NOVA Chemicals - Process Safety Metrics
CCPS Canadian Regional Meeting
September 26th 2017

NOVA Chemicals

Fred Henselwood

Overview

The path we are on

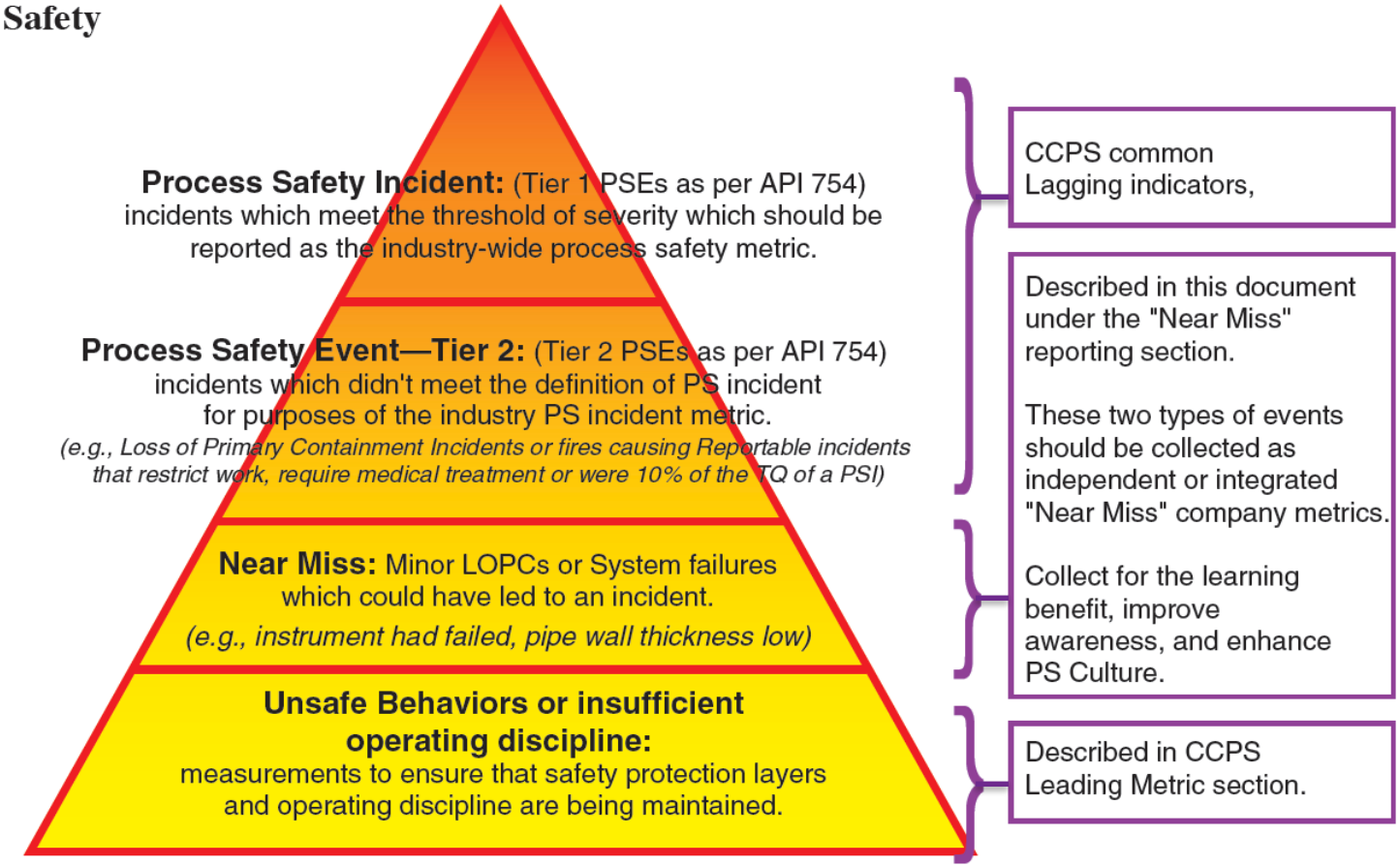
- Share the philosophy behind our Process Safety Metrics
  - What is it we are trying to do
  - What is it we are looking at

