL due to shared final element.	2	4	2	3

DISCUSSION TIME

- Nicole.Heath@cchealth.org
- Kevin.Ong@cchealth.org
- https://cchealth.org/hazmat/calarp/guidance-document.php

APPENDICES

- Program 2 Questionnaire Mapping
- Program 3 Questionnaire Mapping
- Major Incident Flowchart (Draft)

QUESTIONNAIRE MAPPING – PROGRAM 2

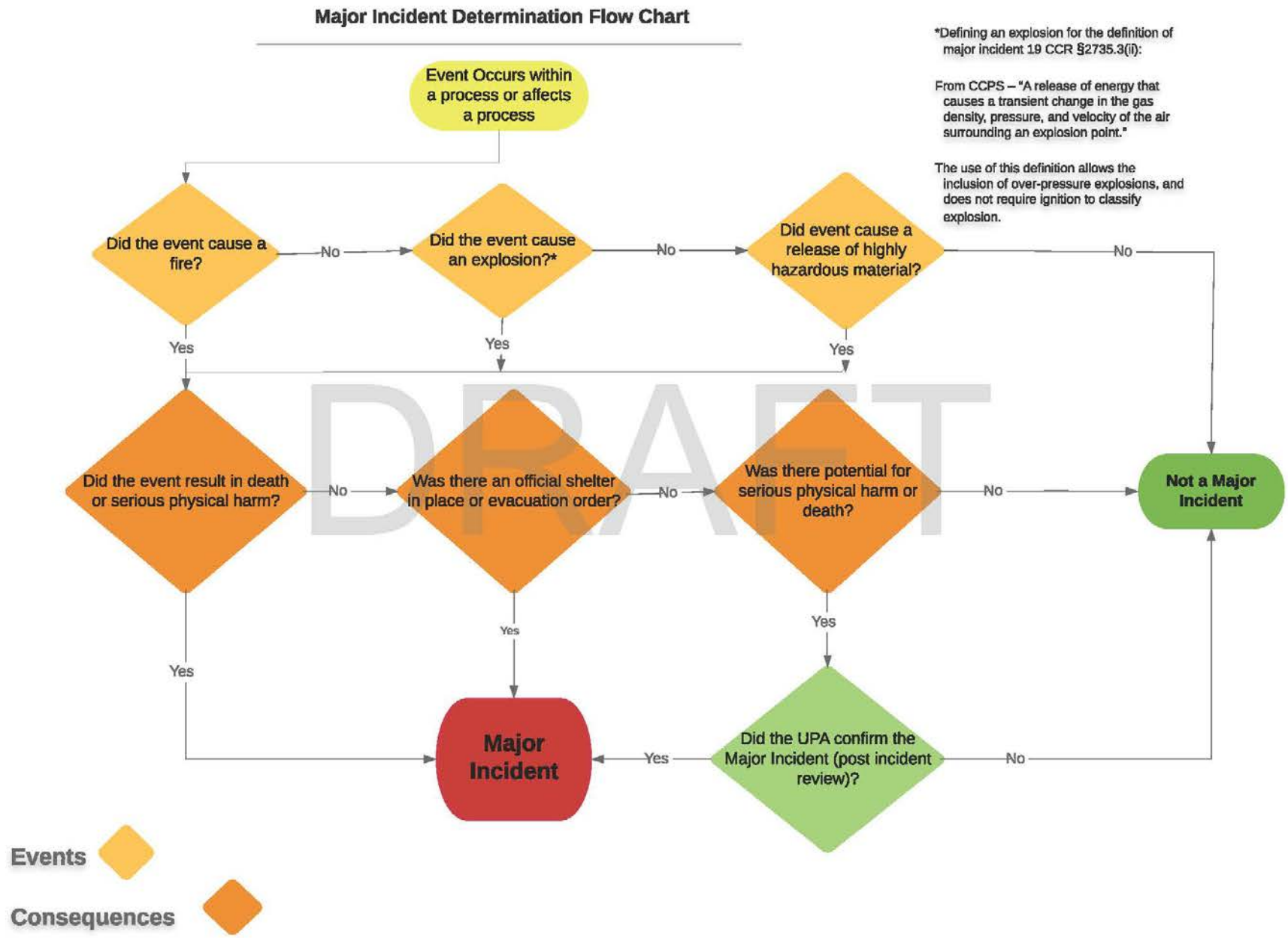
- A05-01: conduct a hazard review [2755.2(a)]
- A05-02: HR identifies process hazards [2755.2(a)(1)]
- A05-03: HR identifies equipment malfunctions or human errors with accidental release potential [2755.2(a)(2)]
- A05-04: HR identifies process safeguards [2755.2(a)(3)]
- A05-05: HR identifies release detection/monitoring systems [2755.2(a)(4)]
- A05-06: Stationary source consults with UPA on appropriate HR methodology [2755.2(b)]
- A05-07: HR included inspection of process equipment to ensure it meets applicable design rules; HR was performed by a team familiar with process operation and at least one employee with experience and knowledge specific to process being reviewed [2755.2(c)]
- A05-08: HR includes consideration of external events (including seismic) [2755.2(d)]
- A05-09: Stationary source documented HR [2755.2(e)]
- A05-10: Items identified by HR were resolved and documented within 2.5 years or by timeline OK'd by UPA [2755.2(e) and 2755.2(h)]
- A05-11: HR updated at least every 5 years and only revalidated once between full HRs; HRs retained for life of process [2755.2(f), (g), and (h)]
- A05-12: Stationary source conducts reviews when a major change in the process is made [2755.2(f)]
- A05-13: Issues identified by major change HR were resolved prior to startup [2755.2(f)]
- A05-14: RMP accurately reflects the program onsite [2745.2(d)]
- A05-15: Action items from previous audit were addressed