- First, Focus on Lagging Metrics
- Second, Focus on Leading Metrics

Center for Chemical Process Safety / API 754

External Requirements (CIAC/ACC) – Graphic taken from CCPS Publication

Figure 1: Process Safety Metric Pyramid



https://www.aiche.org/sites/default/files/docs/pages/CCPS_ProcessSafety_Lagging_2011_2-24.pdf

2016 Tier 1 and Tier 2 Process Safety Incidents

PSTIR is sort of like a Reportable Injury Rate, but for Process Safety

- Tier 1
  - 04/29/2016 - 350527 - MW, Significant Hydrocarbon Release (>500 kg)
  - 08/20/1016 - 374155 - MW, Process Fire with Damage greater than $25,000
- Tier 2
  - 07/12/2016 - 363481 - Corunna, Condensate Burn (release with injury)
  - 06/13/2016 - 358285 - MW, Process Fire with Damage (<$25,000)
  - 11/23/2016 - 386560 - SCRS, Catalyst release (>Tier 2 value 2.5 kg)

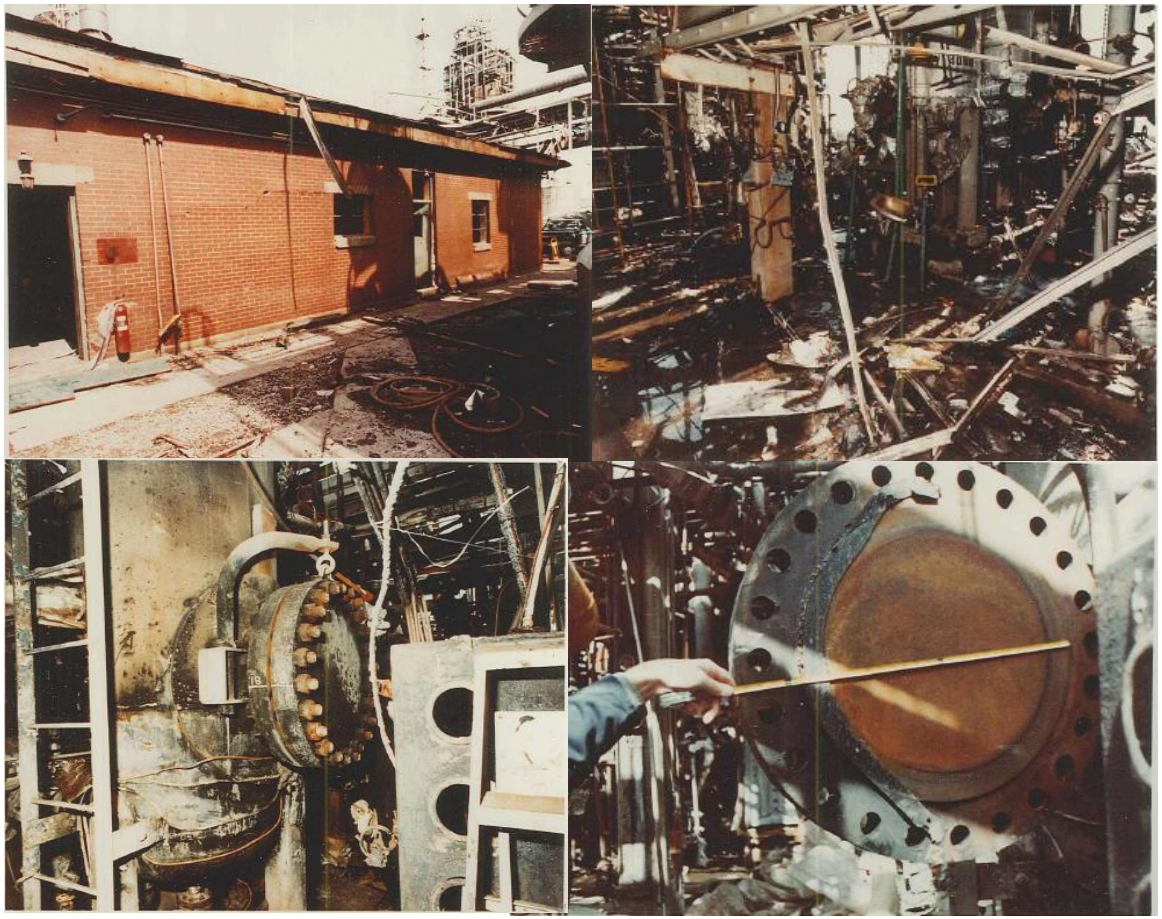
- Tier 1, PSTIR – 0.039 per 200,000 exposure hours (Canada + US)
  - Measure is unstable statistically (too few events being measured)

For NOVA Chemicals – our Worst Case Scenario…

Generally our Worst Case event involve Fire and Explosion

Litol Unit / Styrene 1
Sarnia, Ontario
April 20th 1984

Two Fatalities following a Hydrogen release and explosion



Lagging Metrics

If our goal is to eliminate all catastrophic events, then:

Hydrocarbons + Ignition => Worst Case Scenario

- Work to remove all unanticipated Ignition Sources from our Process Hazard areas
  - This is the focus of our Process Fire metric
- We must always maintain Process Containment
  - This is the focus of our Loss of Containment - Flammable metric

- If either of these events are driven to zero, then the possibility of a catastrophic event must also goes to zero

Process Fires

Goes beyond what most people think of when they think of “Fires”

- For us, a Fire is an event capable of igniting hydrocarbon vapours
  - *An unintended oxidation that produces flame, glowing embers, or sparks and/or evidence that this has occurred* (i.e. a “Fire”)
    - Pyrophoric materials and/or other reactive chemicals
    - Sparking
    - Electrical Shorting
    - Furnace going Positive
    - Hot Work without a Permit
    - Unauthorized Vehicles

- The Process Fire definition does exclude contact with heat sources which may cause melting/discolouration/charring (but not propagation)

Process Fire Classification Considerations

Using the Definitions to Drive Behaviours

- Was the incident in a Process Hazard Area?
  - i.e. could hydrocarbon vapours get to this location?
  - Drive to add Safeguards to limit the extent of Process Hazard Areas (gas detection and shut-off on building air systems, electrical enclosures…)
  - Looking for 2+ barriers (Normal process containment, plus at least 1 more)
- How much Process Materials could possibly have been involved?
  - Drive to limit inventories for things like lab work… lower risk (inventory that could have participated is less than 1% of tier 2 reporting value)
- Were there damages and/or injuries?
  - Aligns us with CCPS/API reporting expectations

(Industry definition includes loss of containment, we would elevate severity for this)

Controlled versus Uncontrolled Process Fires

No Fire is a good thing (but let's explained Controlled)

- The Controlled category is to recognize the behaviours we want to see
  - The fire potential was anticipated – i.e. it was known that it could happen
  - This fire potential was documented – i.e. the risk was documented
  - Controls were in place – i.e. a plan was acted on before the fire occurred
  - The fire controls were effective – i.e. the fire was managed
  - There were no damages or injuries – i.e. the event was controlled
- The first things we look at are the permits and procedures

- The people involved:
  - Thought a fire might occur, documented this potential, put plans in place to manage this risk, these plans proved to be effective, no damages or injuries occurred