QUESTIONNAIRE MAPPING – PROGRAM 3 (CALARP ONLY)

- A12-01: Initial PHA performed by RMP submittal date [2760.2(a)]
- A12-04: SS worked with UPA to decide on appropriate PHA methodology [2760.2(b)]
- A12-05: SS used a listed methodology [2760.2(b)]
- A12-06: SS used a PHA methodology appropriate to the complexity of the process [2760.2(a)]
- A12-07: PHA addressed process hazards [2762.2(c)(1)]
- A12-08: PHA addressed previous incidents with potential for catastrophic consequences [2760.2(c)(2)]
- A12-09: PHA addresses engineering and administrative controls, detection methodologies [2760.2(c)(3)]
- A12-10: PHA addresses failure of engineering and administrative controls [2760.2(c)(4)]
- A12-11: PHA covers stationary source (facility) siting [2760.2(c)(5)]
- A12-12: PHA addresses human factors [2760.2(c)(6)]
- A12-13: PHA includes a qualitative evaluation of potential safety and health effects from failure of controls [2760.2(c)(7)]
- A12-14: PHA includes consideration of external events (including seismic) [2760.2(c)(8)]
- A12-15: PHA complies with PSM requirements [2760.2(a)]
- A12-16: PHA team includes one employee with process-specific experience and knowledge [2760.2(d)]
- A12-17: PHA team includes expertise in engineering and process operations [2760.2(d)]
- A12-18: PHA team includes one member with knowledge of PHA methodology used [2760.2(d)]
- A12-19: SS establishes a system to assure PHA findings and recommendations are addressed and documented to be resolved [2760.2(e)]
- A12-20: SS established a system to document and track PHA recommendations to be completed within 2.5 years of performing PHA or by next turnaround
- A12-21: SS developed PHA action item completion timeline agreed upon with UPA [2760.2(e)]
- A12-22: SS established a system to communicate PHA action items to affected employees [2760.2(e)]
- A12-25: SS considered the use of inherently safer systems (ISS) in the review of new processes/facilities, existing processes, or in developing recommendations/mitigations for PHAs [Section D.1 of CCC Safety Program Guidance Document]
- A12-26: PHA updated/revalidated at least every 5 years [2760.2(f)]
- A12-27: SS retains PHAs for lifetime of the process [2760.2(g)]
- A12-28: SS retains documented resolution of PHA action items for the life of the process [2760.2(g)]
- A12-29: RMP accurately reflects onsite PHA program [2745.2(d)]
- A12-30: Action items from previous audit were addressed

THINGS TO LOOK FOR WHEN ATTENDING A PHA

- No Risk Ranking
- PHA Facilitator going too fast
- Walk downs are not performed
- Walkdowns are performed after the PHA starts or at the end of the PHA
- External events checklist not completed
- Siting checklist not completed
- Operator not on team
- Other knowledgeable personnel absent


Major Incident Determination Flow Chart
*Defining an explosion for the definition of major incident 19 CCR §2735.3(ii):
From CCPS – "A release of energy that causes a transient change in the gas density, pressure, and velocity of the air surrounding an explosion point."
The use of this definition allows the inclusion of over-pressure explosions, and does not require ignition to classify explosion.
Event Occurs within a process or affects a process
Did the event cause a fire?
No
Did the event cause an explosion?*
No
Did event cause a release of highly hazardous material?
No
Yes
Yes
Yes
Did the event result in death or serious physical harm?
No
Was there an official shelter in place or evacuation order?
No
Was there potential for serious physical harm or death?
No
Not a Major Incident
Yes
Yes
Yes
Major Incident
Yes
Did the UPA confirm the Major Incident (post incident review)?
No
Events
Consequences
DRAFT