Process Fire Performance

As of September 1st

- Uncontrolled:
  - 07/23/2017 - 432229 - Corunna, Fire on EA2301E Methanator Feed
  - 07/08/2017 - 430125 - Corunna, Small fire on BA-2111 - "D" coil failure
  - 04/18/2017 - 413134 - ME, COP2E, Temporary Power Cable Failure
  - 03/30/2017 - 410246 - MW, H-240 Small Fire - QMP
  - 01/09/2017 - 395162 - Corunna, EA212AA Insulation giving off vapour.
- Controlled:
  - 06/06/2017 - 424544 - MW, Flame during red hot work
  - 07/28/2017 - 433665 - MW, Poly bag smoldering during red hot work

- Uncontrolled Process Fires impacts everyone's compensation

Flammable - Loss of Containment F-LOC

Keep in it the pipes

- Reporting thresholds designed and aligned with CCPS and API reporting guidance
  - Corporate targets are based on flammable materials (NFPA 2 or greater) and a release quantity greater than 10% of the external reporting threshold (i.e. 10% of CCPS/API Tier 2 Value)
  - For a material like Ethane, the reporting threshold would be 5 kg (2.5 kg for indoor locations – Tier 2 value is 50 kg))
  - If below the volume threshold, we would still capture the incident as part of our general Loss of Containment metric

Other Loss of Containment Measures

Looking at how do we drive these events to zero

- In addition to reporting F-LOC incidents we also track
  - LOC for incidents that fail to meet the F-LOC thresholds
  - Toxic releases (T-LOC), similar to F-LOC but for toxic materials

- We want to encourage full reporting of all releases no matter how small
  - i.e. a Culture of Reporting and Learning
- We want to implement changes to reduce the number of F-LOC events
  - i.e. a Culture of Driving Continuous Improvements to prevent reoccurrence

Safety System Events

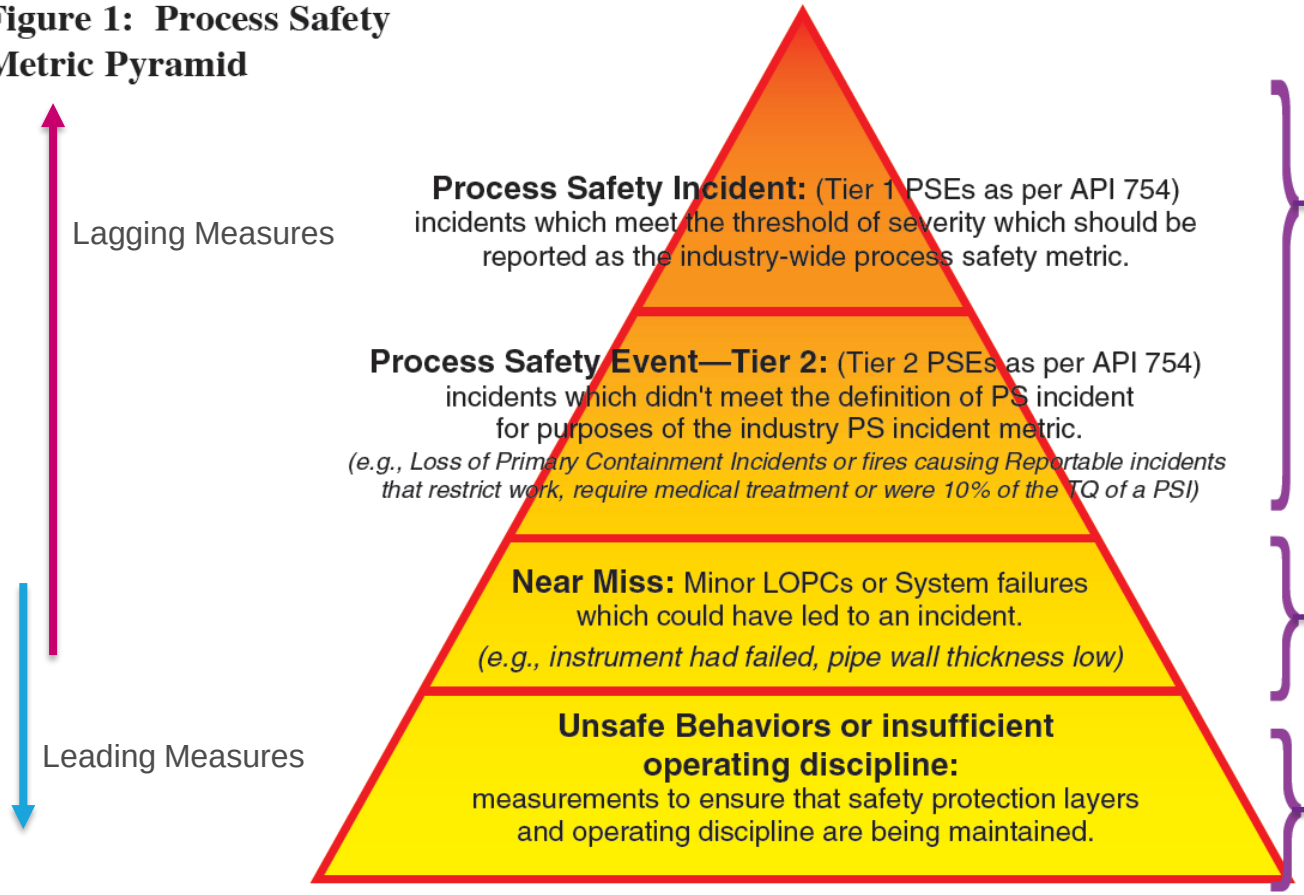
The next area we are focusing significant efforts on

- A few different possibilities
  - Found to be Failed or Impaired
  - Tested and found to be Failed or Impaired
  - Demanded and found to be Failed or Impaired
  - Demanded and Worked as Required
- Starts to blur the line between Leading and Lagging indicators
  - Gives us a sense of our state of readiness (if needed are we ready)
  - Gives us a sense of how safely we operate (are we pushing too hard)
- We have been investigating these events as incidents for many years
  - Looking for consistent application to better support trending

Center for Chemical Process Safety / API 754

External Requirements (CIAC/ACC)

Figure 1: Process Safety Metric Pyramid



Typically too few incidents to assess Performance
Process Fires
Some Flammable Loss of Containment Incidents

Loss of Containment Safety System Events

This is an Area of Improvement and Future work for us

Future: Administrative Control Failures?

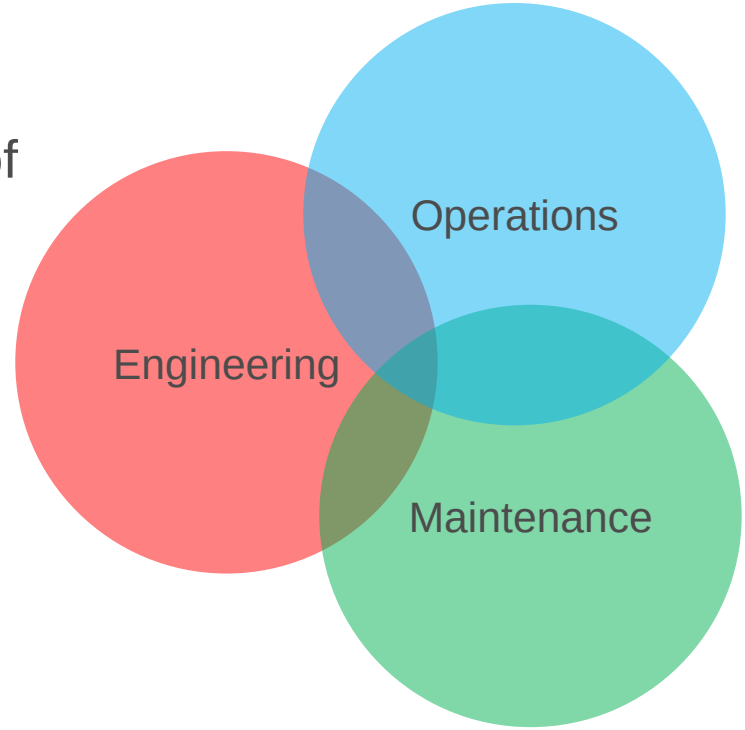
Layers of Protection
Process Safety Programs
Process Safety Projects

https://www.aiche.org/sites/default/files/docs/pages/CCPS_ProcessSafety_Lagging_2011_2-24.pdf

Process Safety at NOVA Chemicals

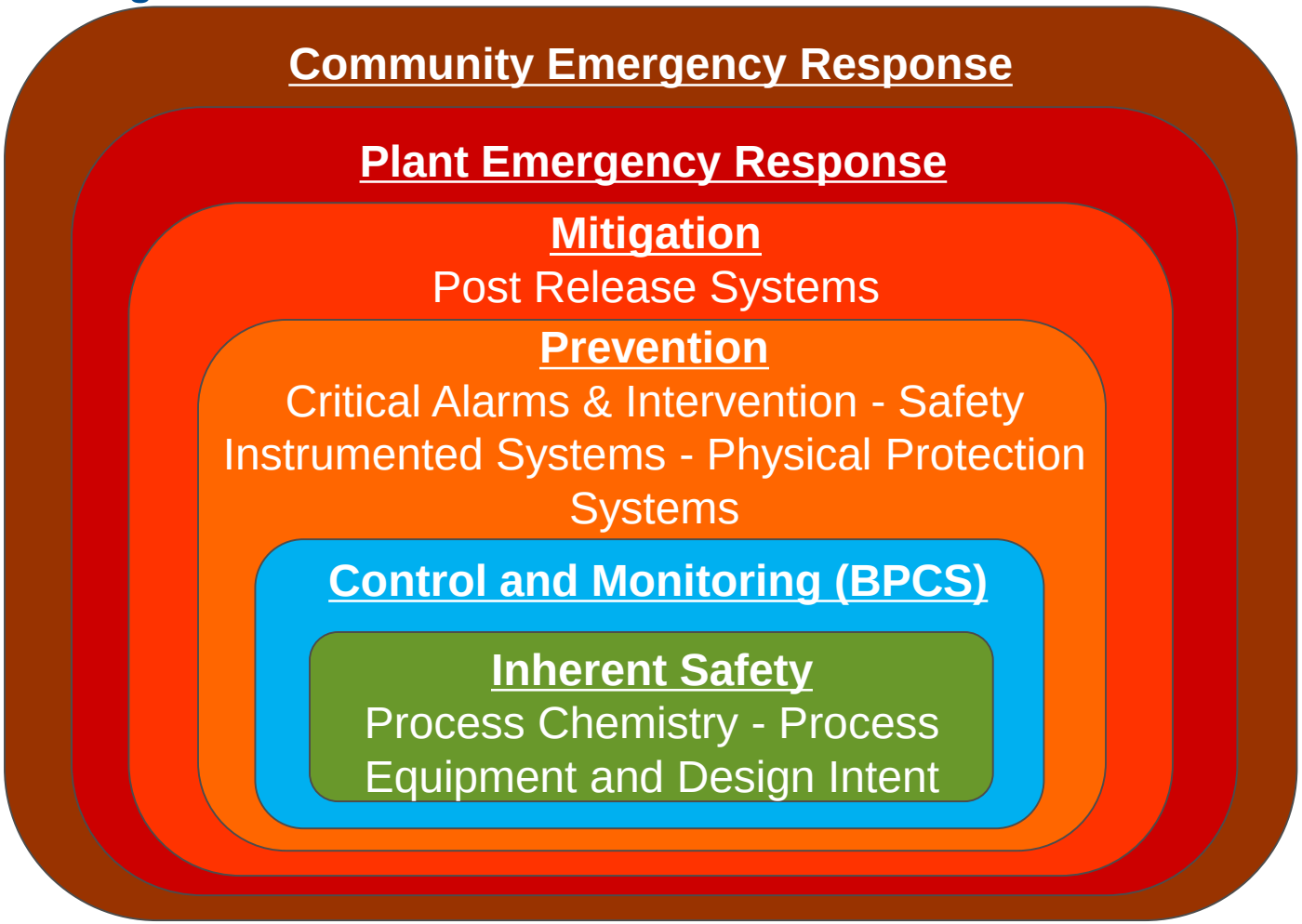
For NOVA Chemicals:

- **Layers of Protection** is the engineering, operating, and maintenance management model being developed for the prevention of Process Safety incidents. This model is based on the concept of multiple lines of defense.



Layers of Protection Model

“Onion Skin Diagram”



Type 1 - Layer of Protection Metrics

How do we monitor the health of each of these Layers of Protection

- We are publishing metrics looking at each of these layers
  - Things like PSV test results
  - Number of Standing Alarms
  - Safety Instrumented System Reviews
- Mix of Leading and Lagging Measures
- Mix of Engineering, Operations, and Maintenance Measures
  - These items tend to be managed and worked outside of Process Safety

- i.e. can we assess the things that create the holes in the Swiss Cheese for each of our Layers of Protection

Type 2 - Process Safety Programs

Are we doing the things we say we should be doing

- These items tend to be managed by Process Safety
  - PHRA Work (5-Year Risk Assessments)
  - Facility Change Management (FCM) Completions
  - Risk Recommendations

- The next challenge will be to continue to evolve these metrics from the current completion based format to a greater focus on effectiveness
  - i.e. it is not just doing the FCM process, but doing the FCM process well

Type 3 - Process Safety Projects

Areas where there is a specific focus for a specific activity

- Often multi-year projects looking at a specific “Program” of work

- Out of Service Equipment
  - Track number of systems identified
  - Track Risk Assessment work completed to determine path forwarded
  - Track isolation and de-inventory
  - Track removal
  - i.e. How do we ensure that this equipment does not pose a risk and that the projects managing these activities are progressing as intended

Challenges

We have a model, a structure, but

- Resources and tools to collect the data
  - Need to balance the value of the information against the effort required to collect the information
- Metrics are usually monitored closest by the group doing the work
  - Most leading Process Safety metrics are from outside of Process Safety
- Consistent reporting definitions
  - Not all areas work in the same way (efforts to harmonize are occurring)
- We now have measures, but we don’t always know what they mean
  - What is a good score, when should we be concerned, when do we take action?

Future

Very much a journey

- Continue to build Layer of Protection Metrics
  - Need to build targets and drive better understanding of the values being reported
- Strive to measure Effectiveness over Compliance/Completion
- Look at Administrative Controls Failures (drive for consistent reporting)
  - Things such as failures of permit processes or procedures
  - Similar to Safety System events (Engineering controls)

- Separate to these metrics, we also measure Process Safety Culture
  - Culture Survey scheduled for 2018 (we do this on a 3 year cycle)

Geismar

Chemical Safety Board Recommendations

- 1 of 3 recommendations made by the Chemical Safety Board required the development of a suite of Process Safety metrics for the Geismar site

  - *CSB Recommendation:*
    - *Develop and Implement Process Safety Metrics*
      - *Both Leading and Lagging measures*

      a) *MOC effectiveness*

      b) *PSSR effectiveness*

      c) *Recommendation (MOC, PHA, Incidents, Audit…) effectiveness*

      d) *Development of Operating Procedures*

NOVA Chemicals®

novachemicals.com

Responsible Care®
Our commitment to sustainability.